# NATIONAL SCIENCE FOUNDATION

## MATCHMAKER PROGRAM

## TECHNOLOGY PROSPECTUS

FY 2004-08

SMALL BUSINESS INNOVATION RESEARCH (SBIR) &

SMALL BUSINESS TECHNOLOGY TRANSFER RESEARCH (STTR) PROGRAM

www.nsf.gov/eng/iip/sbir

I am pleased to offer all potential investors our portfolio companies for your consideration. These small businesses are conducting leading edge research in advanced technology areas including biotechnology, electronics, information technology, advanced materials, manufacturing, and chemical processes. Abstracts of research along with contact information are grouped by technology areas. I sincerely believe you will find in this portfolio, high quality researchers pursuing excellent business opportunities.

We at NSF are offering you a service to match your interest with those small businesses that have expressed interest in seeking investors and strategic partners. This is referred to as MatchMaker. Enrollment requires a simple email. Details regarding enrollment appear in the introduction page. Meanwhile, you are welcome to contact them directly if you wish.

I hope you will take advantage of this opportunity to get to know small businesses supported by NSF with exciting technologies with potential for commercial use.

**Dr. Kesh S. Narayanan**
Director Industrial Innovation & Partnerships
National Science Foundation

# MATCHMAKER PROGRAM PROSPECTUS BOOKLET

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## Introduction

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) Program stimulates technology innovation in the private sector by transforming the federally supported research into commercial application leading to wealth creation and societal benefit. NSF is one of ten federal agencies supporting the SBIR/STTR Program. NSF manages over 400 research grants annually to small business firms with an annual R&D investment of over $100 million each year. These grants are competitively selected for their high-risk technological challenges and high potential for commercial applications. In all, less than 20% of all applicants are selected for research towards commercialization.

The research areas of the SBIR/STTR Program cover a broad range of topics in

- Biotechnology,
- Electronics,
- Information-Based Technology,
- Advanced Materials, Manufacturing and Chemical Processes.

To achieve a robust ROI on federal investment, NSF has launched a new initiative called the MatchMaker Program. The primary intent is to create a win-win opportunity for investors/strategic partners and NSF funded small business firms. It is intended to help potential investors and strategic partners identify these companies whom they wish to invest in or partner with based on the technology being pursued. Typically, NSF has managed research conducted by each small business firm for at least 3 years. Therefore, NSF is in a strong position to identify the small business firms that best match the interest of investors and strategic partners.

This MatchMaker Program Technology Prospectus catalogues over 500 technologies NSF has invested in through the SBIR/STTR Program in fiscal years covering 2004 through 2008. In addition, the name of the company and principal investigator performing the research is included for ease of contact.

The NSF SBIR Program is presenting a unique investment opportunity by introducing you to pre-selected, high technology emerging businesses in our portfolio that have each secured nearly $1 million dollars to develop and advance their early-stage, cutting edge research.

We welcome active participation from Venture Capital Firms, Angel Investors and Strategic Industrial Partners and encourage you to sign up in the MatchMaker Program to take advantage of this unique investment and partnering opportunity.

# MatchMaker Enrollment

To participate, please send us an email at SBIRmatch@nsf.gov with the following information about your organization:

- Organization Name
- Organization Contact Person
- Phone Number, Email and Mailing Address
- Web-Site Address
- Technology Preference
- Regional Preference
- Range of Typical Investment
- Stage of Typical Investment

For additional information, please contact

T. James Rudd, Program Director (Expert), Industrial Innovation and Partnerships at 703-292-4759 or via email tjrudd@nsf.gov

Kesh Narayanan, Director, Industrial Innovation and Partnerships at 703-292-7076 or via email knarayan@nsf.gov.

# Agricultural Biotechnology

Title: SBIR Phase II: Atlantic Cod Nodavirus Vaccine

| | |
|---|---|
| Award Number: | 0724041 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | July 15, 2007 |
| Expires: | June 30, 2009 |
| Total Amount: | $499,393 |

Investigator: Eric Anderson, mainebiotek@hotmail.com
Company: Maine BioTek
259 Main Street
Winterport, ME 04496
Phone: (207)223-4662

Abstract:

This Small Business Innovation Research (SBIR) Phase II project of develops a recombinant vaccine for the prevention of nodavirus disease of cultured Atlantic cod, fisheries of growing importanct to New England and Atlantic Canada. The recombinant technology used to build the vaccine is economical, safe and results in a potent and efficacious product that improves cod health. The research addresses recombinant antigen synthesis, formulation, safety, potency and efficacy. After translational development, manufacturing and regulatory approval, the vaccine will be available to cod producers for the prevention of nodavirus disease.

The broader impacts of this research will be to enable more facile development of the nascent cod aquaculture industry in respect to methods of viral disease control through vaccination. This is in concert with the desire of the nation to increase aquacultural production significantly by 2020 without impacting the ocean environment negatively.

Title: SBIR Phase II: Device for In-ovo Targeting and Delivery to the Early Chicken Embryo

Award Number: 0522040
Program Manager: George B. Vermont

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $494,265

Investigator: Phillip Rybarczyk, prybarczyk@embrex.com
Company: EMBREX, INC.
1040 Swabia Ct
Durham, NC 27703
Phone: (919)941-5185

Abstract:

This Small Business Innovation Research (SBIR) Phase II project integrates the imaging system developed in Phase I with a smart-sensor injection system that can inject or sample from the cavity underlying the early chicken embryo with high levels of accuracy accompanied with improved hatch when compared to manual methods. The Phase I work showed that it was possible to image and detect the blastoderm in the presence of a biological membrane with high levels of accuracy (94%). The Phase II project will focus on the technology required to build an injection system using smart sensors that can detect and then move to the fluid cavity to inject (or to sample). The system will thus provide a totally automated solution to early embryo detection and manipulation, with movement in all three dimensions, while still sustaining hatchability of the developing chicken. This research would advance the state of the art for the production of chimeric chickens with superior traits or for producing transgenic chickens for the avian pharmaceutical industry.

The commercial application of this technology is in two large, important industries. In the commercial poultry industry, chimeric chickens could be created in a high-throughput system that possess desired traits like disease resistance (for example, to diseases such as Marek's, Newcastle and Coccidiosis), increased tolerance to stress, and the ability to digest certain feed compounds such as phosphates. Secondly, in the avian pharmaceutical industry, therapeutic proteins used for manufacturing drugs could be created much more cheaply by using a transgenic chicken that can produce transgenic proteins in its eggs. Many therapeutics for diseases like cancer and leukemia are manufactured in mammalian or bacterial systems that face bottlenecks in supply and are extremely expensive to produce. The proposed device advances the state-of-the-art in early embryo injection beyond the limits of the manual method so as to allow a faster, more accurate way of producing transgenic chickens and proteins.

Title: SBIR Phase II: Developing Crop Plants with Wide-Spectrum Disease Resistance

Award Number: 0450162
Program Manager: George B. Vermont

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $462,138

Investigator: Karen Century, kcentury@MendelBio.com
Company: Mendel Biotechnology Incorporated
21375 Cabot Boulevard
Hayward, CA 94545
Phone: (510)264-0280

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on developing genetically engineered, broad -spectrum disease resistance in plants. An Aribdopsis transcription factor, TDR1, has been identified that causes resistance to three pathogens when overexpressed in transgenic plants. However, constitutive expression of TDR1 or any of three related genes causes growth retardation. Phase I research demonstrated that using tissue specific or inducible promoters to drive the TDR1 genes confers resistance with reduced side-effects. The research objectives of the Phase II project are to test the limits of TDR technology by assaying a broad range of pathogens, optimize the TDR phenotype by mutagenesis, demonstrate TDR function in a crop plant (tomato), and use microarray analysis to correlate gene expression patterns with specific pathogen resistance spectra in Arabidopsis. The results will establish the commercial utility of TDR technology.

The commercial application of this research will be to engineer wide-spectrum disease resistance in crops such as soybean and maize. Chemically based disease management is expensive, harmful to people and the environment, and not always effective. Breeding has long been used for developing resistant cultivars, but the gene pool is limited by reproductive barriers, the technique is slow, and the resistance is generally narrow in scope and often not durable. There clearly is a market for genetically-engineered, durable disease resistance. The main societal benefit of this project is expected to be a decrease in the use of toxic fungicides, which will positively impact the environment and human health.

Title: SBIR Phase II: Quantitative Detection of Bacterial Pathogens in Seeds by Use of a Novel Enrichment Technique Coupled with Automated Real-Time PCR

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| Award Number: | 0450649 |
| Program Manager: | George B. Vermont |
| Start Date: | May 1, 2005 |
| Expires: | April 30, 2007 |
| Total Amount: | $500,000 |

Investigator: Parm Randhawa, randhawa@calspl.com
Company: California Seed and Plant Lab., Inc.
7877 Pleasant Grove Road
Elverta, CA 95626
Phone: (916)655-1581

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a highly sensitive PCR-based diagnostic kit for the detection of pathogens in crop seeds. Seed health testing is important in order to identify infected lots that should be excluded from seed sales. Because only a few seeds in a seed lot are usually infected, highly sensitive test methods are needed. The standard method consists of extracting the pathogen into a buffer followed by plating on selective media to isolate the pathogen or identification by PCR. A major limitation of this method is that only a small sample (0.1 ml) can be tested on an agar plate, which gives a maximum sensitivity of only 10 cells per ml. In this project, a novel device called Ampli-disk, has been developed, that allows testing of a 4 ml sample. Further, this Ampli-disk can be stored and used, as needed, unlike agar plates that require fresh preparation for each use. Prior Phase I research has shown that pathogens from seed extracts can be successfully detected and quantified by using Ampli-disk coupled with real-time PCR. In the Phase II project, the objective is to develop Ampli-disks and real-time PCR primers and probes into diagnostic kits for ten most important bacterial pathogens of vegetable crops.

The commercial application of this project will be in agriculture. The proposed technology will be useful to the seed industry and in other bacterial disease diagnostics.

Title: SBIR Phase II: Microbial Enhancement of Soybeans for Salmonid Diets

Award Number: 0449453
Program Manager: Michael R. Ambrose

Start Date: February 15, 2005
Expires: January 31, 2007
Total Amount: $499,400

Investigator: Clifford Bradley, cbradley@montana.com
Company: Montana Microbial Products
1830 Ronald Ave
Missoula, MT 59801
Phone: (406)544-1176

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a process for enhancing the nutritional value of soybeans to replace fishmeal as the primary ingredient in farmed trout and salmon feed. Fishmeal creates environmental and economic constraints for the aquaculture industry. Plant-derived proteins are a good alternate feed source, but do not meet the nutritional requirements of many farmed fish species including trout and salmon. Prior Phase I work demonstrated that a combination of a selected fungal strain with innovations in solid substrate culture (SSC) would increase the protein content, eliminate the non-digestible carbohydrates and reduce anti-nutritional factors in soybeans. This Phase II project will test pilot-scale SSC technology to determine engineering design and economics for a commercial process to manufacture the bio-enhanced soy protein, and to demonstrate the feed value of this protein in trout feeding trials.

The commercial application of this project will be in the aquaculture industry. The use of fishmeal creates economic, market and water pollution issues for fish farmers, and consumer concerns regarding environmental impacts (for example, there are reports of PCBs, dioxins, and other pesticides detected at higher levels in farmed salmon that have been fed fishmeal based diets). Replacing fishmeal with plant based proteins will promote health through increased fish consumption and will alleviate environmental and economic constraints facing the aquaculture industry.

Title: SBIR Phase II: Implementation of Sex Pheromone-Based Systems to Suppress Populations of Soybean Aphids

Award Number: 0450032
Program Manager: Michael R. Ambrose

Start Date: January 15, 2005
Expires: December 31, 2006
Total Amount: $499,223

Investigator: Junwei Zhu, jwzhu@iastate.edu
Company: MSTRS Technologies Inc.
2501 North Loop Drive
Ames, IA 50010
Phone: (515)294-5930

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop sex pheromone-based techniques for monitoring, mass trapping, and mating disruption of the soybean aphid. Since its first appearance in North America, infestations of the newly invasive soybean aphid, Aphis glycines Matsumura, have continued to cause a significant soybean yield loss due to either direct feeding damage or the vectoring of plant viruses by the aphid. In 2003, the total acreage with soybean aphid infestation was estimated at over 8 million, with yield loss ranging from 32% - 45% in the three biggest soybean growing states in the U.S. (Illinois, Iowa and Minnesota). This project will investigate novel suppression strategies to reduce populations of this pest, thereby reducing the size of the subsequent populations feeding on soybeans.

The commercial application of this project will be to manage aphids in the soybean crop. The research aims to increase knowledge of the chemical ecology of aphids, as well as provide a new understanding of how to use these novel aphid sex pheromone-based control strategies most effectively. This will help growers in the U.S., the world's largest soybean exporting country, to improve crop quality and yield at a minimal cost for soybean aphid management, thereby increasing their competitiveness in the world market.

Title: SBIR Phase II: A Gene Targeting System for Plants

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|---|---|
| Award Number: | 0422159 |
| Program Manager: | Om P. Sahai |
| Start Date: | August 1, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $499,999 |

Investigator: David Wright, wright@phytodyne-inc.com
Company: Phytodyne, Inc.
2711 South Loop Drive
Ames, IA 50010
Phone: (515) 296-5513

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop a non-transgenic approach for genetic improvement of crops by using a zinc-finger nuclease strategy for homologous recombination in plants and a strategy for selection of non-selectable phenotypes. The commercial application of this project will be to enable the production of new crop varieties, including those that better withstand pests, have enhanced food value, and produce compounds of industrial importance.

The proposed approach is expected to produce genetically modified (GM) plants requiring less regulatory oversight than existing technologies for plant genetic engineering, facilitating faster and less expensive marketing of GM plants.

Title: SBIR Phase II: Nematode Intestinal Proteins as Anthelmintic Targets

Award Number: 0349756
Program Manager: Om P. Sahai

Start Date: February 1, 2004
Expires: January 31, 2006
Total Amount: $461,021

Investigator: Michelle Hresko, hresko@divergence.com
Company: Divergence, LLC
893 North Warson Road
St. Louis, MO 63141
Phone: (314)812-8024

Abstract

This Small Business Innovation Research (SBIR) Phase II project proposes to develop transgenic roots that are resistant to nematode infection, through expression of small proteins, protein domains or peptides which when ingested by the nematode interfere with the function of essential proteins of the nematode intestine. The longer term goal of the project is to develop transgenic crops (soybeans, corn and cotton), that are resistant to parasitic nematodes. In Phase I research, essential proteins exposed in the nematode intestinal lumen were identified as outstanding targets for anti-nematode agents produced by plants. These proteins are accessible to the environment since the lumenal membrane of the intestine is the surface through which nutrients are absorbed by the nematode. This Phase II project is expected to show that transgenic expression of nematode intestine-toxic peptides at the site of infection would create inhospital host plants for plant parasitic nematodes and would result in resistant crops which do not require application of toxic chemicals for nematode control.

The commercial impact of this project will be on nematode control in major crops. Plant parasitic nematodes are reported to cause $80 billion in crop yield damage annually. The current chemical solutions are limited, environmentally damaging, and toxic to the applicators. Transgenic resistance to nematodes will provide an economically competitive and environmentally safe alternative.

# Biochips/Biosensors

Title: SBIR Phase II: Multi-Marker Prognostic Test for Breast Cancer Outcome

Award Number: 0750452
Program Manager: Gregory T. Baxter

Start Date: June 1, 2008
Expires: May 31, 2010
Total Amount: $481,960

Investigator: Steven Linke, slinke@predict.net
Company: Prediction Sciences, LLC
9404 Genesee Ave Suite 210
La Jolla, CA 92037
Phone: (858) 404-0404

Abstract:

This Small Bbusiness Innovation Research (SBIR) Phase II project aims to continue the validation of a set of markers for predicting recurrence and guiding the selection of treatment in stage I-III breast cancer patients. Upon removal of their primary stage I-III operable tumors, breast cancer patients must decide whether or not to receive adjuvant therapy such as chemotherapy, or hormone therapy. Currently, the physician and patient can arrive at the decision by relying on several published guidelines whose accuracy is limited by the fact that they are based on general clinicopathologic data such as tumor size and grade. Thus the majority of patients are recommended to receive adjuvant therapy, although only a small fraction of them benefit from it. Availability of a set of reliable markers that can predict recurrence of tumors would allow tailoring of adjuvant therapy for each patient and is thus likely to reduce the chances of under-treatment and over-treatment. As such, it would be of great benefit to cancer patients, as well as to oncologists.

Title: SBIR Phase II: Vertical Perifusion System for Cell Culture and Monitoring

Award Number: 0750508
Program Manager: Gregory T. Baxter

Start Date: April 15, 2008
Expires: March 31, 2010
Total Amount: $495,224

Investigator: Michael Varney, mvarney@tautheta.com
Company: TauTheta Instruments LLC
2100 Central Avenue, Suite 107
Boulder, CO 80301
Phone: (720) 226-0614

Abstract:

This Small Business Innovation Research (SBIR) Phase II research develops tools to monitor live cells in a model system capable of maintaining the cells over extended periods in near normal conditions. The perfusion chamber allows one to interrogate the metabolic response of cells in real-time in a non-invasive manner. Potentially, this technology could open a number of tissues to examination in further detail for research and as an alternative to live animal testing. The broader impacts of this project include significant advances in the science of cell physiology and behavior, mechanistic pathways of diseases, and improved understanding of cellular signaling, growth and death. Rational design of more effective drugs depends on ever improving fundamental knowledge of cellular mechanisms. Commercially this innovation will lower the cost of drug development, testing and clinical trials, thereby providing broad benefit to the US healthcare industry.

Title: SBIR Phase II: Early Growth Metabolic Responses of Mycobacteria

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|---|---|
| Award Number: | 0750054 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $429,080 |


Investigator: Ronald Rieder, Ronald, rieder@biosensetech.com
Company: BioSense Technologies Inc.
4 Arrow Drive
Woburn, MA 01801
Phone: (781) 933-3635



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops a new rapid, nonmolecular method for quickly testing the drug susceptibility of Mycobacteria tuberculosis, the bacterium causing the epidemic disease tuberculosis (TB). Currently, all measurements for determining drug susceptibility - essential for prescribing effective treatment - rely exclusively on detecting changes in the slow growing bacterial population after exposure to drugs known to kill the bacterium. Phase I demonstrated this technology's approach to drug susceptibility testing provides commensurate information without time consuming measurements of growth. Susceptibility results were obtained in only a few hours compared to currently used methods requiring several weeks to obtain the same information. In addition, resistant strains were easily distinguished from sensitive strains inferring the ability to identify drug resistant TB infections in only a few hours time. With this information in hand quickly, physicians will be able to prescribe antimicrobial therapies with confidence because the treatments will be targeted and not empirical. The broader impacts of this research are the reduced spread of drug-resistant infections, increasing of the effective lifespan of drugs now known to cure disease, and lower healthcare costs associated with more successful patient outcomes. Rapid testing will enable better control over the spread of tuberculosis and the management of effective domestic and global policies. This will leave the United States and all other countries better prepared to mount an adequate defense in the event of an epidemic or intentional widespread exposure.

Title: SBIR Phase II: Immunological Tools for Trimetasphere Fullerenes

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| Award Number: | 0724380 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,955 |

Investigator: Roger VanTassell, vantassellr@lunainnovations.com
Company: Luna Innovations, Inc.
1703 South Jefferson Street, SW
Roanoke, VA 24016
Phone: (540)769-8400

Abstract:

This Small Business Innovation Research (SBIR) Phase II research develops antibodies and immunoassays for studying therapeutics based on carbon-based nanomaterials. This research will expand the immunological tools developed in Phase I to focus on detailed characterization of anti-fullerene antibodies and validate and down-select immunoassays and reagents for validated commercial formats. Commercial formats will include enzyme-linked, immunosorbant assays (ELISAs) for medical and environmental applications, neutralization schemes for mitigating potential toxicity of fullerene/nanotubes and biosensors platform for long-term monitoring systems. Biosensor platforms based on fullerene antibodies as affinity ligands will include the quartz crystal microbalance and surface acoustic waveguide.

The broader impacts will be to provide a full spectrum of immunological tools for studying the medically-related nanomaterials and monitoring nanowaste by-products during manufacturing processes. These will be new to the marketplace and enable monitoring of the use of products based on these nanomaterials to asssure their safe application.

Title: STTR Phase II: Microfluidic CD Biochips for Enzyme-Linked Immunosorbent Assays

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| Award Number: | 0548716 |
| Program Manager: | Ali Andalibi |
| Start Date: | December 15, 2006 |
| Expires: | November 30, 2008 |
| Total Amount: | $500,000 |


Investigator: Wei-Cho Huang, wchuang@bioloc.net
Company: BioLOC LLC
1381 Kinnear Road #100
Columbus, OH 43212
Phone: (614)481-9135



Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will develop a low-cost and mass-producible lab-on-a-chip platform for molecular and biological analyses. The platform is a microfluidic CD for Enzyme-Linked Immunosorbent Assays (ELISA) that reduces cost, accelerates results, and improves reliability of analyses for food borne contaminants, cancer diagnoses and environmental contamination.

The CD-ELISA technology platform merges two scientific areas - polymer microfabrication and biotechnology - and can substantially reduce manufacturing costs, improve device performance, and enable the production of low-cost and high-efficiency devices. Moreover, as such a device would be more affordable it will enable point-of-use results for a broader spectrum of molecular and biological testing.

Title: SBIR Phase II: Toxic Mold Sniffer

Award Number: 0548727
Program Manager: Ali Andalibi

Start Date: September 21, 2006
Expires: September 30, 2008
Total Amount: $471,421

Investigator: Debra Mlsna, dmlsna@seacoastscience.com
Company: Seacoast
2151 Las Palmas Drive
Carlsbad, CA 92009
Phone: (760)268-0083

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop a small, battery-powered sensor for the detection of toxic chemicals produced by molds responsible for "sick building syndrome," and for the detection of such toxic molds in infested buildings. The company's MEMS chemicapacitor technology utilizes an array of surface-micromachined capacitors coated with chemo-selective materials. The proposed device will detect toxic compounds produced by indoor molds, as well as associated volatile organic compounds.

The detection and isolation of suspect molds is a major indoor environmental concern. The sensor technology proposed for use in the company's sensor system can be packaged for single-use home detection kits, or can be incorporated into reusable detection units for surveillance by commercial interests.

Title: SBIR Phase II: Microchip Assay for Glycosylated Hemoglobin

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| Award Number: | 0548744 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | March 1, 2006 |
| Expires: | February 29, 2008 |
| Total Amount: | $480,024 |

Investigator: Dale Willard, dale.willard@colostate.edu
Company: AML
527 Matthew St
Fort Collins, CO 80524
Phone: (970)491-4064

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims at developing the next generation of diabetic monitoring devices that will allow the measurement of multiple markers of disease regulation and progression using an innovative lab-on-a-chip technology. The project will develop the first integrated microchip CE device for measurement of an important maker of diabetes.

This technology will impact patient monitoring for disease progression and therapeutic efficacy by following biomarker more efficiently as well as being used at the point of care. This eliminates the time and cost currently required to perform follow up laboratory tests. The technology approaches the chemistry of biomarkers from a non-traditional sensor mechanism and shows great promise for the detection and use of biomarkers for specific diseases.

Title: SBIR Phase II: Biosensor for Rapid Whole Blood Assays using Magnetic Labels and Giant Magnetoresistive Sensors

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|---|---|
| Award Number: | 0548638 |
| Program Manager: | Errol Arkilic |
| Start Date: | January 23, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $466,710 |


Investigator: Curt Bilby, curt.bilby@seahawkbio.com
Company: Seahawk Biosystems
3000 Bryker Drive
Austin, TX 78703
Phone: (512)459-7063



Abstract:

This Small Business Innovation Research (SBIR) Phase II project advances the general state of diagnostics research in the veterinary and security/defense markets using whole-blood assays. This Phase II project will develop (1) an automated Open Assay Development Platform for rapid assay prototyping; (2) whole blood assays for canine immunity assessment and canine thyroid test (T4); and, (3) multiplexed, canine whole blood assays. The approach uses magnetic beads to label biomolecules captured onto a receptor-patterned microchip that contains an embedded array of magnetic microsensors. The magnetic microsensors are wire-like structures that display giant magnetoresistance (GMR). When coupled with controlled fluidic force discrimination - an innovation that greatly reduces unwanted background signal - rapid identification of biomolecules with high sensitivity and specificity is achieved. A prototype system has been developed for both immunoassays and nucleic acid assays, with immunoassays (1 ng/mL) saturating in less than 10 minutes and unmodified DNA detected at 10fm in less than 20 minutes.
Seahawk is responding to the clinical and financial challenges veterinarians face by developing a multi-use, multiplexed instrument and associated disposable cartridges.

This technology platform offers veterinarians superior performance (faster, more accurate, easier to use) and greater profitability than existing products. Initially, the platform will include cartridges for two applications: (1) individualized immunity assessment and (2) disease diagnostics, both specifically for dogs and cats. The system provides an in-clinic, quick turnaround, cost-effective and accurate test of an animal's immune system to determine what, if any, vaccine boosters need to be administered at that time. This provides the veterinarians with three key benefits: (1) improving the quality of care - providing revaccinations only when needed and tailored to each animal; (2) generating additional or replacement revenue due to changes in revaccination protocols; and, (3) replacing annual revaccinations as the impetus for customer compliance with scheduling office visits for physical exams.

Title: SBIR Phase II: Ultra-High Sensitivity Surface Plasmon Resonance (SPR) Sensor for Real-Time Botulinum Detection

Award Number: 0522014
Program Manager: George B. Vermont

Start Date: August 15, 2005
Expires: July 31, 2007
Total Amount: $499,800

Investigator: Paul Melman, melmanp@newtonphotonics.com
Company: Newton Photonics
104 Manet Rd
Chestnut Hill, MA 02467
Phone: (617)928-1221

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a prototype botulinum toxin detector based on a novel ultra-sensitive Surface Plasmon Resonance (SPR) technology. The botulinum toxin will be detected by means of the specific cleavage of a peptide substrate attached to the sensor surface. The system will provide results in a fraction of the time and at a much lower cost compared to currently available methods. The feasibility of this technology was successfully demonstrated in Phase I. The research in Phase II will include assay optimization for detection of botulinum types A and B, development of a toxin extraction protocol from complex solutions, and construction of an instrument for multiplexed detection of botulinum toxins. The developed instrument will have the capability for ultrasensitive detection of Botulinum A and B (comparable to the sensitivity of the mouse LD50 assay) on a single chip.

The principal commercial application of this project will be in the detection of biothreat agents. The proposed work, though initially aimed at rapid detection of botulism in individuals and in foods, will be extendable to other biothreat agents such as anthrax and mycotoxins. Additional applications are expected in drug discovery and biomedical research, and for potency testing of botulinum products in medical and cosmetic applications.

Title: SBIR Phase II: Sensor for Real-Time pH Measurements in Gases

Award Number: 0522325
Program Manager: Michael R. Ambrose

Start Date: August 1, 2005
Expires: July 31, 2007
Total Amount: $500,000

Investigator: Jeffery Schipper, jeff@sierramedical.com
Company: Sierra Medical Technology Inc.
13670 Danielson Street
Poway, CA 92064
Phone: (858)679-2300

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop and market the trademarked Dx-1 pH Measurement System. This medical device integrates the breath pH sensor studied in the Phase I research with an ambulatory, telemetry based data recorder, and data analysis software to provide a non-invasive pH diagnostic tool required by physicians. This pH sensor actively condenses a moisture film on the sensor surface, creating a conduction path across its sensing electrodes. During Phase II, the company plans to complete all technical and regulatory activities in order to gain FDA clearance for product introduction.

The commercial application of this project is in the area of medical devices. The proposed sensor technology will offer a new tool for clinicians to more effectively diagnose and treat respiratory diseases, particularly for children and infants who cannot readily undergo alternative diagnostic procedures.

Title: SBIR Phase II: Kits for the Detection of Bioterror Pathogens

Award Number: 0450469
Program Manager: George B. Vermont

Start Date: April 1, 2005
Expires: March 31, 2007
Total Amount: $499,257

Investigator: Brenda Spangler, brenda.spangler@sensopath.com
Company: Sensopatch Technolgoies, Inc.
2100 Fairview Drive
Bozeman, MT 59715
Phone: (406)585-8192

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop field deployable kits for the detection of bio-terror pathogens. These kits would consist of fluorescent-labeled antibodies directed against protein toxins expressed by bio-terror pathogens, relying for detection on strong antibody-antigen interactions and fast chromatographic discrimination using simple chromatography strips supplied with inexpensive pre-measured reagents. In Phase I project, new water soluble blue-emitting reporter fluorophores were synthesized that were extremely photo-stable and could be easily visualized under any type of light conditions. These fluorophores were conjugated to an antibody against Bacillus anthracis as the initial proof-of-concept, and methodology was developed to attach these reporter fluorophores to monoclonal, polyclonal or recombinant antibodies. The objectives of Phase II project are to optimize reagents and chromatography, to synthesize new fluorophores for multiplexed pathogen detection, to design and assemble prototype kits, and to test and validate the kits.

The commercial application of this project will be in the area of homeland security. The proposed kits are expected to be inexpensive, versatile, and easy to use by relatively untrained first responders (such as police, firefighters, paramedics, hazmat personnel, other emergency response teams).

Title: SBIR Phase II: Novel Bioaerosol Concentrator/Sampler for Enhanced Biosensor Performance

Award Number: 0450612
Program Manager: George B. Vermont

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $469,973

Investigator: Steve Wright, wright@novafilter.com
Company: Innovatech Inc
6320 Angus Dr Suite C
Raleigh, NC 27617
Phone: (919)881-2197

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a robust, generic, front-end, bio-sampler that when combined with either a wet or dry biological detector, will result in more accurate and rapid detection of hazardous airborne biological agents. While most current systems require samples to be delivered in a fluid for analysis, emerging dry detection technologies facilitate near-real time detection, reduce sampling errors and allow for unattended operation. The prototype bio-sampler developed in Phase I demonstrated very high efficiency in the dry collection mode. This Phase II project has the following objectives: (a) to optimize sampling performance for particles at the low end of the range (<2 micron), (b) to maintain high bio-viability of collected organisms, (c) to function efficiently in the wet or the dry mode, (d) to demonstrate self-cleaning / decontamination features, (e) to evaluate scalability to larger air volumes and, finally, (f) to demonstrate enhanced overall performance in an integrated biological detection system.

The commercial application of this project will be in the area of homeland security and public safety. The proposed technology will enhance the performance of both the detection systems that are presently deployed and that of the advanced biological detectors that are currently under development. Additional applications will be in the monitoring of the environment and of industrial air quality.

Title: SBIR Phase II: X-ray Microscope for In-Vivo Biological Imaging

Award Number: 0450518
Program Manager: George B. Vermont

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $494,620

Investigator: Charles Gary, cgary@adelphitech.com
Company: Adelphi Technology, Inc
981B Industrial Rd
San Carlos, CA 94070
Phone: (650)598-9800

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a sub-micron x-ray tomography scanner capable of providing in-vivo and high resolution images of specimens from mice to bacteria. In this era of molecular medicine, where disease and developmental disorders are being re-defined by their peculiar molecular, genetic or cellular profiles, there exists a significant disparity between the type of information gleaned from histological methods and that obtained from conventional non-invasive imaging modalities. With a resolution that is better than these imaging modalities and more than ten times higher than that of current x-ray imaging systems, the proposed device will generate images of development and disease not possible by current methods. The Phase II research will concentrate on the development of the x-ray optical system, including beam conditioning, tomographic imaging capability, and the imaging x-ray lens, and will result in a table-top commercial prototype computerized tomographic imager with 400 nm resolution.

The commercial application of this project will be in the area of medical research. When compared to existing in-vivo imaging technologies, the higher resolution of the proposed x-ray imager will translate to improved sensitivity and specificity of morphologic changes associated with growth and disease. Researchers will be able to use this tool for investigations of a number of medical conditions, including tumor angiogenesis, atherosclerosis, osteoporosis and arthritis.

Title: SBIR Phase II: Electronic DNA Biosensor

Award Number: 0450472
Program Manager: Michael R. Ambrose

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $499,715

Investigator: Richard Murante, rmurante@integratednano.com
Company: Integrated Nano-Technologies LLC
999 Lehigh Station Rd
Henrietta, NY 14467
Phone: (585)334-0170

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a portable, rapid, fully - automated, non-Polymerase Chain Reaction (PCR) based, electronic DNA identification device for field use that is capable of accurately detecting low concentrations of biological agents in a broad range of samples. Prior Phase I work demonstrated the feasibility of using palladium-catalyzed nickel to form conductive DNA wires for use in constructing this device. The Phase II project will further advance the DNA detection technology by refining the metallization protocol and integrating the technology into an automated, easy to use format.

The commercial application of this project will be for use by the military and / or for homeland security. The proposed biosensor system is expected to be readily incorporated into existing nuclear, biological and chemical (NBC) detection and reporting systems, enhancing total force protection by enabling the rapid identification, containment and neutralization of biological agents.

Title: SBIR Phase II: ELISA Biosensor for Rapid Bioterrorism Related Agent Diagnosis

Award Number: 0450635
Program Manager: Michael R. Ambrose

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $468,453

Investigator: Winston Ho, winstonho@maxwellsensors.com
Company: Maxwell Sensors Inc.
10020 Pioneer Blvd., Suite 103
Santa Fe Springs, CA 90670
Phone: (562)801-2088

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a self-contained enzyme-linked immunosorbent assay (ELISA) biochip for rapid and confirmatory clinical diagnosis of multiple bio-threat pathogens such as antigens, antibodies, toxins, and viruses. The ELISA chip utilizes microfluidic technology to automate and simplify the assay process on a small chip platform. The plastic chip (reagent pre-loaded) will be affordable and ready for use, and will eliminate the need for a network of tubing connected to bulky external reservoirs and pump systems used in current large clinical laboratory systems. Prior Phase I work successfully developed the microfluidic chip platform and the reader system, and performed assays with anthrax toxin protective antigen (PA) and Francisella tularensis. The Phase II project will focus on system optimization, integration and panel tests, and will result in a prototype to be refined into a commercial product in Phase III.

The commercial application of this project will be in the area of homeland security, for detecting biological warfare agents (BWA) and in managing BWA suspected patients. The ELISA based biochip has the potential to be used as a rapid testing standard to quickly yield preliminary data in advance of microbiology tests. The system, with its extreme sensitivity and specificity, also offers commercial opportunities in the field of clinical diagnostics.

Title: SBIR Phase II: Rapid Detection of Bacterial Contaminants Using Micro-Fluidic Biochips

Award Number: 0422150
Program Manager: Michael R. Ambrose

Start Date: November 1, 2004
Expires: October 31, 2006
Total Amount: $417,574

Investigator: Laila Razouk, laila.razouk@biovitesse.com
Company: Biovitesse, Inc.
1608 Crow Court
Sunnyvale, CA 94087
Phone: (408)738-4655

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a microfluidic based system for the detection of viable pathogens using dielectric concentration of bacteria as an intermediate step. This system would use a first-stage concentrator, followed by dielectrophoretic concentration, and finally by culturing in media with integrated impedance measurements to detect culture growth.

The commercial application of this project will be on the detection of waterborne microorganisms in biopharmaceutical manufacturing operations. The proposed method would electronically detect the viability of microorganisms in water samples in less than 3 hours, unlike the current technology that takes 2-7 days to yield results.

Title: SBIR Phase II: A Biochip for DNA Detection

Award Number: 0422246
Program Manager: Om P. Sahai

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $499,989

Investigator: Kristian Scaboo, kscaboo@genorx.com
Company: GenoRx, Inc
3916 Trust Way
Hayward, CA 94545
Phone: (510)732-9100

Abstract

This Small Business Innovation Research (SBIR) Phase II project proposes to develop an inexpensive, automated, highly sensitive biosensor chip that would detect small quantities of nucleic acids directly without the need for either a reporter molecule reaction or a PCR expansion reaction. It is expected that the proposed molecular detection platform will provide unparalleled specificity and sensitivity while decreasing sample preparation time by a factor of twenty five, capital costs by a factor of twenty, and the cost of disposables, including the chip, by a factor of five.

The commercial application of this project will be in a number of markets, including biological and biomedical research, diagnostics and forensics.

Title:  STTR Phase II: Novel Lipid Deposition for Biosensor Surfaces

Award Number: 0422010
Program Manager: Om P. Sahai

Start Date: September 1, 2004
Expires: August 31, 2006
Total Amount: $460,789

Investigator: Roger Van Tassell, vantassellr@lunainnovations.com
Company: Luna Innovations, Incorporated
PO Box 11704
Blacksburg, VA 24062
Phone: (540)552-5128

Abstract

This Small Business Technology Transfer Research (STTR) Phase II project will use the LPG (Long Period Grating) technology to interrogate the interactions between drugs and G-Protein coupled receptors (GPCRs). To effectively study these interactions, one has to stabilize the GPCRs by immobilizing them to lipid layers. This Phase II project will focus on optimizing the lipid selection, composition, and attachment to the GPRCs and to the surface of the sensor. The development of stabilized lipid based GPCR coating for the LPG biosensor will provide a valuable tool in the area of drug discovery.

The commercial application of this project will be in the area of new high throughput proteomics instrumentation to aid in the development of new therapeutic products.

Title: SBIR Phase II: Nanoelectronic Capnography Sensors

Award Number: 0421966
Program Manager: Om P. Sahai

Start Date: August 15, 2004
Expires: July 31, 2006
Total Amount: $498,969

Investigator: Alexander Star, astar@nano.com
Company: Nanomix, Inc.
5980 Horton St.
Emeryville, CA 94608
Phone: (510)428-5302

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop a carbon dioxide sensor, using polymer modified carbon nanotudes, for patients receiving anesthesia. The sensor technology relies on two important areas of expertise : the nanotube transducer platform and gas analyte recognition layers. The Phase II project objectives will include optimizing the platform and recognition chemistries that were developed in Phase I. Once a technically suitable recipe is known, sensor chips will be fabricated at the wafer level for large scale testing. The capnography sensors will be packaged and embedded in disposable adapters that fits directly into the patient airway. Hardware and software systems will be designed and integrated with the adapter to deliver sensor information to the end user. At the culmination of Phase II, the capnography sensor system will be validated in a clinical environment and positioned for FDA approval and subsequent market introduction.

The commercial application of this project will be in the area of healthcare. The proposed sensor will have the attributes of low power, small size and low cost.

Title: SBIR Phase II: Portable BioDetection Platform for Rapid Identification of Multiple Biological Agents

Award Number: 0422085
Program Manager: Om P. Sahai

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $499,911

Investigator: Ihab Abdel-Hamid, iabdel-hamid@mesosystems.com
Company: MesoSystems Technology, Inc.
1001 Menaul Blvd.
Albuquerque, NM 87107
Phone: (509)222-2000

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop a portable automated biosensor for detection of proteins, viruses and/or pathogens in liquid and air samples. This technology is based on the integration of highly-specific immunodiagnostics with ultra-sensitive electrochemical sensors in a multiplexed microfluidic format that allows the measurement of up to three proteins, two viruses and two bacteria simultaneously. The biosensor is expected to have low detection limits (that is, of less than 0.5 ng/ml for proteins, 1000 PFU/ml for viruses and 700 CFU/ml for bacteria), with an overall assay time of less than 30 minutes. This system will be tested for detection of potential biological threat agents such as Staphylococcal Enterotoxin B (protein/toxin), Influenza (virus) and Bacillus anthracis (bacteria).

The commercial application of this project will be in the areas of homeland security, clinical diagnostics, food quality control and general environmental monitoring.

Title: SBIR Phase II: A Microfluidic-Based Biosensor for Food Pathogen Detection

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| Award Number: | 0422088 |
| Program Manager: | Om P. Sahai |
| Start Date: | August 1, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $488,054 |

Investigator: Xiao-Li Su, xsu@virtual-incubation.com
Company: BioDetection Instruments, Inc.
21 West Mountain
Fayetteville, AR 72701
Phone: (479)571-2592

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop a portable, rapid and specific capillary channel based immuno-sensing system for food pathogens. The tests will be able to detect concentrations of <10 cfu/ml of various microorganisms (Salmonella, Listeria, Escherichia Coli) in less than 1 hour in contrast to current methods that typically require 24 to 48 hours for preliminary data to become available and typically 3-7 days for definitive results. The capability of the proposed instrument to achieve this significant leap forward in performance was demonstrated by the Phase I results. The Phase II objective is to further refine the instrument with the high performance, ease of use, and low per sample cost needed by the food processing industry.

The commercial application of this project will be in the areas of food safety and bio-defense. Microbial contamination of food products by pathogenic bacteria is a major concern of our society. Contaminated food is estimated to cause 76 million illnesses, 325,000 serious illnesses resulting in hospitalization, and 5,000 deaths in the United States each year. The economic impact of food-borne illnesses has been estimated as high as $10 billion annually. Recent events have also made it clear that the threat from pathogens intentionally introduced into the nation's food supply can be real, with significant economic implications.

Title: SBIR Phase II: Continuously Operating Sensor for Detection of Nerve Agent Contamination in Aqueous Solutions

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|---|---|
| Award Number: | 0422090 |
| Program Manager: | Om P. Sahai |
| Start Date: | August 1, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $487,768 |

Investigator: Markus Erbeldinger, markus@agentase.com
Company: Agentase LLC
3636 Blvd of the Allies
Pittsburgh, PA 15213
Phone: (412)209-7298

Abstract

This Small Business Innovation Research (SBIR) Phase II project is to develop a continuously operating water monitoring device for the detection of chemical warfare agents and hazardous chemicals. Prior Phase I work demonstrated the feasibility of this method and resulted in the construction of a bench-top model that could respond rapidly to contamination, that was resistant to environmental and chemical interference, and that could operate for extended periods of time without user intervention. In Phase II, this model will be modified into a small, self-contained, inexpensive prototype. Several optimized prototypes will be constructed for field trials under operational conditions.

The commercial application of this project will be in the area of bioterrorism.

Title: SBIR Phase II: Nanostructured Optical Fiber Breathing Sensors

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| Award Number: | 0349441 |
| Program Manager: | Om P. Sahai |
| Start Date: | March 1, 2004 |
| Expires: | February 28, 2006 |
| Total Amount: | $500,000 |

Investigator: Jeffrey Mecham, jmecham@nanosonic.com
Company: Nanosonic Incorporated
P.O. Box 618
Christiansburg, VA 24068
Phone: (540)953-1785

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize optical fiber sensors for the quantitative measurement of humidity and air flow for breathing diagnostics. Prior Phase I work has demonstrated that these physically small and mechanically robust sensors respond over a wide range of relative humidities with a response time of microseconds, and are orders of magnitude faster than commercially available devices. The Phase II project will develop sensor thin film chemistries with improved response time, design and fabricate an optical fiber sensor optoelectronic support instrumentation system, and beta-test the sensors and systems with clinicians and physicians. The primary commercial impact of this project will be on home health care and clinical research. Additional applications will be in the industrial gas flow, automotive and transportation areas.

Title: SBIR Phase II: Anthrax Detector for Mail Sorting Systems

Award Number: 0349687
Program Manager: Om P. Sahai

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $505,985

Investigator: Stuart Farquharson, stu@rta.biz
Company: Real-Time Analyzers
87 Church Street
East Hartford, CT 06108
Phone: (860)528-9806

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop two prototype anthrax detector systems designed to screen mail entering a postal facility and/or to identify and to stop distribution of anthrax containing mail as it passes through a sorter. These systems will be able to detect 2 micrograms of spores captured from a letter containing as little as 100 micrograms, as well as similar concentrations on contaminated surfaces. The Phase I project demonstrated feasibility by successfully developing a vacuum/filter collection system that captured Bacillus cereus spores from an envelope passing through a mail sorter, which were detected by Raman spectroscopy. Some 23 micrograms of B. cereus spores were measured in 9 seconds using 1064 nm excitation, with an estimated limit of detection of 10 micrograms or 1 million spores in 10 seconds.

The Phase II project will complete the design of the anthrax detector system, with improved sensitivity nd selectivity. The broader impact of this project will be on the safety and security of mail handling and delivery across the United States.

# Bioinformatics

Title: SBIR Phase II: Permanent Attachment of Antimicrobial Peptides to Central Venous Catheters.

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| Award Number: | 0822959 |
| Program Manager: | Cynthia A. Znati |
| Start Date: | August 15, 2008 |
| Expires: | July 31, 2008 |
| Total Amount: | $499,923 |


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| Investigator: | Christopher Loose, crloose@gmail.com |
| Company: | Semprus Bioscience Corporation<br>107 Gore St #4<br>Cambridge, MA 02141 |
| Phone: | (857) 363-0218 |


Abstract:


This Small Business Innovation Research (SBIR) Phase II project continues SteriCoat's development of a permanent antimicrobial coating for use on central venous catheters. Current leaching antimicrobial technology does not possess the duration of efficacy required to protect these devices over the lifetime of implantation, especially for peripherally inserted central lines (PICCs). Research during this Phase II project will focus on the integration of proprietary polymer technology with tethered antimicrobial peptide (AmP) technology developed in Phase I to maximize the efficacy and bioavailability of the immobilized AmPs in vivo. Work will also be performed to ensure the manufacturability of SteriCoat's coating technology, including prototype production. After transitioning this formulation to the intra- and extraluminal surfaces of a polyurethane tube, efficacy and biocompatibility will be demonstrated both in vitro and in vivo. By the end of this Phase II project, SteriCoat will have an antimicrobial CVC model with efficacy proven in vivo using the models designed by industry thought leaders and will be ready for scale-up and manufacturing. This SBIR Phase II project addresses the hospital infections afflicting 1.7 million patients and killing 99,000 in the US annually, the majority of which are associated with medical devices. Existing slow-release antimicrobial coatings are insufficient in addressing device infection. They have a limited lifespan and concerns over drug resistance and toxicity because the drug gets distributed in the bloodstream. SteriCoat is developing a permanent coating using antimicrobial peptides (AmPs) to prevent bacterial colonization of central venous catheters (CVCs), a $350M market. The goal of this project is to deliver a polyurethane-based antimicrobial CVC model which incorporates a surface functionalization with AmPs and to test the ability of this approach in resisting bacterial colonization. By the end of this phase II project, SteriCoat will have verified in vivo efficacy of prototype catheters and be positioned to begin GLP studies for FDA product approval. In addition, achievement of the technical objectives of this Phase II will open up avenues for additional investigation in the field of bioactive ligand presentation as the developed technology could lend to the efficacy of many biomaterial applications in addition to antimicrobials.

Title: STTR Phase II: Improving Privacy and Security in Biometrics

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| Award Number: | 0750485 |
| Program Manager: | Ian M. Bennett |
| Start Date: | March 1, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $479,685 |

Investigator: Walter Scheirer, Scheirer@securics.com
Company: Securics Incorporated
1867 Austin Bluffs Parkway
Colorado Springs, CO 80918
Phone: (719) 387-8660

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project aims to make fundamental advances in Biotopes -- cryptographically secured privacy-enhanced fingerprint and face-based technologies. The project will develop prototypes to support beta testing in commercial applications and pursue large-scale government testing. The development effort introduces the concept and will develop/demonstrate bi-directional biometric verification, whereby both the sensor and DB receive match confirmation. This is critical for remote/web-based biometric usage and improves security and privacy with match-on-card solutions. It will develop a new Biotope which uses, but never stores, multi-spectral data not obtainable from existing databases or from latent prints, providing a sustainable non-spoofable secured identity tokens that match in encoded form and change on every transaction. It will explore improving accuracy with 'negative' minutiae and PCA-based feature enhancements. To improve reuse of existing minutia-based algorithms and hardware, the effort seeks to develop a minutiae-to-minutiae mapping approach with the same security/privacy protection of existing Biotopes. For face-based biometrics, the project develops new multi-view approaches for face-based verification from non-cooperative subjects in complex unstructured environments. Additionally, the project addresses privacy protection, with a non-searchable technology that still supports a privacy-protecting image-storage for fraud prosecution, and will extend other research work in the area of continuous verification by improving the online verification for distance education and other applications. The broader impact starts with its unique focus on simultaneously improving privacy and security rather than trading one for the other. At a time when citizens feel their privacy is traded for the mere promise of security, this effort is an investment in privacy. The project will transition fundamental research into testing with commercial partners. It directly addresses reasons that other researchers have said cause the perpetual gap between predicted and realized commercial growth in biometrics. It will enhance biometrics, providing 'revocability' and transactional uniqueness to support biometric-based commerce without fear of phishing, hacking or insider access. The project will impact the distance education market for example, by focusing on improving effectiveness of state training for those in need while protecting their privacy and dignity. The projected outcomes also open the potential for passports/IDcard that allow individuals to prove their identity without allowing others to use that data to search for them. It will support smart-card based solutions that allow for biometric-verified yet 'anonymous' transactions. It addresses the often overlooked biometric dilemma, that wide-spread deployments of biometrics today may ultimately increase identify theft and also limit biometrics security value tomorrow.

Title: SBIR Phase II: Shape Memory Polymer Based Orthopedic Fixation Devices

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| Award Number: | 0750247 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $499,826 |

Investigator: Jack Griffis, jack.griffis@medshapesolutions.com
Company: MedShape Solutions, Inc.
1575 Northside Drive
Atlanta, GA 30318
Phone: (404) 583-6889

Abstract:

The Small Business Innovation Research (SBIR) Phase II project includes the design, development and commercialization of shape memory polymer orthopedic soft-tissue fixation devices. Current soft tissue fixation devices are primarily metal or plastic screws used to attach tissue grafts to bone in repair of torn anterior cruciate ligaments (ACL). These threaded devices commonly damage the tendon during insertion; reducing the effectiveness of the surgery. Shape memory polymers are a superior solution in that they can provide a simpler, stronger, and less damaging fixation method for these tendon grafts. Essentially, a shape memory polymer device can be; (1) delivered into the body in a compacted and less invasive state, (2) self-deploy at body temperature and (3) do so without sharp edges that might damage the tissue. The proposed work has immediate commercial potential and direct societal benefit in the field of sports medicine with a significant market on the order of $210 million in ACL repair devices annually. Furthermore, the biomaterial developed for ACL reconstruction should have long-term impact on the 1.6MM orthopedic procedures performed each year to repair tendons and ligaments in knees, shoulders, and ankles and by reducing the invasiveness of surgery and improving the outcomes.

Title: SBIR Phase II: Physiologic High Throughput Screening of Bioengineered Tissues

Award Number: 0724445
Program Manager: F.C. Thomas Allnutt

Start Date: August 15, 2007
Expires: July 31, 2009
Total Amount: $499,956

Investigator: Herman Vandenburgh, hvandenburgh@myomics.com
Company: Myomics
4 Richmond Square, STE 500
Providence, RI 02906
Phone: (401)861-9770

Abstract:

This Small Business Innovation Research (SBIR) Phase II research develops an innovative high-throughput/high content drug screening platform that utilizes three-dimensional human skeletal muscle tissue constructs that mimic in vivo skeletal muscle to quantify muscle force generation. Significant demands exist for new drugs to treat contractility disorders involving skeletal muscle. Myomics' proposed drug testing platform will contribute to significant reductions in time and costs associated with bringing new drugs to market by discovering drug candidates and eliminating ineffective compounds earlier than currently possible. Unlike existing systems, this approach incorporates biomechanics into drug discovery using mechanical sensors to detect contraction of multiple identical tissue samples over extended time periods. Significant socioeconomic and quality-of-life impacts will result for patients with contractility disorders (sarcopenia, atrophy, or Duchennes muscular dystrophy). While most drug screening protocols test one protein pathway at a time, this platform provides a unique physiological screening system and protocol which quantifies contraction as the result of multiple protein pathways interacting over time.

The broader impacts of this research will be to enhance muscle contractility disorder/disease research and provide new tools to the pharmaceutical and biotechnology industries for drug discovery. Upon successful development, the sensing mechanism will potentially be used to develop treatments for several contractile tissues relevant to a range of important human contractile disorders and diseases contributing to improved outcomes for these diseases.

Title: SBIR Phase II: A Bioinformatics System for GCxGC-MS (Comprehensive Two-Dimensional Gas Chromography)

Award Number: 0450540
Program Manager: George B. Vermont

Start Date: February 1, 2007
Expires: January 31, 2007
Total Amount: $493,692

Investigator: Qingping Tao, qtao@cse.unl.edu
Company: GC Imaging
216 N 11th St, Ste 302
Lincoln, NE 68508
Phone: (402)310-4503

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to use bioinformatics to transform complex data produced by comprehensive two-dimensional gas chromatography with mass spectrometry (GCxGC-MS) to usable chemical information. GCxGC-MS is an emerging technology for chemical separations that provides an order-of-magnitude increase in separation capacity over traditional GC. Results from Phase I demonstrated the feasibility of using bioinformatics to automatically identify chemical components in complex matrices analyzed by GCxGC-MS. Phase II will carry out further theoretical and experimental research to develop solutions that will enable broader use of GCxGC-MS system. The key project objectives include (a) developing a hybrid method that combines three approaches for chemical identification from GCxGC-MS data, (b) establishing the mathematical foundation and practical algorithms for co-elution analysis in GCxGC-MS, and (3) developing new XML technologies for shared and distributed GCxGC-MS data, metadata, and information.

The commercial impact of this project will be to develop information technologies for a new generation of analytical instruments. GCxGC-MS system is likely to capture a significant share of the existing gas chromatography market, currently in excess of $ 1 billion per year, and to open new markets in applications requiring superior separations. These applications with important societal benefits, would include environmental monitoring of air, water, and soil; development and processing of foods, flavors, fragrances, and essential oils; processing of petroleum and industrial chemicals; health-care assays of blood, urine, milk, and breath samples; and analysis and discovery of drugs and medicinal herbs.

Title: SBIR Phase II: Bioinformatic Data Mining for AIDS Resistance Genes

Award Number: 0450627
Program Manager: George B. Vermont

Start Date: September 15, 2005
Expires: August 31, 2007
Total Amount: $499,961

Investigator: Walter Messier, wmessier@evolgen.com
Company: Evolutionary Genomics, LLC
6840 N. Broadway
Denverm CO 80221
Phone: (303)429-5800

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the use of novel evolution-based data mining software to discover targets for the development of human therapeutics for currently intractable diseases. Phase I demonstrated that the evolution-based data-mining software was useful for dramatically narrowing the search for proteins that make chimpanzees resistant to the progression of AIDS after infection by HIV-1. In Phase II, the impact on in-vitro HIV-1 infectivity of a human cell line transfected with the gene encoding one of the adapted chimpanzee proteins will be assessed. Screening of other chimpanzee homologs of genes differentially regulated in human cells upon HIV-1 infection will continue to ensure that all potential AIDS resistance proteins have been identified. The adapted chimpanzee genes/proteins will be compared to those from humans in which HIV-1 infection has not progressed to AIDS for at least 10 years to see if there are any commonalities.

The commercial application of this technology is in the battle against AIDS disease. The identification of proteins that have undergone adaptive evolution should lead to drugs to mediate the progression of HIV-1 infection. This same approach may have broader impact against several other intractable diseases for which non-human primates are less susceptible than humans. This includes hepatitis-C, sepsis, type-1 diabetes, and certain cancers.

# Biomaterials

Title: SBIR Phase II: BP 1 - Microwaveable Bioplastic Packaging

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| Award Number: | 0822999 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $500,000 |


Investigator: Laura Hollingsworth, lauraohollingsworth@hotmail.com
Company: PolyNew Incorporated
1021 18th Street
Golden, CO 80402
Phone: (303) 277-9033



Abstract:

This Small Business Innovation Research (SBIR) Phase II research develops innovative nanotechnology to allow the use of bioplastics for food packaging. Polylactic acid (PLA) is an environmentally beneficial bioplastic made from renewable resources; however, the properties of PLA are limited. This makes it unsuited for use in microwaveable food packaging. In Phase I, university expertise resulting from earlier NSF funding was used to formulate a bioplastic with suitable properties, including cost. In Phase II, a viable manufacturing route towards food packing trays will be demonstrated at the pilot plant level working in close collaboration with a large industrial manufacturing partner. The broader impacts of this Phase II SBIR research will be manifold. The new bioplastics are quantitatively more environmentally benign that petroplastics. Bioplastics are made form renewable resources and therefore simultaneously help decrease dependence on foreign oil while providing environmental benefits. Using a domestic biomass resource provides a competitive advantage against low labor cost manufacturers like China helping to stem job losses in the plastics industries. Presently, polystyrene is largely used for tray applications and foamed with 3-5 weight percent hydrocarbons. PLA can be foamed with carbon dioxide so the new technology has the additional benefit of displacing at least 1 million pounds per year of the pollutant volatile organic carbons (VOCs).

Title: SBIR Phase II: Shape memory polymer AAA Endograft

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| Award Number: | 0823015 |
| Program Manager: | Cynthia A. Znati |
| Start Date: | July 1, 2008 |
| Expires: | June 30, 2010 |
| Total Amount: | $450,989 |

Investigator: Craig Lanning, clanning@endoshape.com
Company: EndoShape Inc
1408 Kingwood Pl
Boulder, CO 80304
Phone: (303) 652-7338

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to continue the development of novel endografts for percutaneous treatment of abdominal aortic aneurysms (AAA) using unique and proprietary shape memory polymer (SMP) technology. Abdominal aortic aneurysms are both common and lethal in the older population, affecting between 7 and 13 % of older persons (> 60 years), accounting for between 13,000 and 18,000 deaths per year in the US alone, and increasing in diagnostic prevalence as both diagnostic techniques improve and the population ages. Endovascular treatment using covered stainless steel or Nitinol stent-grafts is now the preferred option for AAA treatment. However, current devices are far from perfect, and complications from endovascular repair such as endoleaks, continued growth of the aneurysm, device migration, arterial dissections, and other problems persist at very high (> 25-35%) rates. Most if not all these problems can be traced to the inherent limitations of the materials used in current devices. We propose to continue the highly promising Phase I work with particular focus on four areas: finalize polymer formulation; develop methods to manufacture patient-specific endograft designs; finalize biocompatibility evaluation; and evaluate endografts in acute and chronic animal studies. Anticipated deliverables at the end of the Phase II project are a finalized polymer formulation particularly suitable for endografts, complete ISO 109993 biocompatibility evaluation, methods to manufacture patient-specific endografts, and comprehensive data on the acute and chronic vascular response of the shape memory polymer endografts. The broader impacts of this work lie in the development of the next generation of medical devices using advanced materials with characteristics that can be customized to the patient. The successful development of useful devices from such technologies should pave the way for a plethora of commercial opportunities including tissue-engineering applications whereby the "seeds' of new tissues or organs can be incorporated into shape memory polymer devices and delivered using minimally invasive methods into the target site to eventually grow healthy tissue. The ability to fuse shape memory polymer technology with advanced three-dimensional imaging and automated manufacturing methods, such as rapid prototyping and stereo-lithography, promises to open up the exciting prospect of creating patient-specific devices within the operating suite; devices that once manufactured can be compacted in situ into a catheter and delivered immediately into the patient. Lastly, successful completion of the overall project should have immediate impact on a disease that is the 13th leading cause of death in the US, and consequently on human health.

Title: SBIR Phase II: Fire-Retardant Phase Change Materials from Fats and Oils

Award Number: 0750470
Program Manager: Gregory T. Baxter

Start Date: April 15, 2008
Expires: March 31, 2010
Total Amount: $500,000

Investigator: Mark Sutterlin, rusty@renewablealternatives.com
Company: Renewable Alternatives, LLC
4009 Day Flower Ct.
Columbia, MO 65203
Phone: (573) 884-0562

Abstract:

This Small Business Innovation Research (SBIR) Phase II research focuses on a new type of phase change material(PCM)that can meet performance goals of being fire-retardant, non-toxic, and renewable. This project will advance the state of understanding of fat/oil chemistries. It will also advance our understanding of non-ideal mixture behavior. Applications that will benefit include such things as clothing, building construction and HVAC systems. Fat and oil based PCMs currently produced by the company both out-perform paraffin-based PCMs and cost less. While customers have overwhelmingly accepted these renewable PCMs, they overwhelmingly expressed their desire that fire-retardant phase change materials be developed. The broader impacts of this research includes the incorporation of PCMs into applications that would have impacts for both general public and the military/emergency response personnel. Phase change materials find a range of applications, including clothing, construction materials, and food containers. The introduction of lower-cost fire-retardant phase change materials will have broader impacts through improved utilization in consumer products. Applications not previously pursued will be open to use of these materials because of reduced risk of fire. When used in buildings, the phase change materials can reduce energy costs year-round. An improved understanding of the associated fat and oil chemistry will likely find other applications in the fat and oil industries.

Title: SBIR Phase II: Novel Titanium Tantalum Materials for Improved Biomedical Implants and Medical Devices

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| Award Number: | 0724433 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | August 1, 2007 |
| Expires: | July 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Harvey Fisher, hfisher@dynamettechnology.com
Company: Dynamet Technology, Inc
Eight A St
Burlington, MA 01803
Phone: (617)272-5967



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will use Titanium-Tantalum (Ti-TA) alloys, with the objective that these materials will become commercial alloys used in orthopaedic and stinting devices. Ti-30Ta has potential as a highly biocompatible implant alloy with a modulus closer to that of bone (thus mitigating bone shielding), and is potentially less notch-sensitive than standard titanium implant alloys. This project will also demonstrate that advanced powder metallurgy can produce novel titanium alloys that are extremely difficult and prohibitively expensive to produce by other means. Critical material property data of these alloys will be generated that will lead medical device manufacturers to incorporate these alloys into specific devices and to conduct the necessary testing and clinical trials for commercial product release.

The broader impacts from the use of Ti-Ta alloys will enable the development of improved medical devices that will last longer; are less invasive, promote faster patient recovery times and minimize the risk of adverse reactions. Advances in orthopedic and cardiovascular products will also significantly reduce short-term and long-term health care costs associated with such medical conditions and surgical procedures. Ti-Ta materials will also offer advantages for non-biomedical applications, in regard to mechanical properties as well as to shape memory and superelastic properties. For example, such materials can be expected to also offer improved properties such as resistance to corrosion, oxidation and high temperatures. Thus, availability of these alloys will be applicable to a wide variety of industrial, consumer and aerospace products in addition to biomedical applications, resulting in significant commercial potential.

Title: STTR Phase II: Variable Diameter Fiber Reinforced Biopolymers for Minimally Invasive Orthopedic Implants

Award Number: 0548663
Program Manager: Rathindra Dasgupta

Start Date: September 20, 2006
Expires: September 30, 2008
Total Amount: $499,849

Investigator: James Mason, grangeng@comcast.net
Company: Granger Eng
PO Box 845
Granger, IN 46530
Phone: (574)272-0552

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will develop a new ceramic fiber technology for reinforcing injectable bioplastics used in orthopaedic applications. The main goal of this research project is to achieve a significant increase in strength and stability of the proposed product over current injectable polymer based biomaterials through a combination of variable diameter fibers and new cements.

The proposed product would result in the enablement of new surgical techniques. In addition, the research might be applicable to injection molding of mass produced plastics which could significantly strengthen many products.

Title: SBIR Phase II: All Natural Biobased High Performance Composites for Industrial Applications

Award Number: 0518940
Program Manager: George B. Vermont

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $450,117

Investigator: N Hecht, bhecht@acrtucson.com
Company: Advanced Ceramics Research, Inc
3292 E Hemisphere Loop
Tucson, AZ 85706
Phone: (520)573-6300

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to optimize and commercialize the manufacturing of all natural biobased composites from renewable resources. Phase I research demonstrated the technical feasibility of fabricating soybean oil based composites using a selected fiber/resin polymer composite combination. The Phase II project will focus on optimization and scale-up of the fabrication approach and process to improve the performance of the biobased composites. Further, with the help of commercial partners, Phase II work will develop a number of full scale prototype products with the following features: (1) the products contain 80% or more natural fibers and resins; (2) the products rely on economical and environmentally friendly tooling and manufacturing processing; and (3) the products comply with performance, safety, durability, and cost requirements set by end-users.

The commercial applications of this project will be in a number of areas, including low cost building materials for industrial and household furniture, packaging materials, piping for remote areas and aquaculture systems. The proposed biobased composites are expected to have higher value-in-use industrial applications than their petroleum counter-parts (that is, to be available at a lower cost while offering the same functionality).

Title: SBIR Phase II: Advanced Controlled-Impedance Transfemoral Knee/Ankle Prosthesis

Award Number: 0450632
Program Manager: Michael R. Ambrose

Start Date: January 15, 2005
Expires: December 31, 2006
Total Amount: $500,000

Investigator: Edwin Iversen, ed@utaharm.com
Company: Motion Control, Inc.
2401 S 1070 W # B
Salt Lake City, UT 84119
Phone: (801)978-2622

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a transfemoral prosthesis which will allow wearers to walk and run more smoothly, with greater stability and less effort. Typically, transfemoral amputees have difficulty achieving a natural gait, thus causing discomfort and greater energy expenditure. It is expected that the development of this advanced prosthesis will greatly enhance the function and comfort of amputees and bring new technology to the prosthetic industry. In Phase I research, a unique engineering model of the knee and the ankle was developed, implementing the pneumatic compliance (spring) and electrically-controlled hydraulic damping. In Phase II, complete prototypes of the microprocessor-controlled knee/ankle prosthesis will be developed, with the following features: (a) compliant (elastic, rather than stiff) knee flexion during stance phase, which will return energy to the wearer and improve comfort, (b) co-ordination of knee and ankle impedance to match desired walking cadence, and minimal energy expenditure by tuning the spring rate to the natural frequency; and (c) myoelectric control of knee impedance. In addition, high-performance features will be integrated into the prosthetic device, including adaptive swing phase knee impedance, and automatic control of stance phase impedance.

The commercial application of this project will be in the area of prosthetic devices for use by people with knee and foot (transfemoral) amputation. The proposed product will allow the amputees to wear their prosthesis for a longer time period, with less effort and more safety, and to walk on more rugged and uneven terrain. Estimates of revenues resulting from this project show gross sales starting at $750,000 per year, growing rapidly after 5 years to over $8,000,000.

Title:  SBIR Phase II: Tissue Engineered Cartilage for Drug Discovery

Award Number: 0422194
Program Manager: Om P. Sahai

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $498,843

Investigator: Brian Pfister, bpfister@articular.com
Company: Articular Engineering, LLC
1818 Skokie Blvd. Suite 158
Northbrook, IL  60062
Phone: (847)498-9634

Abstract

This Small Business Innovation Research (SBIR) Phase II project is to develop scale-up production technology to produce engineered cartilage for drug discovery using a proprietary Alginate Recovered Chondrocyte (ARC) method. This method stimulates adult human cartilage cells to form a cartilaginous tissue with proper compositional and functional properties. ARC cartilage tissue is expected to offer a cost-effective alternative to current culture systems and expensive animal studies while utilizing human tissue.

The commercial application of this project will be in the area of drug discovery for cartilage-related problems such as rheumatoid arthritis.

Title: SBIR Phase II: Scalable Synthesis and Processing of Nanocrystalline Hydroxyapatite

Award Number: 0349884
Program Manager: Om P. Sahai

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $499,999

Investigator: Edward Ahn, eahn@angstrommedica.com
Company: Angstrom Medica, Incorporated
150 California Street
Newton, MA 02458
Phone: (617)454-3620

Abstract

This Small Business Innovation Research (SBIR) Phase II Project proposes to use a newly developed synthetic nanocrystalline hydroxyapatite (HAP) bone material to produce high-strength, resorbable synthetic bone implants for anterior cruciate ligament surgeries. This material solves the problem of current orthopedic implants (made of polymer and/or metal) which either permanently reside as foreign material in the body or quickly degrade into a formless mass of non-ossified, non-load bearing tissue. The objectives of the Phase II work are to concurrently scale up manufacturing processes for HAP to near-commercial levels while developing an anterior cruciate ligament (ACL) prototype product for testing in vivo.

The commercial impact of this project will be in the area of orthopedics. The proposed technology will help decrease the time of healing in surgeries requiring implants (fractiures, ACL) and will minimize the need for second surgeries to remove the screws and/or to correct for morbidities.

# Biomedical Devices and Instrumentation

Title: STTR Phase II: Magnetohydrodynamic-based Circular Liquid Chromatography

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| Award Number: | 0822723 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $499,923 |

Investigator: Christine Evans, ceevans@sfc-fluidics.com
Company: SFC Fluidics, LLC
535 W Research Blvd, Suite 135,
Fayetteville, AR 72701
Phone: (479) 571-2592

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project develops a circular chemical separation system on a small (~1 inch x 1 inch) chip. This chip and the associated instrument will separate complex mixtures for biological, chemical, medical, and industrial applications. Based on magnetohydrodynamic (MHD)-driven liquid flow, liquid chromatographic (LC) separations will be accomplished in a circular, closed-loop format. Typically, LC separations require a sample containing multiple analytes to flow in a single direction along a fixed-length, linear column with detection performed after the analytes elute from the column. In the circular LC system, miniaturization is possible because samples are instead circulated around a closed-loop chromatographic column thus, the effective column length is not limited to small chip dimensions. Very few methods can provide the mobile-phase pumping in a closed-loop that is required for practical application of circular LC. The MHD-based circular LC system envisioned will be small, portable, and designed for laboratory as well as field use. The sealed LC chip will contain the stationary phase, mobile phase, and all in situ MHD pumps needed to conduct the separation of complex samples. This prototype LC instrument will be designed and fabricated with a built-in fluorescence detector for monitoring analyte separation directly on the chromatographic column. The broader impacts of this research are highlighted by the ability of the proposed circular separation system to miniaturize a valuable analytical tool, liquid chromatography (LC). Samples of interest include human blood serum, saliva, and urine, with component analytes of interest that are equally diverse (e.g. proteins, pharmaceuticals, and small molecular biomarkers). Many analytes in these complex mixtures have similar properties and cannot be separated and analyzed using a very short chromatographic column, which has limited the miniaturization of this important analytical tool. This limitation is overcome using circular LC, where the effective column length is not limited by the small chip sizes that are essential for portable LC instrumentation. SFC Fluidics' core technology makes possible the miniaturized, closed-loop pumping required for implementation. This method has broad implications for the portable LC systems for field deployment or point-of-care applications. The market opportunity is expected to be significant, particularly when considering that applicability extends beyond the traditional instrumentation market into the worldwide point-of-care diagnostics market.

Title: SBIR Phase II: Optical Spectroscopy for Colon Cancer Screening without Colonoscopy

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|---|---|
| Award Number: | 0823064 |
| Program Manager: | Cynthia A. Znati |
| Start Date: | July 15, 2008 |
| Expires: | June 30, 2010 |
| Total Amount: | $500,000 |


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|---|---|
| Investigator: | Andrew Cittadine, andrew.cittadine@americanbiooptics.com |
| Company: | American BioOptics, LLC<br>1801 Maple Ave<br>Evanston, IL 60201 |
| Phone: | (847) 467-0628 |


Abstract:


This Small Business Innovation Research (SBIR) Phase II project aims to develop a commercial grade optical probe and system for FDA clinical trials and subsequent commercialization of a population-wide colon cancer screening test. An interdisciplinary research team of engineers, biologists, and clinicians has developed low-coherence enhanced backscattering (LEBS), an optical technique which enables sensing tissue microarchitectural correlates of the genetic/epigenetic changes in otherwise histopathologically normal mucosa. The preliminary animal and human studies demonstrated the potential of LEBS to detect subtle alterations in histologically normal-appearing tissue that occur with the presence of precancer in a different part of an organ, a consequence of the well-established concept of field carcinogenesis. This opens a possibility to detect colonic adenomas by means of LEBS analysis of rectal tissue, which is readily accessible using a rectal probe and without the need for colonoscopy or bowel preparation. Indeed, ex vivo human studies and a small-scale trial of the in vivo LEBS probe from Phase I research demonstrate that rectal LEBS is remarkably accurate for predicting neoplasia anywhere in the colon. In continued close collaboration with the research team, American BioOptics endeavors in Phase II to refine the prototype LEBS probe into a medical-grade probe for use in a patient without bowel preparation and to develop a low-cost LEBS optical system for multi-center FDA trials and subsequent commercialization. LEBS has the potential to become the first truly population-wide test for colon cancer screening performed during an annual exam by a primary care physician, without colonoscopy or bowel preparation to determine the need for colonoscopy. The proposed test would be simple, inexpensive, minimally intrusive and highly accurate without the need for bowel cleansing. Colon cancer is the second leading cause of cancer deaths in the U.S. largely because of especially poor screening participation relative to other major cancers. Only a small fraction of eligible population (90 million Americans over age 50) undergoes screening colonoscopy due to a variety of reasons including expense, patient reluctance, complications, and insufficient number of endoscopists. Development of a minimally invasive test to identify patients who do and do not harbor colonic adenomas is of crucial importance to enable, for the first time, population-wide screening for this disease. Currently, no such initial screening test is available. Based on the results of the LEBS test, the physician could recommend either no colonoscopy (the majority of cases) or need for colonoscopy (which the patient will be more compliant with). Thus, with a readily available LEBS screening test developed in Phase II and subsequent FDA approval, more patients with colonic neoplasia will undergo colonoscopy. The LEBS test would not only prevent many more colon cancer deaths by screening a larger part of the population, but it would also reduce costs/complications of screening in the majority of the population who are not destined to develop neoplasia.

Title: SBIR Phase II: Automated Analysis of Body Fluid Chemistry Using MHD-Based Microfluidics

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| Award Number: | 0750328 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | February 15, 2008 |
| Expires: | January 31, 2010 |
| Total Amount: | $500,000 |

Investigator: Christine Evans, ceevans@sfc-fluidics.com
Company: SFC Fluidics, LLC
535 W Research Blvd, Suite 135,
Fayetteville, AR 72701
Phone: (479) 571-2592

Abstract:

This Small Business Innovation Research (SBIR) Phase II Proposal develops a suite of labs-on-a-chip that can be used to establish the metabolic health of an individual in real-time from a finger-prick sample of blood. Each disposable chip will contain all reagents necessary to run the assay and all waste will be stored on the chip. These sealed, self-contained assay chips will be based on magnetohydrodynamic microfluidics and microelectrochemical detection and will allow for the simultaneous quantization of multiple biomarkers. The biomarkers chosen for this project have been linked to an individual?s metabolic health in a broad range of high importance areas, including aging, cardiovascular health, neurochemical health, and prepregnancy health. The ability to quantify the biomarkers simultaneously will allow for assessment of an individual?s metabolic status and determination of an intervention strategy within the time scale of a single visit to the doctor. Any necessary follow-up visit will provide immediate feedback on success or failure of the intervention strategy. This point-of-care testing platform will allow both doctor and patient to take a more proactive stance in the management of an individual?s metabolic status. The broader impacts of this research meet a need for improved preconception care. This technology can be expanded to include additional biomarkers that will allow for convenient, inexpensive screening of a number of health issues, including pernicious anemia, renal disease, neurochemical health and cardiovascular health that could broaden its impact on improving the Nation's healthcare.

Title: SBIR Phase II: High-Throughput In-Situ Crystallography Screening System

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| Award Number: | 0750353 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | February 15, 2008 |
| Expires: | January 31, 2010 |
| Total Amount: | $499,393 |

Investigator: Steve Wang, youngkreisler@gmail.com
Company: Xradia
4075A Sprig Drive
Concord, CA 94520
Phone: (925) 288-1818

Abstract:

The Small Business Innovation Research (SBIR) Phase II project aims to develop a high throughput crystallography screening system aimed at accelerating and automating crystal growth for structural studies. X-ray crystallography is the primary method for determining the molecular structure of biological macromolecules, including proteins and nucleic acids. Yet, although crystals are an ideal material for analyzing the structure of solids, growing crystals of sufficient quality for diffraction studies has heretofore been a tedious and labor-intensive undertaking. Thus, the development of a platform that allows automation, miniaturization and parallelization for obtaining crystals of optimal quality would be a significant step forward in crystallography and would accelerate structural studies. An improvement in this area would therefore be of interest not only to academic scientists engaged in structural studies, but also to pharmaceutical researchers who are interested in the structural relationship of drugs and their targets.

Title: SBIR Phase II: Non-Contact Optical Stethoscope for Neonatal Patients

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|---|---|
| Award Number: | 0724449 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | July 15, 2007 |
| Expires: | June 30, 2009 |
| Total Amount: | $500,000 |

Investigator: Andrey Vyshedskiy, andrey@stethographics.com
Company: Stethographics
21 Wayside Road
Westborough, MA 01581
Phone: (508)320-2841

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop a non-contact optical stethoscope for use in Neonatal Intensive Care Units (NICU). Premature babies in NICU require monitoring for signs of lung congestion and heart disease. Currently NICU medical personnel use acoustic stethoscopes. The use of acoustic stethoscope has a number of highly undesirable side effects including withdrawal response, flinching, apnea, hypoxemia, change in sleep state, and possibility of contamination. During Phase I a prototype non-contact optical stethoscope, capable of recording good quality heart and lung sounds was developed. The non-contact stethoscope is based on a standard technique of interferometry with a novel fiber optic design. The fiber optic design avoids the use of glass components - mirrors, lenses, splitters, and prisms - and yields a light, rugged and inexpensive interferometer.

The non-contact optical stethoscope based on the fiber optic interferometer could greatly improve the quality of care for neonates, burn victims, immuno-suppressed patients, and in those cases where direct contact should be avoided. A laser interferometer based on a novel fiber optic design has been developed. The interferometer based on fiber optics is light, inexpensive, and rugged as it does not require component alignment. The handheld point-and-listen microphone based on the fiber optic interferometer can be ideally positioned to enter the existing laser interferometry market and to open new markets including medical, preventive maintenance of rotating machinery, military urban and rescue operations, as well as law enforcement surveillance.

Title: SBIR Phase II: POINT - Precision Optical Intra-Cellular Near-field Technology

Award Number: 0548768
Program Manager: Ali Andalibi

Start Date: September 25, 2006
Expires: August 31, 2008
Total Amount: $338,122

Investigator: Joanne Ebesu, doconnell@oceanit.com
Company: Oceanit Laboratories
1001 Bishop St Suite 2970
Honolulu, HI 96813
Phone: (808)531-3017

Abstract:
This Small Business Innovation Research (SBIR) Phase II project proposes to develop a novel high-resolution instrument capable of penetrating live cells. Currently there are no methods that allow the inside of a living cell to be imaged down to 50 nm resolution or less. Confocal microscopes, MRI and ultrasound cannot image to this resolution and the use of electron microscopes destroys the cells. The potential to develop nanosensors capable of penetrating a cell without destroying its natural environment may provide new information about the molecular makeup of a cell. The proposed Precision Optical Intra-cellular Near-field Technology (POINT) is an innovative adaptation of Near-Field optical microscopy using solid emersion lens (SIL) technology coupled with a sub-wavelength aperture probe. The goal of the Phase I project was to research the feasibility of developing a near-field probe and solid immersion lens combination that would be useful for biological research by providing nanometer scale resolution and enhanced light throughput to image inside intact cells. A small optical excitation volume is provided by a near-field probe, circumventing the diffraction limit to obtain sub-wavelength spatial resolution. This new capability offers higher sensitivity and resolving power than is presently available in microscopy, and could provide a more detailed understanding of molecular processes underlying mutations that lead to any of a number of diseases such as cancer. Solid immersion lenses were successfully fabricated in house by grinding and polishing commercially available ball lenses and validation experiments were then carried out. It was demonstrated that a tighter focused laser spot and narrower spectral width were achieved when using a SIL. This corresponds to higher light coupling to a probe placed at the bottom of the SIL. Successful probe fabrication was achieved based on optical modeling for optimum light throughput.

In phase II we will develop the platform needed to use this SIL/Probe optical tool in conjunction with a regular microscope. The use of a nanoposition stage for precise alignment and extremely small motion of the probe will be integrated as well as a feedback mechanism that signals when physical contact is achieved, such as the probe penetrating a cell's membrane. Various SIL/Probe designs will be characterized including a custom SIL with phase grating for laser wavelengths in the blue. The work in Phase II is a direct follow-on from what was achieved under the Phase I effort.

Title: SBIR Phase II: Microelectrochemical Assays for Malaria Parasites

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| Award Number: | 0548742 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | February 16, 2006 |
| Expires: | February 29, 2008 |
| Total Amount: | $518,000 |


Investigator: Zoraida Aguilar, zoraida.aguilar@vegrandis.com
Company: Vegrandis
535 West Research Blvd
Fayetteville, AR 72701
Phone: (479)571-2592



Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of an automated, high-throughput, sensitive and specific assay for the micorelectrochemical detection of malaria parasites. The use of microelectrochemical assay will allow for the detection of malarial parasites with a combination of attributes, such as all four species to the level of one parasite per microliter of blood without sample preparation.

This technology will impact the current blood donor screening guidelines that call for the deferral of potential donors for one year following travel to malaria endemic regions. Not only do cases of fatal transfusion-transmitted malaria occasionally occur, but also the availability of the blood supply is reduced. This technology will aid the blood banking industry by providing an inexpensive, high-throughput, low detection limit malaria test as blood donor screening tool.

Title: SBIR Phase II: Hybrid Inorganic/Organic Ion Exchange Material for the 227Ac/223Ra Generator

Award Number: 0450581
Program Manager: George B. Vermont

Start Date: April 15, 2005
Expires: March 31, 2007
Total Amount: $452,553

Investigator: Hariprasad Gali, hari.gali@lynntech.com
Company: Lynntech, Inc
7607 Eeastmark Dr Ste 102
College Station, TX 77840
Phone: (979)693-0017

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a generator to produce pure radium-223 for use in cancer therapy. The alpha-emitter Ra-223 has a longer half-life than the other alpha-emitting radioisotopes (213 Bi, 212Bi and 211At) that are currently being evaluated for use in radio-immunotherapy (RIT), and has been shown to have higher bone uptake than the commercially available beta-active bone seekers. This makes it very attractive for Ra-223 to be developed further for radiopharmaceutical applications and for use as a pain palliation agent. However, the research and clinical application of this isotope are hindered by the limited availability of pure Ra-223. A simple technique to produce the isotope is a generator where a suitable parent, in this case Ac-227, is immobilized on an ion exchanger column and Ra-223 is eluted when required. Current separation methods frequently use organic resins, which tend to degrade under ionizing radiation and thus the product may contain impurities. Prior Phase I work developed new hybrid inorganic/organic ion exchange materials with high affinity for actinium, but low affinity for radium and good resistance against radiation. The Phase II project will optimize the exchanger performance and fabricate a prototype of the Ra-223 generator.

The commercial application of this project will be in the area of cancer therapy. It is expected that the easy - to - use generator, which poses a smaller radiation hazard to personnel, will be used at medical research centers, radio - pharmacies and hospitals to produce pure radium - 223 to treat patients with bone metastases and other small solid tumors.

Title: SBIR Phase II: Detection and Identification Instrument for Single Molecule Analysis

Award Number: 0450539
Program Manager: George B. Vermont

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $500,000

Investigator: Arieh Karger, AKarger@RMDInc.com
Company: Radiation Monitoring Devices Inc
44 Hunt Street
Watertown, MA 02472
Phone: (617)668-6801

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a novel, low cost laboratory instrument for genetic analysis and single molecule studies. The technology is suitable for the detection and identification of DNA and RNA through fluorescent hybridization probes without the need for Polymerase Chain Reaction (PCR) amplification, or for proteins and small molecules through fluorescence immunoassays. The general scheme is based on single molecule detection (SMD) and utilizes the two-color cross-correlation spectroscopy (TC-FCCS) technique with coincident detection analysis scheme to simultaneously probe ten focal regions of a microfluidic assay. High efficiency single photon detectivity Geiger mode microavalanche photodiode (uAPD) arrays will function as detection elements.

The commercial application of this project will be on biological and medical research, and on the drug development process. Examples of potential applications range from the study of conformational dynamics and interactions of macromolecules to biochemical kinetics of single molecules.

Title: SBIR Phase II: Three-Dimensional (3D) Laparoscope

Award Number: 0422102
Program Manager: George B. Vermont

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $428,918

Investigator: Kurtis Keller, kurtis@inneroptic.com
Company: Inneroptic Technology Incorporated
106A N. Churton St.
Hillsborough, NC 27278
Phone: (919)962-1746

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to develop a fully functional prototype 3-D laparoscope, which will be superior to the 2-D laparoscopes currently used in surgeries, based on laser illuminated miniaturized projector for computer generated light patterns and two cameras for acquisition of color and depth.

The commercial application of this project will be in surgical operations. This device will have the capacity to provide depth and computer enhanced view of the surgical domain more akin to open surgery. This would allow for more precision in surgical procedures, thereby eliminating hand-eye coordination issues and reducing mistakes and accidents.

Title: SBIR Phase II: Novel Nanosized Magnets for Highly Sensitive Multiplexing Bio-Molecular Detection

Award Number: 0450641
Program Manager: George B. Vermont

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $497,185

Investigator: Ted Sun, ted@ls-tek.com
Company: LS Technologies
44160 Old Warm Springs Blvd
Fremont, CA 94538
Phone: (510)651-1329

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop and validate highly sensitive contrasting agents in-vivo, for magnetic resonance imaging (MRI) diagnosis, based on a series of novel nano-sized ferromagnets. Prior Phase I work used combinatorial chemistry to synthesize magnetic nanoparticles with significantly enhanced magnetic resonance signal and sensitivity than currently available paramagnetic contrasting agents. The specific objectives of Phase II research are to further optimize the nano-magnet cores with combinatorial chemistry , to functionalize their surfaces for in-vitro imaging of cells, to validate the newly developed contrasting agents in comparative animal MRI studies against products in use, and to evaluate their toxicity effects.

The commercial application of this project will be in the area of whole-body imaging techniques. The proposed technology will enable superior medical images to be taken at significantly higher throughput and sensitivity, and at a lower cost. Further, it may allow for new medical diagnosis-imaging applications using magnetic resonance (for example, in the early detection and prevention of cardiovascular disease).

Title: SBIR Phase II: Catheters with Anticoagulation and Fibrinolytic Properties

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| Award Number: | 0422181 |
| Program Manager: | Michael R. Ambrose |
| Start Date: | November 1, 2004 |
| Expires: | October 31, 2006 |
| Total Amount: | $510,774 |

Investigator: Jun Du, Ydu@spirecorp.com
Company: Spire Corporation
1 Patriots Park
Bedford, MA 01730
Phone: (781)275-6000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop blood-compatible biomaterials for end-stage renal dialysis (ESRD) catheters through an integrated biological coating (IBC) that combines protein passivation, anticoagulation, and fibrinolytic mechanisms on the surface. Phase II work will build on the Phase I demonstration that internal and external surfaces of $BaSO_4$-loaded polyurethane catheters were activated by an electron cyclotron resonance (ECR) process that promoted uniform deposition of an IBC coating. In the Phase II project, the coating process will be optimized and deposition equipment will be upgraded to enhance reliability and repeatability. Finished catheters will be produced and evaluated for blood compatibility through in vitro human blood testing and ex vivo sheep shunt model experiments. Finished IBC catheters will also undergo rigorous mechanical, biocompatibility, and toxicity testing to show compliance with FDA standards.

The principal commercial application of this project will be on the catheter industry. The proposed technology will also find applications in coatings for other blood-contacting devices such as grafts, polymeric stents , valves and by-pass systems.

Title: SBIR Phase II: Robotic Scrub Technician

Award Number: 0422114
Program Manager: George B. Vermont

Start Date: November 1, 2004
Expires: October 31, 2006
Total Amount: $491,500

Investigator: Michael Treat, mt23@columbia.edu
Company: Robotic Surgical Tech, Inc.
5141 Broadway
New York, NY 10034
Phone: (212)932-4520

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a robotic scrub technician that anticipates a surgeon's request for an instrument during surgery using robotics technology. Phase II research will build upon the success achieved in Phase I work , and will implement cognitive architecture over the current physical and sensory system of the robot. To validate the cognitive architecture, the robot will assist surgeons while performing operations on a physical simulator and in experimental animals. In this way, errors both robotic and human will come into play. The robot's actions will be judged using criteria for speed and clinical appropriateness, and the cognitive architecture will be modified to eliminate undesired behaviors. It is expected that the robot will perform in a clinically acceptable way.

The commercial impact of this project will be in the area of healthcare. The proposed work addresses the issue of critical shortage of nurse technicians, and could reduce personnel costs in hospitals. Furthermore, the use of robots for this environment may free up human technicians to do more critical tasks.

Title: SBIR Phase II: Multipass Second Harmonic Generation

Award Number: 0421974
Program Manager: Om P. Sahai

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $492,690

Investigator: Guido Knippels, gknippels@picarro.com
Company: Picarro, Inc.
480 Oakmead Parkway
Sunnyvale, CA 94085
Phone: (408)962-3919

Abstract

This Small Business Innovation Research (SBIR) Phase II project is to develop low-cost, 20-50 mW blue and green lasers for bioinstrumentation applications. The Phase II program objectives are to : (1) design, assemble and test 20 mW 505 nm laser prototypes; (2) to validate laser performance in a commercial bio-instrumentation application; and, (3) to assemble, test, and validate 50 mW blue-green laser prototypes using a higher efficiency second harmonic generation (SHG) architecture.

The commercial application of this project will be the availability of inexpensive laser light sources for researchers in cellular biology and DNA sequencing.

Title: SBIR Phase II: Automated Monitoring and Alarming for Elder Care

Award Number: 0422154
Program Manager: Om P. Sahai

Start Date: September 1, 2004
Expires: August 31, 2006
Total Amount: $481,203

Investigator: Rajeev Sharma, rsharma@advancedinterfaces.com
Company: Advanced Interfaces, Inc.
403 South Allen Street
State College, PA 16801
Phone: (814)867-8977

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop an automated monitoring system for residents living in elder care facilities. This system will enable the facility staff to quickly respond to any event or behavior requiring intervention, such as an accidental fall, using computer vision for tracking and behavior analysis. Prior Phase I research demonstrated the feasibility of this approach for fall detection and behavior analysis with the help of a laboratory prototype. This work also highlighted several challenges, such as dealing with changing lighting conditions and complex behaviors. Phase II research will focus on addressing these challenges and creating twelve beta sites in actual elder care facilities to further develop and test the algorithms.

The commercial application of this project will be on institutions linked to the care of the elderly. With over 50% of the growing population of seniors staying in independent / assistive living facilities or nursing homes, injuries and deaths resulting from unattended falls represent a serious societal and economical problem. Over 1.8 million seniors fall each year, with each fall costing an average of $9,400 in hospitalization. The proposed work could lead to a solution that provides a way for quickly responding to falls, saving hospitalization costs up to 26% and more importantly, reducing the likelihood of death by as much as 82%. It would also help in generating a feeling of security for the elders and their care givers, without a substantial increase in healthcare costs.

Title: SBIR Phase II: MicroElectroMechanical Systems (MEMS) Wavefront Correction Device for Ophthalmic Adaptive Optics

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| Award Number: | 0421965 |
| Program Manager: | Om P. Sahai |
| Start Date: | August 15, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $492,983 |

Investigator: Steven Rodgers, steve.rodgers@memx.com
Company: MEMX, Inc.
2620 Augustine Drive
Santa Clara, CA 95054
Phone: (408)764-0185

Abstract

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a MEMS wavefront correction device for ophthalmic adaptive optics. The use of adaptive optics in ophthalmics shows great promise, but the lack of suitable cost-effective solutions has hindered the advance of research and the development of associated commercial markets. The proposed work will leverage the most sophisticated surface micromachining technology available to design and deliver, for the first time, a MEMS wavefront correction chip that addresses all of the requirements specified by the vision science community. The commercial application of this project will be in the area of ophthalmology. Ophthalmic equipment suppliers need low cost wavefront correction devices for use in next generation phoropters and autorefractors, LASIK preview systems, and high resolution fundus imaging systems.

The ophthalmic market for low cost wavefront correction devices, once such devices are available, is projected to be at least $20 million per year. Such devices may also have utility outside of ophthalmics. Optical coherence tomography, confocal microscopy, portable military imaging systems, free space optical communication systems, and semiconductor lithography are other potential application areas for wavefront correction devices.

Title: SBIR Phase II: Mouthrinse Generator for Plaque and Halitosis Control

Award Number: 0349689
Program Manager: Om P. Sahai

Start Date: March 1, 2004
Expires: February 28, 2006
Total Amount: $492,100

Investigator: Charles Tennakoon, charles.tennakoon@lynntech.com
Company: Lynntech, Inc
7607 Eastmark Drive, Suite 102
College Station, TX 77840
Phone: (979)693-0017

Abstract

This Small Business Innovation Research (SBIR) Phase II will develop and commercialize electrochemically operated devices that will revolutionize the oral hygiene industry by providing an on-demand generation of mouthwash in a portable device and in an irrigator. The mouthwash generated in these devices will be effective in controlling halitosis and dental plaque and will also provide tooth whitening. In the Phase I study, all of the proposed objectives and specified criteria of success were accomplished to amply establish the proof of concept and feasibility of the project. In Phase II, further optimization of the parameters will be followed by the design and fabrication of prototypes in conjunction with a prominent company dealing with turnkey manufacturing, and the testing of 100 portable units in a clinical setting.

The commercial impact of this project will be in the area of oral hygiene products. It is broadly estimated that up to 85 million Americans have halitosis, and over 35 million suffer from periodontal disease. Thus, the cost effective devices to be developed in this project are expected to have a large market potential in the $ 4.7 billion oral care industry.

Title: SBIR Phase II: Novel Breath Diagnostic Instrument for Detection of Disease

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| Award Number: | 0349782 |
| Program Manager: | Om P. Sahai |
| Start Date: | February 1, 2004 |
| Expires: | January 31, 2006 |
| Total Amount: | $490,293 |

Investigator: Douglas Baer, d.baer@lgrinc.com
Company: Los Gatos Research
67 East Evelyn Avenue, Suite 3
Mountain View, CA 94041
Phone: (415)965-7772

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a carbon isotope ratio analyzer based on Off-Axis Integrated Cavity Output Spectroscopy to measure the ratio of the isotopic abundances of 13C to 12C in exhaled breath. The compact analyzer will serve as a medical diagnostic instrument and will operate in a point-of-care setting. The instrument combines robust telecommunications-grade diode lasers with Off-Axis ICOS, an innovative technology that provides extremely long optical paths (several kilometers typical) for ultrahigh sensitivity. The instrument will be inexpensive, portable and easy to use and report measurements of 13CO2/12CO2 with sufficient sensitivity and precision to replace mass spectrometry in 13C-labeled breath tests for diagnosis of several diseases. Prior Phase I work has successfully demonstrated a laboratory instrument with a precision of 0.24 per mil (0.024%) in less than 6 minutes. In Phase II, a prototype instrument capable of autonomous operation, will be developed and tested in on-going clinical trials.

The commercial impact of the project will be significant, as the proposed instrument will aid in quick diagnosis of gastrointestinal diseases at the doctor's office, thereby enhancing rates of patients' compliance with treatment regimens.

# Bioprocessing and Industrial Bioproducts

Title: SBIR Phase II: Room Temperature Medical Waste Treatment

Award Number: 0750056
Program Manager: Gregory T. Baxter

Start Date: February 15, 2008
Expires: January 31, 2010
Total Amount: $505,999

Investigator: Czeslaw Golkowski, cg18@cornell.edu
Company: Super Pulse
227 Durfee Hill Rd
Ithaca, NY 14850
Phone: (607) 255-6474

Abstract:

This Small Business Innovation Research (SBIR) Phase II research develops a novel, reliable, affordable, technology for effective decontamination/sterilization of medical waste. The technology is based on an air/gas sterilant produced in a non-thermal plasma source powered by a standard microwave oven magnetron. The simplicity and the affordability of the technique to produce an effective gas sterilant capable of sterilizing a wide range of materials and surfaces at low-temperature and with low energy requirements provides technology suitable for a low cost decontamination/sterilization device for medical and dental offices/clinics. This technology is free of chemical residue, low maintenance, and simple in operation. The broader impact of this research is to improve the safety of doctors' offices and hosptials through on-site sterilization of biohazardous and infectious wastes. The technology provides a significant power saving and decreases the number of medical waste incinerators that contribute harmful emissions to the environment.

Title: SBIR Phase II: High Performance Cement Additive from an Agricultural Byproduct

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| Award Number: | 0724463 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | September 15, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Rajan Vempati, chkgroup@worldnet.att.net
Company: ChK Group, Inc.
11700 Audelia Road
Dallas, TX 75243
Phone: (972)234-6744

Abstract:

This Small Business Innovation Research (SBIR) Phase II project develops the manufacturing process for a cement additive from an agricultural biomass waste to be used in the production of High Performance Concrete (HPC), and blended cement. This additive imparts increased strength and durability to concrete; therefore will mostly be used in high-rise buildings, highway construction, and infrastructures built in severe environmental conditions, e.g. petrochemical plants and marine structures. This project will generate increased revenues to the US farmers by selling their byproduct at a higher price and will create jobs in rural areas. Also, potential exists to license the technology to several emerging economies, where there is an urgent need to build transportation-, energy- and building-infrastructures.

The Broader Impacts of this research will be increased and higher value use of this agricultural waste in high strength cement. Utilization of this improved product will reduce pollution caused by the current alternatives in both air and at landfill sites. This research is intended to provide a profitable alternative to farmers producing this crop and create rural jobs.

Title: SBIR Phase II: Development of Resonant Waveguide-Grating Elements for High Throughput Screening of Proteins

Award Number: 0724407
Program Manager: Muralidharan S. Nair

Start Date: July 15, 2007
Expires: June 30, 2009
Total Amount: $500,000

Investigator: Debra Wawro, wawro@resonantsensors.com
Company: RSI
202 E. Border Street
Arlington, TX 76010
Phone: (817)300-8297

Abstract:

This Small Business Inovation Research (SBIR) Phase II research project applies a new sensor principle to develop commercial High-Throughput Screening (HTS) systems for drug-development applications. The advantages of the Guided-Mode Resonance (GMR) sensor concept for such applications reside in its inherent physical characteristics including polarization diversity, materials independence, choice of spectral regions, angular-addressing flexibility, and associated compact system configurations. These properties enable tag-free sensor technology with high sensitivity, high accuracy, and multi-parameter detection. A major objective is the development and verification of GMR-sensor HTS commercial system prototypes in standard formats. Integrated analysis software will present data on biomolecular binding events, including background density and molecular accumulation dynamics, to the user. An additional main thrust is the development of attachment chemistry and methods for sensor activation where a set of protocols and processes for example measurands will be optimized to maximize detection sensitivity. Finally, by applying transmission sensor formats with shaped input light beams and integrated detector matrices, the next-generation compact system designs for massively parallel screening of drug compounds will be provided.

This research project will stimulate progress in drug discovery. Guided-mode resonance sensors operate without chemical tags permitting observation and study of unperturbed biochemical processes, as no foreign substance is introduced. Therefore, these sensors provide enhanced understanding of chemical and biomolecular reactions and may lead to advances in chemical process development and drug discovery and design. Moreover, this class of biosensors has other potential applications including medical diagnostics, proteomics, genomics, environmental monitoring, and homeland security. Application of this technology to microfluidics, lab-on-a-chip, and wireless integrated sensors for homeland security and environmental monitoring may provide new tools for accurate and cost-effective detection of biotoxins, explosives, and hazardous materials.

Title: SBIR Phase II: An Innovative Photobioreactor for Commercial Production of Astaxanthin from Genetically Improved Haematococcus Pluvialis Strains

Award Number: 0724411
Program Manager: F.C. Thomas Allnutt

Start Date: July 1, 2007
Expires: June 30, 2009
Total Amount: $499,866

Investigator: Fan Lu, LF1230NC@yahoo.com
Company: Algaen
3488 Bramlet
Clemmons, NC 27012
Phone: (336)577-4354

Abstract:

This Small Business Innovative Research (SBIR) Phase II research develops an innovative biotechnology for commercial production of natural astaxanthin using genetically improved microalgal strain(s) grown in a proprietary large-scale photobioreactor, and to demonstrate the effectiveness of the new strains in improving bioavailability of astaxanthin. The proposed R&D efforts aim to overcome the major weakness inherent in the present production of astaxanthin-enriched Haematococcus: poor bioavailability of astaxanthin for humans and animals. The company will use several genetically modified Haematococcus strains with remarkably improved bioavailability of astaxanthin. The major objectives of the Phase II research are to design, construct, and evaluate an innovative large-scale photobioreactor system for sustainable mass culture of these new strains. The improved production system will increase astaxanthin productivity by 1.5- to 2-fold with at least 30% cost reduction.

The broader impacts of this technology will be to overcome two major hurdles for the Haematococcus-based astaxanthin industry. The application of this biotechnology will lead to major increases in astaxanthin sales by 2015. It will also result in job expansion in the Haematococcus-astaxanthin production and related industries (e.g., cosmetic, pharmaceutical, and nutraceutical). Reduction in the production costs will lead to decreasing prices, making astaxanthin more affordable to allow more people to take advantage of astaxanthin as a strong antioxidant for improving health and well-being.

Title: SBIR Phase II: Development of a BioAcoustic Mixing Platform

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| Award Number: | 0646562 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $500,000 |


Investigator: Todd McAdams, lcfarrar@resodyn.com
Company: Resodyn Corporation
130 N Main St Ste 600
Butte, MT 59701
Phone: (406)497-5252



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops a mixer based on sound waves applicable for use in bioreactors for cell culturing and fermentors. Cell culturing and fermentation are large markets where significant growth is forecast over the next several years. This research will establish the optimal design and operating conditions for this non-invasive and non-destructive mixing technology. It is anticipated that performance for many applications can be enhanced by 50% or greater over state-of-the-art technology using this novel agitation technology.

The broader impact will be to reduce the costs of pharmaceutical production, when such production is based on biological feedstocks. Media and process development for biological production of pharmaceuticals is costly and time-intensive and performed using stirred-tank bioreactors due to the limitations of orbital shake-flask and cell culture flasks. A mixing technology that could unify laboratory-scale and pilot-scale experiments would be highly valuable in speeding the pace of process development. Low-frequency acoustic energy will dramatically enhance gas-liquid mass transport without increasing hydrodynamic shear stress. The research project will enhance the scientific understanding of low frequency acoustic mixing processes by quantifying the impact of acoustic frequency on oxygen transfer rates and cellular growth. The significance to society that the successful development is a dramatic increase in the pace of biotechnological process development. This will lead to more rapid commercialization of and lower prices for pharmaceutical products that enhance overall quality of life.

Title: STTR Phase II: Engineering Geobacter for Enhanced Electricity Production

Award Number: 0548633
Program Manager: F.C. Thomas Allnutt

Start Date: September 25, 2006
Expires: September 30, 2008
Total Amount: $499,665

Investigator: Christophe Schilling, cschilling@genomatica.com
Company: Genomatica Inc.
5405 Morehouse Dr. Suite 210
San Diego, CA 92121
Phone: (858)824-1771

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project aims to develop commercially viable bacterial strains (Geobacter sulfurreducens) for use as biocatalysts in microbial fuel cells. The research genetically manipulates these bacteria to enable the utilization of alternative substrates and increase current generation through the expression of an energy consuming futile cycle. The rates will be increased and alternative cheaper substrates utilized during this project.

The broader impact of this research will result in development of novel microbial fuel cells that can convert renewable resources such as biomass and agricultural wastes to electrical energy in an efficient fashion with varied commercial applications.

Additionally, innovative the metabolic engineering strategy that is developed could be applied to other industrially relevant microorganisms. In addition, there are significant societal and educational components of this program. One example would be a microbial fuel cell that harnesses electricity from organic waste can be valuable in electrifying remote rural communities in developing countries by decentralizing power generation while protecting the environment.

Title: SBIR Phase II: Continuous Spray-Capture Production System

Award Number: 0620389
Program Manager: Rosemarie Wesson

Start Date: September 21, 2006
Expires: September 30, 2008
Total Amount: $467,005

Investigator: Piechocki Piechocki, JPiechocki@ABN-Corp.com
Company: ABN
7155-H Columbia Gateway Drive
Columbia, AL 21046
Phone: (410)730 8600

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a technology that allows the stabilization of live probiotic bacteria for incorporation into food products outside the dairy case. ABN proposes a novel microencapsulation solution that involves pumping viscous liquids through a spray nozzle, followed by the capture of the resultant particles in a cross-linking fluid. The Phase II objectives are to complete the commercial acceptability of this novel process by modifying the system to make all processes steps compliant with current Good Manufacturing Processes and by designing and fabricating the final critical drying step for the microencapsulated probiotics. This final step will provide a product that is stable enough to be used by the food and feed industries to allow the use of probiotics in products that do not need to be refrigerated.

The manufacturing technology proposed herein is an enabling technology that will open many new commercial opportunities for a number of industries. Stabilization of the probiotics and incorporation into nutritional bars, beverages, cereals, and other food products that do not require refrigeration will greatly expand the commercial potential, and choices for consumers who will benefit from these gut-friendly bacteria. The same technology could also be used for the stabilization and delivery of enzymes, vaccines, and other small molecules whose oral delivery is limited by gastric digestion.

Title: STTR Phase II: A New Hyperspectral Imaging Spectrometer

Award Number: 0620581
Program Manager: F.C. Thomas Allnutt

Start Date: August 24, 2006
Expires: October 31, 2008
Total Amount: $479,219

Investigator: Rand Swanson, swanson@resonon.com
Company: Resonon
619 North Church Ave Suite 3
Bozeman, MT 59715
Phone: (406)586 3356

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project develops a macroscopic fluorescent scanner that utilizes hyperspectral imaging with enhanced capability for reading microarrays, multiwell plates, and two dimensional (2D) gels. The system utilizes novel optical design to provide more efficient light gathering and less aberration for better imaging versus conventional hyperspectral optical designs. The anticipated technical benefits include improved signal-to-noise (greater sensitivity) and the better dye multiplexing (enabling the use of multiple dyes to detect of multiple analytes simultaneously).
The broader impact of this research will be to enable more rapid advancement of scientific discovery by providing enhanced tools for study of the complexity of biological signaling, metabolic and response networks using non-radioactive optical detection methods to improve safety and reduce waste problems with optical detection.

Title: SBIR Phase II: Dynamic Signal Processing and Information Extraction for E-Noses

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| Award Number: | 0522225 |
| Program Manager: | George Vermont |
| Start Date: | November 30, 2005 |
| Expires: | November 30, 2007 |
| Total Amount: | $506,000 |


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| Investigator: | Neil Euliano, neil@conveng.com |
| Company: | Convergent Engineering<br>4817 SW 34th Street, Suite 4<br>Gainesville, FL 32608 |
| Phone: | (352)378 4899 |



Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of electronic nose signal processing and dynamic pattern recognition systems specifically tuned to the properties of odors. This advanced e-nose signal processing toolbox should improve current selectivity by an order of magnitude. A prototype exhaled-breath propofol (anesthetic) monitor for use in measuring depth of anesthesia in patients undergoing surgery will be built and demonstrated.
The initial commercial application of this project will be in the medical surgery area where the product should provide more accurate patient dosing during anesthesia. The technology, however, may be broadly applicable to such key areas as medical diagnostics, illicit drug detection, glucose monitoring, etc.

Title: SBIR Phase II: Designer Cellulases for Biomass Conversion

Award Number: 0522310
Program Manager: Michael R. Ambrose

Start Date: October 1, 2005
Expires: September 30, 2007
Total Amount: $500,000

Investigator: William Coleman, wcoleman@kairos-scientific.com
Company: Kairos Scientific Inc.
10225 Barnes Canyon Rd., A110
San Diego, CA 92121
Phone: (858)626-8170

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop new technology to improve the high-temperature performance of endoglucanase, which can be used to manufacture pulp from wood chips and other biomass. Producing pulp for papermaking via thermomechanical pulping (TMP) of biomass is a highly energy intensive process that is performed at high temperatures. Research is proposed to demonstrate the feasibility of using a directed evolution strategy and high-throughput, solid-phase enzyme library screening to engineer a new endoglucanase variant with significantly improved thermoactivity, thermostability and resistance to inhibitors. This enhanced enzyme will be sold as an additive to manufacturers who produce pulp and paper via the TMP process. Major benefits include energy savings and improvement of paper quality.

The commercial application of this project will be on the pulp and paper industry. New screening technology will be used to engineer an enhanced enzyme that will modify pulp fibers under high-temperature conditions. This enzyme additive will accelerate the pulp refining process and thereby lower production costs by reducing the amount of electricity needed to complete the conversion. Any significant reduction in the energy input will be very economically attractive to the pulp producers. If introducing an effective enzyme treatment could eliminate even a modest 10% of the current energy expenditure, the potential worldwide savings could total nearly US$500 million per year. The enhanced enzyme will be able to create a new market by offering these significant savings to the pulp producers. In addition, the information gained from this study could be applied to other similar enzymes to expand the market for thermostable biocatalysts and broaden the understanding of protein structure-function.

Title: SBIR Phase II: New Approaches to Using Renewable Biomass Derived Materials in Epoxy and Vinyl Ester Resin Products to Reduce Styrene and Other Petroleum Based Raw Materials

Award Number: 0521976
Program Manager: George B. Vermont

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,993

Investigator: Earl Wagener, ewagener@bellsouth.net
Company: Tetramer Technologies, L.L.C.
657 S Mechanic Street
Pendleton, SC 29670
Phone: (864)653-4339

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to reduce the levels of styrene in commercial vinyl ester-styrene resin formulations and other polymers by replacing all or a portion of the high VOC (Volatile Organic Compounds) toxic monomer with a biomass-derived material. Prior results have shown that the styrene content can be reduced from 45% to 35% or lower without increase in cost or the loss of polymer physical properties. Phase II work will entail commercial development with three customers, scale-up process engineering to commercial levels and expansion of the technology into the broader thermoset market.

The commercial application for this technology is in polymer and resin markets where styrene and other petroleum based, high VOC monomers are used. These are huge markets, and the products are used in hundreds of applications. Successful introduction of these replacements will reduce our dependence on imported oil, promote the use of domestic, crop-based resources, and reduce the use of high VOC pollutants.

Title: SBIR Phase II: Low Cost, Needleless Drug Injection System

Award Number: 0450559
Program Manager: George B. Vermont

Start Date: February 15, 2005
Expires: January 31, 2007
Total Amount: $483,086

Investigator: James Scherer jjscherer@novawavetech.com
Company: Novawave Technologies
900 Island Dr Ste 101
Redwood City, CA 94065
Phone: (650)610-0956

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a cheap and novel needleless injector (NI) that uses a ceramic-based electrokinetic pumping mechanism together with suitable nozzle arrays. The Phase II effort will focus on building numerous prototype pump / nozzle systems and determining the ability to achieve performance adequate for subcutaneous and intramuscular injections. Models for predicting the temporal response of the pump / nozzle systems will also be refined and compared to experimental results.

The commercial application of this project will be for delivering therapeutics such as vaccines and drugs for both human and veterinary markets. The ability to precisely control the injection temporal profile with the proposed device will enable injection site pain and trauma to be significantly reduced, thereby increasing effectiveness of NI drug delivery as well as reducing the probability of cross - contamination.

Title:  SBIR Phase II: Characterization of the Metabolic Competency of Centrifugal Bioreactors

Award Number: 0421962
Program Manager: Om P. Sahai

Start Date: October 1, 2004
Expires: September 30, 2006
Total Amount: $500,000

Investigator: Heath Herman, hherman@kbi-usa.com
Company: Kinetic Biosystems, Inc.
430 Tenth Street, N.W.
Atlanta, GA 30318
Phone: (404)607-7331

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to develop a pilot-scale Centrifugal Bioreactor (CBR) for the continuous cultivation of hybridoma cells. The commercial application of this project will be in the biopharmaceutical industry for cell culture production of therapeutic agents. It is expected that the technology will reduce the scale and capital costs of commercial animal cell culture equipment and improve the quality and consistency of the secreted protein product.

Title: SBIR Phase II: A Novel Resonant-Enhanced Crystallization (REC) Process

Award Number: 0349704
Program Manager: Om P. Sahai

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $512,000

Investigator: Fangxiao Yang, fxyang@resodyn.com
Company: Resodyn Corporation
1901 South Franklin
Butte, MT 59701
Phone: (406)723-2222

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a novel Resonant-Enhanced Crystallization (REC) process for pharmaceutical and biotechnology industry applications. REC technology is expected to be superior to the conventional crystallization process that incorporate impeller stirring for crystallization, due to its enhanced mass and heat transfer, lower shear (or reduced crystal breakage), and improved crystal size distribution.

The commercial impact of the project would be on pharmaceutical and biotechnology industries. REC technology will make the crystallization process more attractive to pharmaceutical separation and purification operations.
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Title: SBIR Phase II: Photochemical Treatment of Dioxin-Furan Compound Emissions from Industrial Processes

Award Number: 0822985
Program Manager: Gregory T. Baxter

Start Date: August 1, 2008
Expires: July 31, 2010
Total Amount: $490,912


Investigator: John Richards, john.richards@aircontroltechniques.com
Company: Air Control Techniques, P.C.
301 East Durham Road
Cary, NC 27513
Phone: (919) 460-7811



Abstract:

This Small Business Innovation Research (SBIR) Phase II research will advance the use of photochemistry for the control of toxic air pollutants emitted from industrial sources such as furnaces, boilers, and kilns. The types of ultraviolet lamp sources now used successfully for wastewater treatment, water purification, and air stream disinfection will be adapted for use in the more challenging environment of industrial process effluent gas streams. This research program concerns a photochemical system designed to destroy highly toxic compounds called dioxin-furans, which are unintended byproducts of some industrial processes. During an extended test program at an industrial facility, the researchers will evaluate: (1) long-term ultraviolet lamp energy efficiency in hot, dust-laden gas streams, (2) dioxin-furan destruction efficiencies during routine variations in source conditions, (3) reaction product characteristics, and (4) reductions in pollutants in addition to the targeted dioxin-furans. The broader impacts of this research will include an improved understanding of the chemical reactions of dioxin-furan compounds at the gas temperatures and pollutant concentrations typical of industrial gas streams. The results will help assess the applicability of photochemical systems to provide high efficiency air pollution control while reducing emissions of greenhouse gases produced by existing control techniques. Photochemical systems that destroy toxic air pollutants will provide an attractive alternative to systems that retain the toxic compounds on adsorbents disposed in landfills. The development of ultraviolet light technology will result in reduced air emissions of persistent toxic pollutants that bio-accumulates in the food chain and cause adverse human health effects.

Title: SBIR Phase II: A Portable Dissolved Oxygen Delivery System for Rapid Treatment of Organic Spills

Award Number: 0750402
Program Manager: Gregory T. Baxter

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $494,416

Investigator: Clay Thompson, clay.thompson@blueingreen.biz
Company: Blueingreen
535 W. Research Ctr. Blvd.
Fayetteville, AR 72701
Phone: (479) 571-2592

Abstract:

This Small Business Innovation Research (SBIR) Phase II project completes the design, construction, and testing of the largest readily portable Supersaturated Dissolved Oxygen (SDOXTM) injection system developed in smaller scale in Phase I. During the first year of the project, the SDOX will be used to study the effect of dissolved oxygen addition on water quality and fish health in the tailrace of a hydroelectric dam. In the second year of this project, the SDOX will be used in the prevention of spills and remediation of waterbodies impacted by organics and phosphorous. The effects of the SDOX on removing DO as the limiting component in aquatic ecosystems will be studied during all four seasons of the year. The broader impacts of this research are the ability use of a portable SDOX 400 on aquatic ecosystem restoration that has previously been impractical or impossible. This technology benefits an improved environment for aquatic species, minimized environmental impact from hydroelectric dams, and more economic and efficient wastewater treatment. The technology could positively impact drinking water, recreation, irrigation and other aqueous ecological services important to the public and the environment.

Title: STTR Phase II: Plant Bioreporters for Arsenic

Award Number: 0548751
Program Manager: F.C. Thomas Allnutt

Start Date: September 25, 2006
Expires: September 30, 2008
Total Amount: $500,000

Investigator: Mark Elless, elless@edenspace.com
Company: Edenspace
15100 Entp Ct Suite 100
Chantilly, VA 20151
Phone: (703)961-8700

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop plant bioreporters for arsenic which is widely dispersed in the environment. Detecting and monitoring arsenic in soil and water, particularly in large or remote areas, is often cost-prohibitive due to the expense of sample collection and analysis. This research will lead to an innovative, cost-effective, real-time system to monitor water and soil quality offering high spatial resolution, stand-off reporting, ready scaling to large treatment areas, and continuous in place reporting of bioavailable arsenic. Applications for this technology include detection and investigation of arsenic contamination and risk assessment during remedial activities at contaminated sites.

The broader impact of this technology will be to enable more extensive use of in place environmental cleanup methods such as phytoremediation, assist efforts to monitor and clean the environment, and reduce environmental health hazards posed by arsenic. Improving the ability to accurately assess arsenic contamination will improve awareness of contaminated areas and make affordable arsenic monitoring by homeowners, farmers, and industry. Of particular usefulness would be the ability of farmers and gardeners to detect the potential bioavailability of arsenic to food crops as a result of arsenic in biosolids and pesticides.

Title: SBIR Phase II: Water Purification Technology for Removal of Chemical and Biological Contaminants

Award Number: 0620568
Program Manager: Errol Arkilic

Start Date: August 25, 2006
Expires: July 31, 2008
Total Amount: $499,997

Investigator: Lisa Farmen, farmen@yahoo.com
Company: CCT
3933 N.E. Royal Court
Portland, OR 97232
Phone: (503)544-2330

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops a low-cost, water purification technology for removal of biological and chemical contaminants. In combination with research at the University of Oregon and technology licensed from the University of Texas, a proprietary surface-modified mineral adsorbents will sequester high concentrations of chemical contaminants, such as arsenic, lead, mercury, PCE, TCE and MTBE. The current effort will: a) optimize specific bifunctional ligands and mineral substrates capable of removing heavy metals to meet the EPA drinking water standards; b) demonstrate alternative ligand/substrate combinations capable of selective removal of contaminates from a water stream; c) demonstrate qualification to EPA and California drinking water requirements of a CCT water filter and ultra-violet lamp combination; d) field test the solution in an underdeveloped location.

Currently two-thirds of the world's population does not have access to clean water and one-third lack access to a reliable source of water. In certain parts of the world, mostly the underdeveloped world, water is already the most precious necessity. From the executive summary of the World Water Assessment Program sponsored by the United Nations under UNESCO: "In 2000, the estimated mortality rate due to water sanitation hygiene-associated ... diseases.. was 2,213,000." That equates to one person every 15 seconds. In the U.S., an 2001 EPA report estimates that over two million Americans get sick from contaminated water each year. In China, over one billion people lack acceptable water resources. At the completion of the Phase II effort, CCT will have a complete solution, using both passive and active technologies, for a low cost, sustainable water purification module.

Title: SBIR Phase II: Environmental Neurotoxicity Using Zebrafish

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| Award Number: | 0548657 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | February 7, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $512,000 |

Investigator: Catherine Willett, kptnkate@phylonix.com
Company: Phylonix Pharm Inc
100 Inman St Suite 300
Cambridge, MA 02139
Phone: (617)441-6700

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims at developing a large-scale quantitative assay procedure for the evaluation and detection of potential developmental neurotoxic environmental pollutants. The assay will use zebrafish as the model to investigate the presence of these potential pollutants and as such, will be a relatively simple, fast and cost effective method to evaluate and prioritize potential chemicals for subsequent testing.

The ability to detect, evaluate and determine levels of potential developmental neurotoxic compounds in ground water and other industrial sites will provide for a more comprehensive understanding of potential hazards that industrial runoff may have. To date, very few chemicals that are being tested have been assayed for their potential neurotoxic effects. This assay will provide such a method for testing and will have an impact on environmental pollution and public health.

Title: SBIR Phase II: Field Demonstration of a Novel Biotechnology for In-Situ Bioremediation of Methyl Tert-Butyl Ether (MTBE) in Groundwater

Award Number: 0450486
Program Manager: Michael R. Ambrose

Start Date: May 1, 2005
Expires: April 30, 2007
Total Amount: $499,999

Investigator: Fatemeh Shirazi, fshirazi@microvibiotech.com
Company: Microvi Biotech LLC
11966 W 119TH ST
Shawnee Mission KS, 66213
Phone: (913)696-9934

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a novel process for in-situ bioremediation of methyl tert-butyl ether (MTBE) in groundwater. The Environmental Protection Agency (EPA) considers MTBE a potential human carcinogen. Currently, MTBE's Maximum Contaminant Level (MCL) in drinking water has been set for 18 parts per billion. It is estimated that the cost of cleaning up MTBE contamination nationwide is $29 billion and growing. Bioremediation holds a great promise for destruction of MTBE in groundwater. The key problems with currently used bioremediation methods for MTBE are (1) the inability to establish high densities of MTBE- degrading bacterial, (2) the inability to maintain contact between the degrading bacteria and MTBE, and (3) the upsets and losses of key bacteria. Prior Phase I work has successfully demonstrated the effectiveness of a new technical approach called Biological Permeable Barrier (BPB) that uses encapsulated MTBE-degrading bacteria for removal of MTBE in water. The primary objective for the Phase II project is to assess the long-term performance of a BPB field pilot unit to remove MTBE at Port Hueneme Navy site, and to assess the cost and performance of the BPB / MicroBeads system for longer periods of time under field conditions. The novelties of this technical approach are four folds : (1) the proposed system will deliver high cell density of MTBE-degrading bacteria right to the zone of contamination; (2) the proposed system will create the perfect environment for bacteria with a high degree of degradation and stability; (3) the proposed system will protect the bacteria against environmental stresses; and, (4) the proposed system will prevent wash out of key bacteria. It is anticipated that the proposed BPB pilot scale unit at Port Hueneme will effectively degrade MTBE and other contaminants in groundwater to non-detectable levels.

The immediate commercial application of this project will be on the bioremediation of MTBE in groundwater. However, the proposed technology holds promise for effective, controlled and cost efficient cleanup of groundwater at sites contaminated with other toxic and polluting chemicals as well. Other potential applications include the treatment of industrial wastewater and drinking water.

Title: SBIR Phase II: An Automated Water Pathogen Monitoring System

Award Number: 0450613
Program Manager: George B. Vermont

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $512,000

Investigator: Zoraida Aguilar, zoraida.aguilar@vegrandis.com
Company: Vegrandis, LLC
535 W. Research Blvd.
Fayetteville AR, 72701
Phone: (479)571-2592

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop an automated instrument for rapid and specific detection of waterborne pathogens in municipal water supplies using methods combining immunoassay with electrochemistry. Although the disposable cartridges for this instrument could be specified for nearly any pathogen of interest, this project will focus primarily on the detection of Cryptosporidium parvum oocysts. C. parvum is a threat to the nation's water supply, does not respond to common antibiotics and resists water purification treatments.

The commercial application of this project will be on the monitoring of drinking water supplies for pathogens. This would include testing of water at the source, in distribution networks, and at bottling and packaging facilities. The proposed device would eventually be adapted for emergency field use, for home use by safety conscious consumers, and for medical, industrial, recreational and combat purposes.

Title: SBIR Phase II: The Use of Halophytic Plants and Fish for the Bioremediation of Coal Bed Methane Discharge Waters

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| Award Number: | 0422222 |
| Program Manager: | Om P. Sahai |
| Start Date: | September 15, 2004 |
| Expires: | August 31, 2006 |
| Total Amount: | $500,000 |

Investigator: John Woiwode, woiwodejon@cs.com
Company: AquaMatrix International, Inc.
270 Veronica Lane, Suite D
Jackson, WY 83001
Phone: (307)739-7185

Abstract

This Small Business Innovation Research (SBIR) Phase II project is to develop a process that uses halophytic plants and aquaculture effluent to treat highly saline coal bed methane (CBM) discharge water. Vast volumes of water are a necessary though unwanted byproduct of the gas drilling process. The saline discharge is widely viewed as an environmental liability. Discharges into streams are essentially forbidden, while indiscriminant surface discharge causes soil salination. Prior Phase I work has shown that halophytic plants may be successful in sequestering significant amounts of sodium when irrigated with CBM discharge waters. This Phase II project will confirm Phase I greenhouse data with field trials of plants irrigated with CBM water and fish effluent when compared with controls under otherwise normal farming practices. Soil impacts and tilth will also be examined in great detail.

The commercial application of this project will be to alleviate the negative impact of CBM discharges on the environment in Wyoming, and to open up huge areas of land for responsible CBM exploration and recovery.

# Genomics

Title: SBIR Phase II: Automated culture and differentiation of human Embryonic Stem Cells

Award Number: 0823027
Program Manager: Gregory T. Baxter

Start Date: October 1, 2008
Expires: September 30, 2010
Total Amount: $500,000

Investigator: Veit Bergendahl, vbergendahl@stemcell-products.com
Company: Stem Cell Products Inc.
525 Science Dr.
Madison, WI 53711
Phone: (608) 310-5105

Abstract:

This Small Business Innovation Research (SBIR) Phase II research is focused on methods to utilize blood precursor cells derived from human embryonic stem (HES) cells. The project uses a new defined differentiation system which allows automation and scale-up production of this important cells. There is a significant demand for these cells from research and drug discovery. Increased availability and batch-to-batch reproducibility of HES cell-derived blood cells, resulting from the defined genetic background of the starting material and this standardized, automated culture system, make this technology invaluable model systems for basic research and drug development. Based on the automated pilot system for handling and scale-up production of HES cells developed in phase I of this SBIR project we will transfer our current culturing protocols into robust automated production procedures to provide a reproducible quality of CD34 positive cells The broader impacts of this research will be improving the process of drug discovery and development and in the long term by providing revolutionary new applications for medical treatment to improve public health. Nearly 98% of a multi-million dollar stem cell market is currently consumed by blood and immune system treatments. We anticipate that the proposed research will lead to the faster integration of HES cell biology into biomedical research. It will help to provide a variety of other blood cell types in quantities required for basic research, drug development, high throughput screening, biochemical characterization and potential medical treatment of blood related disease.

Title: SBIR Phase II: Development of Agents to Promote Cellular Ga-67 (Gallium-67) Uptake

Award Number: 0450618
Program Manager: George B. Vermont

Start Date: October 1, 2005
Expires: September 30, 2007
Total Amount: $499,992

Investigator: Takuji Tsukamoto, taku@chemica.com
Company: Chemica Technologies Inc
325 S.W. Cyber Dr.
Bend OR, 97702
Phone: (541)385-0355

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of new pharmaceutical agents to selectively enhance tumor imaging using gallium 67. A photo-degradation product of nifedipine, nitrosipine, has been found to selectively enhance the uptake of Ga67 by tumor cells. A specific derivative of nitrosipine has an even better selective uptake of the radioactive imaging agent. This project will synthesize and test other nitrosipine derivatives and determine the efficacy of Ga67 uptake in animal models using these complexing agents.the commercial application of this technology is in the area of diagnostic imaging. The use of Ga67 in tumor imaging is currently very limited due to poor selectivity of the agent for tumor cells. Enhanced uptake in tumor cells relative to normal cells would expand the types of tumors that could be effectively imaged and possibly replace the more costly and complex PET scan imaging using radioactive fluorinated sugars.

Title: SBIR Phase II: Development of Anticancer Drugs Using Novel Drug Delivery Systems

Award Number: 0521900
Program Manager: George B. Vermont

Start Date: September 15, 2005
Expires: August 31, 2007
Total Amount: $500,000

Investigator: C.J. Yu, yucjyu@aol.com
Company: GlyPort, Inc.
118 S. Berkeley Ave.
Pasadena CA, 91107
Phone: (626)844-7896

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the enhancement of water solubility and efficacy of sparingly soluble anticancer drugs. Many of the clinically accepted anticancer drugs have side effect problems because of the dosages that must be used to overcome low solubility and bioavailability properties. A new delivery vehicle has been developed, which, when attached to known chemotherapeutic agents , increases water solubility and improves the drugs anticancer activity in in-vitro tests. The Phase II goals are to evaluate further enhancement of solubility with modified delivery segments, do in-vivo evaluations in mice with human tumor xenografts, and to do pharmacokinetic studies of the drugs in the rat model.

The commercial application of this technology is in cancer chemotherapy. Increased solubility and bioavailability should reduce the quantity and side effects of the expensive drugs that are currently used. Furthermore, certain drugs that could not be used previously because of poor cellular uptake, might now be made available using this mode of delivery.

Title: SBIR Phase II: Software for Micro RNA Detection and Analysis

Award Number: 0522270
Program Manager: George B. Vermont

Start Date: August 15, 2005
Expires: July 31, 2007
Total Amount: $405,905

Investigator: Gary Fogel, gfogel@natural-selection.com
Company: Natural Selection Inc
3333 N Torrey Pines Ct Ste 200
La Jolla CA, 92037
Phone: (858)455-6449

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop machine learning tools for RNA gene detection. Prior Phase I research resulted in the successful development of artificial neural networks for the discrimination of functional RNA (fRNA) coding regions from non-coding regions in four model eukaryotes. The Phase II project will focus on (1) refinement of best evolved neural networks for 10 key eukaryotes capable of discriminating fRNA coding from non-coding sequence information, (2) experimental verification of predicted fRNA coding regions in human and mouse, (3) development of machine learning algorithms capable of discriminating between eukaryotic fRNA subtypes, (4) extension of the approach to include machine learning tools capable of discriminating between fRNA subtypes and to evaluate this potential for additional functionality, and (5) development of a user-friendly graphical user interface (GUI) for the product.

The commercial application of this project will be to identify a new class of targets for drug design and discovery for the pharmaceutical industry. The educational aspects of the proposed work will be to assist in dissemination of knowledge about the importance of fRNAs to the next generation of scientists.

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Title: SBIR Phase II: Development and Manufacture of High-Density Plate Washer

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| Award Number: | 0450448 |
| Program Manager: | Michael R. Ambrose |
| Start Date: | January 15, 2005 |
| Expires: | December 31, 2006 |
| Total Amount: | $500,000 |

Investigator: Richard Kris, richardkris@earthlink.net
Company: NeoGen, LLC
2602 E Avenida De Posada
Tucson AZ, 85718
Phone: (520)906-2002

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a plate washer capable of washing very high-density plates, such as 1536 well plates, for ELISA and high-throughput screening assays. Currently, there are automated plate washers for 96 and 384 well plates, but there are none available for plates with ultra-high density. This is because currently available washer technology, employing a nozzle system, cannot be made reliable enough to allow dispense and aspirate nozzles to properly reach within each of the many, very small wells, and because the thin nozzles needed can get easily clogged using many standard buffers. In contrast, the proposed system uses a steady stream or sheet of solution, making the system less likely to clog.

The commercial application of this project will be to allow use of high-throughput screening assays by industrial and academic researchers involved in genomics and drug discovery research. The proposed technology will enable additional use of fluorescent chemical compounds, that typically require a wash step to remove interfering substances, for screening.

Title: SBIR Phase II: Development of a Microfluidic Device for Rapid Analysis, Sorting, and Collection of Biological Particles Using Photonic Forces

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| Award Number: | 0422059 |
| Program Manager: | Om P. Sahai |
| Start Date: | September 1, 2004 |
| Expires: | August 31, 2006 |
| Total Amount: | $499,940 |


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| Investigator: | Jonathan Diver, jdiver@genoptix.com |
| Company: | Genoptix, Inc.<br>3398 Carmel Mountain Road<br>San Diego, CA 92121 |
| Phone: | (858)523-5003 |



Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop a fluorescence activated cell sorter (FACS) that uses optical forces to move cells and to sort cell sub-populations. The specific Phase II objectives are : (1) to build an integrated prototype cell sorter with flexibility to configure multiple lasers and detectors, (2) to develop a self contained microfluidic cartridge that can handle 1,000-100,000 cells/sample and sort with purities greater than 95% and total recovery rates greater than 80%, (3) to develop microfluidic flow assays, and (4) to validate that the mechanical and optical stresses do not adversely affect cells.

The proposed work will result in a prototype cell sorter, self-contained microfluidic cartridges, and a panel of assays that demonstrate the broad utility of the instrument. The commercial application of this project will be in the area of cell-based assays for use in biological and biomedical research.

Title: SBIR Phase II: Innovative control of ectoparasites: key to expansion of open ocean fish farming

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| Award Number: | 0822862 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | August 15, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $499,910 |


Investigator: Jennica Lowell, jennica@kona-blue.com
Company: Kona Blue Water Farms, LLC
P.I. Box 4239
Kailua Kona, HI 96745
Phone: (808) 331-1188



Abstract:

This Small Business Innovation Research (SBIR) Phase II research targets innovative means for controlling ectoparasite pests in open ocean aquaculture. Offshore fish farming offers tremendous growth opportunities. Adaptive fish health management offshore remains a challenge for environmentally sound expansion of this potentially lucrative industry. PEDICURe (Passive Ectoparasite Device In Counter-current Underwater Reservoir) prototypes showed great efficacy in treating ectoparasite pests in marine fish in tank trials. Phase II research will refine therapeutic treatments, PEDICURe designs and protocols for use. Commercial-scale prototypes will be deployed and tested in offshore cages. PEDICURes could be sold or licensed to fish farms worldwide. PEDICURes could also provide compelling competitive advantages to drive expanded production in Hawaii, U.S. waters, or globally. The broader impacts of this research are in increasing the environmentally sound means for optimizing fish health in open ocean aquaculture, and thereby aiding the growth in this innovative, exciting and potentially lucrative industry. Offshore farms can produce high-value marine fish without significant impacts on water quality, benthic habitats or other ocean user groups. Cost savings to a $1 billion U.S. offshore farming industry could be $115 million p.a. There are potential applications worldwide.

Title: STTR Phase II: Commercialization of an Innovative Green Technology for Controlling Zebra Mussels

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| Award Number: | 0750549 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | March 1, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $500,000 |


Investigator: Pamela Marrone, pmarrone@marroneorganics.com
Company: Marrone Organic Innovations, Inc.
2121 Second Street
Davis, CA 95618
Phone: (530) 750-2800



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project is focusing on the development and commercialization of a new, environmentally safe biopesticide for the control of zebra and quagga mussels. These freshwater, invasive bivalves foul water pipes and cause severe economic and ecological harm throughout North America and Europe. Marrone Organic Innovations, a leader in biopesticide commercialization, is partnering with biological control experts at the New York State Museum who have discovered a bacterium, Pseudomonas fluorescens, that produces a natural compound that is selectively lethal to these pest mussels. The microbial biopesticide developed in this project will be an environmentally safe alternative to the polluting, non-selective chemicals that infested facilities, due a lack of alternatives, are currently forced to rely on to control mussel infestations. The broader impacts of this research include both economic and ecological benefits to society. Mussel infestations cause hundreds of millions of dollars in additional expenses every year, and the chemical methods currently used to control them are known to be harmful to other aquatic organisms. The proposed research will advance a project of national significance and reach across numerous scientific disciplines, including biochemistry, microbiology, and invertebrate zoology, serving as a model in the effort to reduce the use of polluting pesticides. Training and learning will be fostered by involving postdoctoral, graduate, and undergraduate students. Because of its extraordinary safety, this bacterial biopesticide will serve as an example of a green technology that will benefit the environment as well as industrial and recreational users of freshwater.

Title: SBIR Phase II: Compact genetic assessment using the Infrarray SNAP (Simple Nucleic Acid Profiler)

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| Award Number: | 0724423 |
| Program Manager: | Ali Andalibi |
| Start Date: | September 15, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,986 |

Investigator: Steve Savoy, ssavoy@nanohmics.com
Company: Nanohmics
6201 East Oltorf St.
Austin, TX 78741
Phone: (512)389-9990

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to further develop a microfluidic device for the detection of nucleic acids for a variety of studies where genetic analysis and identification of target sequences are required. The instrument proposed is designed to be compact and capable of reading a disposable cartridge on which sample preparation, amplification, and multiplex detection, with a modest-sized microarray, are performed. The proposed instrument is enabled by direct imaging of a PhotoGenerated Reagent (PGR) microarray, with an image sensor positioned near the face of the microarray. It is also enabled by the use of up-converting phosphors as the label, which are in turn excited by infrared radiation that passes through the silicon microarray.

The development of and inexpensive, fully integrated and automated microfluidic device for use in genetic analysis would give individuals in academic, commercial and defense settings access to affordable microarray analysis. The availability of such a versatile platform would allow the development of arrays for any nucleic acid target, as well as easy multiplexing. With such a platform, production of custom arrays and off-the-shelf ones will be achieved with great facility. Moreover, the integrated platform will reduce the cost and effort associated with microarray analysis.

Title: SBIR Phase II: Novel Labeling Method for Multicolor Fluorescence in situ Hybridization (FISH) Probes

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| Award Number: | 0724876 |
| Program Manager: | Ali Andalibi |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Joan Aurich-Costa, joan@onecell.com
Company: One Cell Systems Inc
100 Inman St Ste 200
Cambridge, MA 02139
Phone: (617)868-2399



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to further develop a panel of multicolor oligonucleotide fluorescence in situ hybridization (FISH) probes for performing preimplantation genetic diagnosis (PGD) and detecting aneuploidies in eggs used for in vitro fertilization (IVF) protocols. The use of oligonucleotides offers advantages such as enhanced specificity and sensitivity, shorter hybridization times as well as a reduction in manufacturing cost when compared to currently available genomic DNA derived probes. The panel that the company plans to develop will cover 8 chromosomes known to be particularly susceptible to deletions and rearrangements and would allow simultaneous detection of any abnormalities that may be associated with them.

The development of a panel of probes for the detection of genetic abnormalities in preimplantation embryos will increase the success rate of IVF procedures and thus reduce the financial and emotional cost associated with them. Moreover, use of the proposed labeling method can be useful in a variety of areas outside of PGD, including basic research, clinical diagnostics and cytogenetic testing.

Title: SBIR Phase II: Rapid and Automated Differential Gene Expression Profiling

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| Award Number: | 0548750 |
| Program Manager: | Ali Andalibi |
| Start Date: | September 21, 2006 |
| Expires: | September 30, 2008 |
| Total Amount: | $499,995 |

Investigator: Jian Tajbakhsh, jtajbakhsh@maxwellsensors.com
Company: MSI
10020 Pioneer Blvd Suite 103
Santa Fe Springs, CA 90670
Phone: (562)801 2088

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop a rapid and automated microarray expression profiling chip and system for gene expression profiling. As part of this project a miniaturized automated system will be developed to integrate key steps in target synthesis, labeling and hybridization.

The use of the integrated system will enhance the reproducibility and cost of running microarray experiments.

Title: SBIR Phase II: Enabling High Output Metabolism in Plant Cells

Award Number: 0548640
Program Manager: F.C. Thomas Allnutt

Start Date: January 11, 2006
Expires: December 31, 2007
Total Amount: $511,937

Investigator: Michele Champagne, kasllc@hawaii.rr.com
Company: KAS
2800 Woodlawn Dr. Suite 281
Honolulu, HI 96822
Phone: (808)753 2693

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop and validate a novel chloroplast transformation vector for protein expression in chloroplasts. The research project will broaden scientific understanding of the parameters of chloroplast transformation by addressing stoichiometric expression of multiple transgenes for effective engineering of pathways such as carotenogenesis, feedback regulation and expression of multimeric proteins.

The commercial impact of this technology will provide an enabling strategy for expression of genes of interest in chloroplasts to potentially increase the production of high value nutraceutical and pharmaceutical compounds. Application of this technology for stable, high output metabolism with regulatory compliance will reduce production cost and increase the reliability for downstream processing and eventual commercialization.

Title: STTR Phase II: Engineering of Non-leaching Antibacterial Non-woven Textiles

Award Number: 0450527
Program Manager: George Vermont

Start Date: October 21, 2005
Expires: October 31, 2007
Total Amount: $505,450

Investigator: Nina Lamba, cclbiomed@verizon.net
Company: CCL Biomedical, Inc.
224 North Washington St.
Havre de Grace, MD 21078
Phone: (410)939-9356

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project proposes the development of a unique family of biocidal polymers that have been shown to be non-leaching, and do not require regeneration or refreshment of activity. The Phase I study demonstrated the synthesis of these polymers containing potent broad-spectrum biocides. The polymers were spun into nanofiber webs using electrospinning techniques. The webs were challenged with bacteria and a 99% reduction in bacterial viability in one hour was demonstrated. The Phase II program will continue to explore the electrospinning processing of the polymers. The polymers will be optimized for activity against bacteria, viruses and molds. Microscopic and mechanical tests will be performed on materials to identify structure-property relationships.

The commercial application of this technology will be in textile products where antimicrobial protection is critical, e.g., homeland security (biodefense) garments, first responders emergency clothing, hospital garments and supplies, etc. Current systems are water leachable and use can lead to reduced protection.

Title: SBIR Phase II: A Novel Resonant-Enhanced Crystallization (REC) Process

Award Number: 0349704
Program Manager: Om P. Sahai

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $512,000

Investigator: Fangxiao Yang, fxyang@resodyn.com
Company: Resodyn Corporation
1901 South Franklin
Butte, MT 59701
Phone: (406)723-2222

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a novel Resonant-Enhanced Crystallization (REC) process for pharmaceutical and biotechnology industry applications. REC technology is expected to be superior to the conventional crystallization process that incorporate impeller stirring for crystallization, due to its enhanced mass and heat transfer, lower shear (or reduced crystal breakage), and improved crystal size distribution.

The commercial impact of the project would be on pharmaceutical and biotechnology industries. REC technology will make the crystallization process more attractive to pharmaceutical separation and purification operations.

# Pharmaceutical Drug Delivery

Title: SBIR Phase II: Multivariate Analysis of Heterologous Protein Expression

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| Award Number: | 0750206 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | March 15, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $500,000 |

Investigator: Mark Welch, mwelch39@comcast.net
Company: DNA Twopointo Inc
1430 O'Brien Drive
Menlo Park, CA 94025
Phone: (650) 853-8347

Abstract:

This Small Business Innovation Research (SBIR) Phase II research develops methods to improve the manufacture of recombinant protein products produced in foreign hosts. Cost-effective production of proteins generally utilizes organisms that are well-suited for protein engineering and large-scale production. Establishing a suitable production system for a protein is often a time-consuming, trial-and-error-based process and can be a significant barrier for the commercialization of a protein. In cases where production systems are found, they are often far from optimized due to the time and cost required as well as our current limited understanding of the critical parameters. In Phase I several gene design variables were assessed for their importance to protein expression in the bacterium Escherichia coli, a commonly used production organism. Data suggested novel means for gene optimization that were unexpected from conventional wisdom. In Phase II relevant gene design variables suggested by Phase I will be explored toward development of a refined model of the relationship of gene design to protein expression in E. coli as well as in other useful production organisms. The broader impacts of this research are improved manufacturing techniques for recombinant protein based products. Protein products constitute a currently >$40 billion and rapidly growing world-wide market including industrial enzymes, diagnostic enzymes and protein pharmaceuticals. The tools developed from this project will drastically improve the speed, reduce the cost, and remove the uncertainties of modern protein manufacturing, which significantly limit this market. Improved production will also accelerate the study of proteins with therapeutic or otherwise marketable potential, expanding the field of candidate proteins for commercialization.

Title:  SBIR Phase II:  Lantibiotic Synthesis Using Differentially Protected Orthogonal Lanthionines

Award Number: 0749884
Program Manager: Gregory T. Baxter

Start Date: February 15, 2008
Expires: January 31, 2010
Total Amount: $500,000

Investigator: Jeffrey Hillman, jhillman@oragenics.com
Company: Oragenics Corporation
13700 Progress Blvd.
Alachua, FL  32615
Phone: (386) 418-4018

Abstract:

The Small Business Innovation Research (SBIR) Phase II project aims to develop differentially protected orthogonal lanthionine technology (DPLOT) to synthesize novel antibiotics.   Lanthionines are found in nature and have been isolated from a variety of sources. Although amino acids, lanthionines are not components of  proteins.  They are however, constituents of a group of naturally occurring peptide antibiotics called lantibiotics, which includes nisin (a food preservative), subtilin, epidermin (an anti staphylococcus and streptococcus agent), and ancovenin (an enzyme inhibitor).  Due to their mechanism of action, resistance to lantibiotics is uncommon and as such they can be of value for treating antibiotic resistant bacterial infections.    The technology under development would allow the synthesis of novel lantibiotics that may be effective against the growing number of antibiotic resistant bacteria and would expand the therapeutic arsenal available for treating such infections.  It would therefore have a profound impact on public health and the control of infectious diseases caused by bacteria.

Title: SBIR Phase II: Disposable pL Fluid Transfer/Microarray Printing Device

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|---|---|
| Award Number: | 0646638 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $498,437 |

Investigator: Robert Haushalter, bob@parallel-synthesis.com
Company: PSTI
3054 Lawerence Expy
Santa Clara, CA 95051
Phone: (408)749-8308

Abstract:

This Small Business Innovation Research (SBIR) Phase II project provides an inexpensive disposable polymer tool that will perform extremely accurate fluid transfer in the picoliter to nanoliter range. Research efforts have already demonstrated that the costs associated with fabricating molds employing a combination of silicon micromachining and electroforming will allow these tools to be disposable. Fabrication processes will be transitioned to injection molding by adapting the micromachined/electroformed molds to the injection process. The research will design the final generations of the printing and fluid transfer pin designs, use silicon micromachining and electroforming to prepare the injection molds for the 96 and 384 pin printheads, design new collimator / printheads for both microarray printing and fluid transfer applications and redesign and scale up the chemical surface treatment process to treat thousands of pins simultaneously. Because the polymer pins can be manufactured so inexpensively compared to current technology, the number of laboratories around the world that can utilize this nanoscale fluid handling will dramatically increase.

The broader impacts of this project will be to provide disposible plastic parts at less than ten percent of the least expensive current technology thereby enabling reductions in costs for high throughput technologies important to drug discovery and diagnostics. This could improve the delivery of healthcare to the nation and reduce its overall cost.

Title: SBIR Phase II: Chiral Polymers for Pharmaceutical Purification

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|---|---|
| Award Number: | 0620587 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | August 8, 2006 |
| Expires: | July 31, 2008 |
| Total Amount: | $496,939 |


Investigator: Alexander Gorkovenko, agorkovenko@materialmethods.com
Company: Material Methods
30 Hughes, Suite 205
Irvine, CA 92618
Phone: (949)206-0967


Abstract:


This Small Business Innovation Research (SBIR) Phase II project develops new chiral stationary phases for pharmaceutical purification. Drug manufacturers seek new chiral stationary phases with high throughput, extended chiral selectivity, high loading capacity, with the ability to tolerate a wide range of mobile phases. To meet this need, artificial saccharides will be synthesized and polymerized into a 100% stereo specific chiral stationary phase for liquid chromatography of enantiomers. These polymers have remarkable propertie such as stereo specificity, five asymmetric centers, functionality for tailoring phase/ligand recognition, extensive crosslinking capability, and ether bonding. This chemistry was demonstrated in Phase I and in Phase II will lead to a new family of chiral polymers to speed drug discovery and reduce the cost of drug manufacture.

The broader impact of this research will be to provide artificial polysaccharides to provide novel activities versus the natural products currently sold. Polysaccharides have multiple, chiral centers, unparalleled optical integrity; and the highest density of functional groups of all known molecules. Artificial polysaccharides are most readily functionalized and tailored to form desired chiral selectors. This project will molecularly design chiral selectors. The impact of this research extends beyond drug purification to sugar separations, high performance fibers, tissue scaffolds, and nano machinery.

Title: STTR Phase II: Antibacterially-Active Nanoparticles

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|---|---|
| Award Number: | 0620572 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | August 3, 2006 |
| Expires: | July 31, 2008 |
| Total Amount: | $499,977 |

Investigator: Seyoung Jang, syjang77@hotmail.com
Company: Nanopharma
3802 Spectrum Blvd.
Tampa, FL 33612
Phone: (813)469-7107

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project develops a novel nanoparticle delivery system for treatment of antibiotic-resistant infections. This extends previous findings using antibacterially active polyacrylate nanoparticles to animal infection models. Penicillin containing nanoparticles are the intial focus due to the clinical importance of penicillin in treating bacterial infections and the extreme sensitivity penicillin has to degradation by proteins produced by methicillin-resistant Staphylococcus aureus (MRSA). The research will determine the stabilities of penicillin nanoparticles under various chemical and biological conditions, evaluate potential in vitro and in vivo toxicity of the nanoparticles, examine the biodistribution of the two most active nanoparticles in healthy mice, and assess the effectiveness in treating early stage (skin) and advanced (systemic) MRSA infections in mice. The results from this project will provide both fundamental data to the scientific community on these polyacrylate nanoparticles as a drug delivery platform, as well as animal testing data needed to advance this nanoparticle technology towards IND and FDA approval.

The broader impact of this research will be to demonstrate that nanoparticle technology can be applied to treatment of MRSA infections and provide essential data on the use of polyacrylate nanoparticles as a drug delivery platform. Use of nanoparticles in anti-infectives is essentially unexplored. These novel nanoparticles will enable characterization of the properties for creating FDA guidelines on the use of nanoparticles in medicine. In addition, the training of students at the graduate and undergraduate level in bio-nanotechnology is a central element of this joint project between industry and academia. The precipitous loss in the ability of antibiotics to treat bacterial infections is already having enormous societal implications. The number of deaths and serious illnesses due to clinical complications from drug-resistant infections is staggering. This research will establish a new treatment protocol for these types of infections through use of cutting-edge nanotechnology, both as a drug-delivery platform and as an effective way to recover the therapeutic effectiveness of antibiotics like penicillin. There are currently no existing technologies like this in the anti-infectives area, indication of an unmet health need and a large commercial market.

Title: SBIR Phase II: High-Density Microcapillary Bioplate

Award Number: 0548332
Program Manager: Ali Andalibi

Start Date: February 7, 2006
Expires: February 29, 2008
Total Amount: $500,000

Investigator: Joseph Krans, jak@incomusa.com
Company: Incom Inc
PO Box G
Southbridge, MA 01550
Phone: (508)765-9151

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will aid in the development of high-density glass microcapillary bioplates that will offer complete flexibility in the choice of diameter and thickness of the capillaries. These features are not currently available in an exiting product. Through an innovative low-cost fabrication approach, the disposable bioplate will allow for massive parallel experimentation that is crucial for large-scale high-integrity measurements.

The proposed research will provide for a dramatic and cost effective increase in high-throughput screening programs in all phases of drug discovery and target validation. The ability to accelerate the analysis of targets in a cost effective manner will provide for more effective screening programs.

Title: SBIR Phase II: Device for the Activation of Nanoparticle-Based Cancer Therapies

Award Number: 0548741
Program Manager: F.C. Thomas Allnutt

Start Date: February 7, 2006
Expires: January 31, 2008
Total Amount: $500,000

Investigator: Patrick O'Neal, poneal@nanospectra.com
Company: Nanospectra Bio, Inc.
8285 El Rio St Suite 130
Houston, TX 77054
Phone: (713)842-2720

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims at developing a minimally invasive, image-guided cancer therapy for the optimum activation of nanoparticle based, photo-thermal cancer therapies. This will allow for the treatment of deep-seated tumor, irregular shaped tumors as well as regional metastatic spread and tumors situated near or within sensitive tissues.

This technology will impact the current therapies for cancers, especially those of the brain and other sensitive areas. The technology will provide a minimally invasive therapy with a high safety profile that allows treatment of poorly defined tumors margins without damage to surrounding, often sensitive tissues. This would make the treatment not only more effective but will also limit damage to healthy tissue and as such, limit side effects and other organ dysfunction. Additionally, this therapy is compatible with and potentially synergist with existing treatment modalities.

Title:  SBIR Phase II: A New Biotherapeutic Approach to Combating Unwanted Bacteria

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|---|---|
| Award Number: | 0421991 |
| Program Manager: | Om P. Sahai |
| Start Date: | July 15, 2004 |
| Expires: | June 30, 2006 |
| Total Amount: | $498,903 |

Investigator: Hideki Suzuki, hsuzuki@conjugon.com
Company: ConjuGon, Inc.
505 South Rosa Rd, Suite 29
Madison, WI 53719
Phone: (608)441-2890

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop a commercial biotherapeutic using a unique bacterial conjugation technology to deliver cytotoxic genes and their products to bacterial pathogens. The Phase I work successfully demonstrated proof of concept by effectively killing multi drug resistant bacteria in vitro. The Phase II project will optimize the technology further to create a treatment for nosocomial (hospital acquired) urinary tract infections.

The commercial application of this project will be in the area of anti-infective therapy. The proposed work provides a unique therapeutic approach that can compliment standard antibiotic therapies as well as reduce the dire problem of the burgeoning development of antibiotic-resistant bacteria in the clinic.

# Proteomics

Title: SBIR Phase II: Proteome Epitope Tags-Based Antibody Arrays for High-Throughput, Proteome-Wide Kinase Pathway Profiling

Award Number: 0522303
Program Manager: George B. Vermont

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $500,000

Investigator: Neal Gordon, ngordon@epitomebiosystems.com
Company: Epitome Biosystems, Inc.
100 Beaver Street
Waltham MA, 02453
Phone: (781)209-2369

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel antibody microarray for high-throughput, multiplexed profiling of a large number of signaling proteins from multiple pathways by measuring protein phosphorylation. The antibody array will simultaneously measure kinase activities in Ras effector pathways including the Raf-MEK-ERK pathway, the P13K-Akt pathway, the p38 and JNK pathways. Current kinase profiling technologies such as Western blotting of flow cytometry are low throughput, not quantitative and difficult to multiplex and standardize. This novel technology (Proteome Epitope Tag or PET) creates antibodies with pre-defined specificity that can be multiplexed using standardized assays on antibody microarrays for measuring protein phosphorylation. The PET approach will be further developed to construct highly multiplexed antibody arrays for simultaneous measurement of a large number of kinase protein activities from multiple pathways. The ability to measure all signaling proteins from interconnected pathways will provide an unprecedented opportunity to decipher the complexity of cell signaling.

The commercial applications of this technology will be in large scale protein analysis relevant to basic biological research, drug discovery, and clinical medicine. Protein biochips hold great promise for biomarker discovery which is important in all these areas. Large-scale protein biochips capable of standardized and high-throughput protein measurement on differentially perturbed biological systems do not exist today. This is due primarily to the lack of highly specific antibodies for all human proteins predicted by gene sequences. The PET technology addresses this urgent, unmet need by generating antibodies for highly specific peptide tags of defined sequences in a proteome, representing a universal method for producing antibodies and standardized chip-based assays for any protein of interest. PET chips for profiling kinase signaling networks will have enormous utility for drug discovery by better characterizing drug efficacy, side effects and potential toxicity.

Title: SBIR Phase II: High Speed Sequencing and Structure Analysis

Award Number: 0450640
Program Manager: George B. Vermont

Start Date: May 15, 2005
Expires: April 30, 2007
Total Amount: $462,352

Investigator: Jack Syage, jsyage@syagen.com
Company: Syagen Technology Inc
1411 Warner Ave Ste D
Tustin CA, 92780
Phone: (714)258-4400

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop new methods for achieving high-speed sequencing and structure analysis of drug and biological molecules . The benefits of high-speed Molecular Sequencing (MSn) will be broadly applicable to end users through compatibility with ion trap MS instruments in general and specifically for the proposed QitTof MS (quadrupole ion - trap, time - of - flight mass spectrometry), which will provide the highest potential analysis speeds. The technical objectives for Phase II research are to (a) to develop high-speed MSn algorithms, (b) to optimize accurate mass neutral loss performance, (c) to develop CE / ESI (capillary electrophoresis / electrospray ionization) interface, and (d) to demonstrate CE / ESI / QitTof MS/MS for high-speed peptide sequencing. The final outcome of this Phase II work will be an instrument that will clearly achieve the highest speeds for peptide sequencing and overall protein identification.

The commercial application of this project will be in the area of proteomics. The proteomics market is forecasted to grow from $ 0.7 billion to $ 5.8 billion over the next 5 years. There is a tremendous need to develop automated methods for the analysis of proteins and peptides linked to specific cells and tissues, in order to better understand global biological function for improved drug therapy and early detection of diseases such as cancer.

Title: SBIR Phase II:  Membrane Protein Microarrays

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| Award Number: | 0450262 |
| Program Manager: | George B. Vermont |
| Start Date: | April 1, 2005 |
| Expires: | March 31, 2007 |
| Total Amount: | $500,000 |

Investigator: Athena Guo, athena@memsurface.com
Company: Microsurfacees Inc
4001 Stinson Blvd Suite 430
Minneapolis MN, 55421
Phone: (612)789-0104

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a product platform based on polymer cushion coated glass slides with controlled surface charge density for membrane protein microarray fabrication. The key technical objectives for Phase II research are : (a) to complete quantitative studies on surface charge density in the formation of supported phospholipid bilayer (SPB) from charged lipids , (b) to develop the chemistry for the grafting / adsorption of polymer cushions, (c) to measure the activities of membrane proteins in SPBs, and (d) to fabricate membrane protein microarrays based on surface pre-patterning using soft lithography techniques.

The commercial application of this project will be in the area of protein microarrays for use in disease diagnostics and for drug discovery research. The proposed technology will enable development of therapeutics aimed at membrane protein targets.

Title: SBIR Phase II: Overexpression of Membrane Proteins from Hyperthermophilic Bacteria - Refinement of a Novel Expression System

Award Number: 0349777
Program Manager: Om P. Sahai

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $500,000

Investigator: Hiep-Hoa Nguyen, hiephoa@its.caltech.edu
Company: TransMembrane Biosciences
145 N. Sierra Madre Blvd.
Pasadena, CA 91107
Phone: (626)536-0691

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project proposes to continue the development and refinement of a novel membrane protein expression system utilizing a unique group of bacteria capable of synthesizing a vast amount of membrane proteins and supporting extensive internal membrane structures. Membrane proteins are of significant medicinal importance. However, efforts to study membrane proteins are often hampered by their low level of biosynthesis. An efficient membrane protein overexpression system will facilitate their biochemical and biophysical characterization. This will allow for the economical mass production of membrane proteins essential for large-scale structural genomics effort as well as for industrial applications.

The commercial impact of the project will be on drug discovery work by biotechnology and pharmaceutical companies. Additional impact will be in areas of biology and physiology where processes are modulated by membrane proteins (for example, in agriculture).

Title: SBIR Phase II: Innovative Protein Microarrays

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|---|---|
| Award Number: | 0349712 |
| Program Manager: | Om P. Sahai |
| Start Date: | February 1, 2004 |
| Expires: | January 31, 2006 |
| Total Amount: | $499,807 |


Investigator: Andrzej Drukier, akd@biotraces.com
Company: BioTraces Inc
13455 Sunrise Valley Dr. Ste 200
Herndon, VA 20171
Phone: (703)793-1550



Abstract:

This Small Business Innovation Research(SBIR) Phase II project proposes to develop a novel supersensitive multiphoton detection system for protein chips (P-chip/MPD) for applications in drug discovery and in early detection of prostate cancer and breast cancer. The commercial impact of the proposed work will be in the area of diagnostic proteomics. The diagnostics industry is large, currently estimated at around 10 billion dollars per year. The most profitable and dynamically growing fields are those that permit early detection of cancer and therapy monitoring, or provide toxicity assays for new drugs.

It is expected that the P-Chips/MPD developed in this project will eventually capture a significant share of the diagnostic proteomics market.

# Detectors/Sensors/Instruments

Title: STTR Phase II: Diamond Nanoprobes for Atomic Force Microscopy - Imaging, Metrology, Material Property Measurement, Process Control, and Manipulation with Ultrahigh Performanc

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| Award Number: | 0823002 |
| Program Manager: | William Haines |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $484,464 |

Investigator: John Carlisle, carlisle@thindiamond.com
Company: Advanced Diamond Technologies
429 B Weber Road
Romeoville, IL 60446
Phone: (815) 293-0900

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop commercially viable atomic force microscope (AFM) probes fabricated from ultrananocrystalline diamond. The project will refine the processes developed in Phase I and bring contact and non-contact all-diamond probes to market. Probes using conducting diamond that are chemically and electronically tunable and have superb tribological properties will also be developed. This work will facilitate new industrial applications for AFM, including high-throughput imaging, metrology, and characterization of large quantities of materials, local electrical characterization for process control in micro/nanoelectronics, nanomechanical characterization of MEMS/NEMS devices, and ultraprecise hard mask correction for the micro/nanolithography industry.

Title: STTR Phase II: High Resolution Spectrometer-on-a-Chip Based on Nano-Optic Plasmonic Device

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| Award Number: | 0823023 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $500,000 |


Investigator: Byounghee Lee, blee@nanolambda.net
Company: NanoLambda, Inc.
510 William Pitt Way
Pittsburgh, PA 15238
Phone: (412) 828-6266



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project is to develop an ultra-compact, high-resolution and low-cost spectrometer-on-a-chip, based on plasmonic nanowire arrays. In response to the growing demands for miniaturized non-invasive spectroscopic sensor, there have been many efforts to miniaturize optical spectrometers using various conventional technologies. However they are not yet conducive to both dramatic miniaturization and also high spectral performance at low production cost. Unlike the bulky and expensive conventional diffractive optical devices, the proposed nano-optic device utilizes the wavelength-dependent plasmonic phenomena occurring on metal nanowire surfaces and the gaps between the metal nanowires. This single layered nano-optic filter array is expected to enable a high resolution spectrometer-on-a-chip, overcoming the limits of diffractive optics. This proposal is to design, and fabricate the nano-optic filter array structure using standard wafer processes, to integrate it with a custom designed CMOS detector array to form a spectrometer-on-a-chip. The anticipated outcome of this project are spectrometer-on-a-chip samples for customer test and evaluation, and demonstration of high spectral resolution (10nm) over 380nm ~780nm wavelength range in a compact size, less than 5 mm x 5 mm x 2 mm, at significantly lower cost. If successful the proposed ultra-compact high-resolution low-cost spectrometer-on-a-chip can be used in various applications such as high-resolution color sensing, multiple gas detection, and mobile/wearable health monitoring. Consumer electronics manufacturers, portable medical device vendors, and wireless sensor node suppliers can be all potential customers. As a key component to these markets, it is anticipated that the total addressable market for the proposed spectrometer-on-a-chip will be over $1 billion in around 2012. Considering the manufacturability of the proposed technology and the readiness of the markets, it is feasible to launch the first commercial product in 2010. The proposed activities will contribute to enhancing color quality and color consistency across consumer color devices, and has potential to contribute to advancing personalized point-of-care, environmental monitoring, and homeland security by enabling non-invasive, high-throughput, low-cost sensing. The proposed activities will provide further solid understanding of the phenomena occurring when a light interacts with nanostructured metal, and enhance the mass production capabilities of nano-structures. Successful completion of this project will also open up new application opportunities in the convergence areas of information, bio and nanotechnologies.

Title: SBIR Phase II: A High-Throughput Scanning Probe Microscope Using Micromachined Ultracompliant Probe Arrays with Embedded Sensors for Simultaneous Topography and Thermal Imag

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| Award Number: | 0822810 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $499,694 |


Investigator: Angelo Gaitas, angelo@picocal.com
Company: Picocal, Inc.
333 Parkland Plaza
Ann Arbor, MI 48104
Phone: (734) 972-9348



Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to produce a commercial prototype of a state-of-the-art high throughput scanning probe microscope (HT-SPM), which can be used for measuring topography and thermal parameters in nanotechnology, bio, and semiconductor applications. The scanning probe microscope has been a very successful tool, but emphasis has not been put on rapid data acquisition. The HT-SPM is an enabling technology that consists of a transformative and patented method for extracting topography which allows for higher throughput. The project leverages experience in atomic force microscope (AFM) probe micro-fabrication and industry. An immediate outcome of this SBIR project will be a fully functional and market ready HT-SPM. The broader impact/commercial potential of measurements in nanometer scale devices and structures have both scientific and industrial importance. Although the Atomic Force Microscope (AFM) is one of the most important tools for nanotechnology, there has not been any fundamental innovation in the way it operates for more than a decade. This project provides faster measurement as a result of a fundamentally different way of imaging. Faster characterization permits manufacturers to expedite problem isolation, leading to higher productivity and higher return-on-investment (ROI). The HT-SPM also benefits R&D, failure analysis and off-line engineering. The HT-SPM offers critical capabilities that will allow users too quickly and clearly measure topography/friction/temperature at the nanoscale and view critical characteristics. The HT-SPM fills a critical need in integrated circuits, nanotechnology, life sciences and other markets that rely on sub-micron microscopy, as it will provide users with a superior and inexpensive measurement system to aid in studying new properties.

Title: SBIR Phase II: Sub-100nm Infrared Spectroscopy Based on Atomic Force Microscopy

Award Number: 0750512
Program Manager: William Haines

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $493,057

Investigator: Kevin Kjoller, kevin@anasysinstruments.com
Company: Anasys Instruments Corp.
3944 State Street, Suite 345
Santa Barbara, CA 93105
Phone: (805) 455-5482

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to develop the prototype of a characterization system which can perform IR spectroscopy and imaging at sub-100nm spatial resolution and thus break the 5 micron resolution barrier that has limited IR spectroscopy for the last 50 years. This 50x breakthrough in spatial resolution is enabled by the proprietary technique of Photo-Thermal Induced Resonance (PTIR) whose feasibility has already been demonstrated in the Phase I work. IR spectroscopy is a critical analytical technique which itself comprises a $1 Billion/yr industry. However, its spatial resolution limitation has seriously limited researchers who need information on nanoscale chemical composition. The potential impact of nanoscale IR ranges from new materials discovery to interfacial property improvements in high value applications.

Title: SBIR Phase II: Picotesla Magnetic Sensor Using MgO-Based Magnetic Tunnel Junction Technology

Award Number: 0750584
Program Manager: Muralidharan S. Nair

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $498,295

Investigator: Benaiah Schrag, schrag@micromagnetics.com
Company: Micro Magnetics Inc
421 Currant Road
Fall River, MA 2720
Phone: (508) 672-4489

Abstract:

This Small Business Innovation Research(SBIR) Phase II research project will develop a compact, easy-to-use two-axis magnetic sensing module with picotesla sensitivity, based on the use of Magnesium Oxide (MgO)-based Magnetic Tunnel Junction (MTJ) sensor devices and associated electronics. The sensor module will have superior field sensitivity with excellent linearity and orthogonality, thanks to a specialized control circuitry which allows the sensors to operate under optimal magnetic conditions. The sensor module will operate under ambient conditions, with no extra infrastructure required, and will therefore be easily integrated into a number of emerging applications. The field sensitivity of the sensor module will be more than a factor of ten larger than any commercially-available thin film sensor, giving it a dominant technical edge for high -performance applications. This sensor module will be realized through the synergy of three key innovations: enhanced device performance derived from magnesium oxide tunnel barrier technology, active sensor compensation via on-board current-carrying striplines, and anisotropy engineering using specialized annealing processes. This research will create a new product family with greatly enhanced capabilities for use in many critical segments of the world sensor market, including remote sensing applications in the defense and homeland security segments, as a key component of non-destructive evaluation systems, and in emerging medical applications. It will expand the utility and availability of a number of powerful new medical technologies. This research will improve the understanding of the emerging spintronic technology of magnetic tunnel junctions, a class of devices which forms the central component of several important commercial products in the high-tech semiconductor and data storage industries.

Title: STTR Phase II: Coherent THz Sources and Amplifiers Using Carbon Nanotubes

Award Number: 0750559
Program Manager: Juan E. Figueroa

Start Date: February 15, 2008
Expires: July 31, 2010
Total Amount: $508,705

Investigator: Christian Drouet d'Aubigny, cdaubign@teravision-inc.com
Company: TeraVision Inc.
5516 E. South Wilshire Dr.
Tucson, AZ 85711
Phone: (520) 465-1909

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project will design and develop practical traveling-wave tube (TWT) amplifiers and oscillators at THz frequencies. During Phase II the research team will 1) optimize the design for low noise operation, 2) add a tuned feedback loop to the 0.345 THz TWT so the unit can function as a stand-alone oscillator, 3) based upon the experience gained at 0.345 THz, develop a detailed design for a TWT for higher frequency operation (e.g. 0.65, 0.82, and 1.5 THz where atmospheric absorption by water is at its minimum at THz frequencies), and 4) package a THz TWT for a wide variety of commercial uses. The proposed developments will increase the coherent output power available at frequencies above ~200GHz by orders of magnitude, while dramatically reducing the cost per milliwatt. The work will also provide a path for the realization of the first THz low-noise amplifiers. If successful the results from the proposed research will lead to the availability of signal sources and amplifiers capable of yielding orders of magnitude more coherent power in the THz regime than is currently available. The devices coming out of the effort will lead to THz components and devices that can be used in applications ranging from communications and remote sensing to medical imaging. . Potential end-users include NASA, aerospace companies, telecommunication companies, the security industry, companies engaged in the development of medical imaging systems, and the military.

Title: SBIR Phase II: Vapor Generator for the Calibration of Explosive Trace Detectors

Award Number: 0749979
Program Manager: Cheryl F. Albus

Start Date: February 1, 2008
Expires: January 31, 2010
Total Amount: $499,961

Investigator: Donald Hayes, dhayes@microfab.com
Company: MicroFab Technologies Inc
1104 Summit Ave Ste 110
Plano, TX 75074
Phone: (972) 578-8076

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to use digitally controlled vapor generators for calibration and test of explosive. Two systems will be created: a research oriented system, targeting manufacturers, for development of new explosive vapor trace detectors and production quality control and a portable system, intended for end users, for field testing and calibration. The use of digitally controlled ink-jet dispensing to precisely eject minute amounts of dilute explosive solutions and convert them into vapor has been demonstrated. We have also identified unique requirements of distinct vapor trace detector models and the actual needs of the marketplace. This project will: design and fabricate the two systems; generate the software control program; formulate explosive solutions customized for commercial explosive vapor trace detectors; develop test protocols for each system; evaluate the systems with commercial vapor trace detectors; and run reliability and repeatability testing. The research performed will also include: material compatibility studies; distribution of various explosive vapors by flow simulations and measurements; shelf life studies of the cartridges; and development of methods to calibrate the cartridges for explosive solutions. The broader impact/commercial potential from this technology will be a method to evaluate the development of the next generation detectors. This project will lead to products (vapor generator systems and associated consumables). These products will provide the means to compare the various explosive trace detectors and to identify the most accurate ones. Ultimately, the ability to further miniaturize the vapor generators will lead to units that are embedded into next generation detectors for real-time verification and calibration. The overall societal benefit of successfully developing vapor generator products will be improved protection of the public, both real and perceived, from terrorist threats while minimizing the cost and negative perception related to false alarms. Technological advances from this project will facilitate basic research on detection mechanisms for explosives, drugs and chemical threats. Researchers in government labs and academia will be able to use the vapor generator to evaluate and quantify improvements of promising detection methods. The technology also has spin-off opportunities in olfaction based medical diagnostics.

Title: SBIR Phase II: Automated Structural Health Monitoring Sensor

Award Number: 0724434
Program Manager: Muralidharan S. Nair

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $499,838
Investigator: An-Dien Nguyen, a.d.nguyen@lgrinc.com
Company: Los Gatos Research
67 E Evelyn Ave Ste 3
Mountain View, CA 94041
Phone: (415)965-7772

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will support the development of a new automated structural health monitoring (SHM) sensor system capable of detecting cracks and measuring stress in advanced structures. Current electrically-based SHM instrument is bulky and expensive. With the increase of sensing points and structure size, the amount of cabling, weight, and cost for hardware increases dramatically. This instrument combines optical waveguides and fibers, and Bragg Gratings (BG) with a low-cost, rugged light source to yield a SHM instrument capable of continuous measurements in the field with high precision and sensitivity. Phase II research will develop a field-tested 8-channel BG-based SHM instrument for simultaneous crack detection and loading stress measurements in large structures.

This novel SHM instrumentation will offer significant cost saving by providing a low cost solution for crack detection in large airframe structures such as wings, fuselage, and lap joints, as well as in civil structures such as oil pipelines, bridges, freeways, plants and buildings. The new sensor technology will enhance public safety as a result of low-cost condition-based maintenance and effective warning systems due to the sensor instrument's accurate prognosis and early prediction of catastrophic failures in large public transportation and utility systems.

Title: SBIR Phase II: A Novel Imaging Device for Infrared and Terahertz Radiation Beams Utilizing Thermochromic Liquid Crystal Materials

Award Number: 0724505
Program Manager: Juan E. Figueroa

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $499,170

Investigator: Alex Murokh, murokh@radiabeam.com
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1600 Sawtelle Blvd
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Phone: (310)444-1475

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will construct a detector with the capabilities of broadband imaging in the far infrared to terahertz band. The far infrared (FIR) to terahertz (THz) band of the electromagnetic spectrum has recently opened up with the proliferation of sources in this regime. However, the detector systems available on the market for this spectral region are currently expensive and inflexible. The research is centered on the study of a specific material that will convert the thermal imprint of incoming THz radiation into a visible, wavelength dependent signature that is analyzable by a detector and specialized software. A scanning system based on this detector combined with a tunable source will be designed for use as a security/inspection system. The research will incorporate this detector, capable of imaging a wide spectrum of FIR-THz radiation sources with sensitivities better than current technologies at a fraction of the cost, into a scanner system that can scan small parcels, bags and humans to identify hazardous materials or contraband.

As researchers and industries increasingly exploit this previously inaccessible portion of the electromagnetic spectrum, the need for a better imaging diagnostic tool becomes ever more important. A less-expensive, more sensitive imaging detector of FIR-THz sources is necessary before real-world applications, such as in medicine, become widespread. The realization of this particular application will impact the security and non-destructive testing markets.

Title: SBIR Phase II: Photon-Assisted Hydrogenation Process Technology for Manufacturability and Improved Operability of HgCdTe Infrared Detectors

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| Award Number: | 0724233 |
| Program Manager: | William Haines |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,901 |


Investigator: Ronald Hellmer, admin@amethystresearch.com
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Ardmore, OK 73401
Phone: (405)227-9414



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will deliver an innovative hydrogen passivation technique for improving manufacturability and performance of HgCdTe infrared detectors. Photon-Assisted Hydrogenation (PAH) causes the substrate to be hydrogenated by simultaneous exposure to hydrogen gas and ultra-violet (UV) light which allows hydrogen to diffuse into and become a permanent part of the substrate. In Phase I the feasibility of PAH for the fabrication of high-performance near-infrared HgCdTe avalanche photodiode (APD) arrays on large-area silicon wafers was demonstrated. In Phase II PAH will be optimized for fabrication of HgCdTe infrared sensors from a variety of sources.

The PAH process will not only create a new product line of high-performance HgCdTe/Si-based APDs, but may also provide a means to effect significantly higher yields, and thus lower costs for all manufacturers of HgCdTe-based detectors. PAH technology will enable all HgCdTe infrared device manufacturers to grow on Silicon wafers, significantly reducing the cost of these high value systems, and making them more generally available for a broad range of currently unaffordable applications, including civil transport, aviation, medical and robotic vision systems. Derivatives of the this technique may be applied to the manufacture of a variety of other optoelectronic semiconductor devices requiring passivation to mitigate defects.

Title: SBIR Phase II: Three-Dimensional Microscopy of Surfaces by Grazing Incidence Diffraction

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| Award Number: | 0724428 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $493,370 |

Investigator: Thomas Ditto, 3d@taconic.net
Company: DeWitt
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Phone: (212)226-6440

Abstract:

This Small Business Innovation Research (SBIR) Phase-II project is aimed at building a working three-dimensional microscope for industrial applications. This patented optics using holography will be grafted onto a two- dimensional inspection microscope now sold into the thread spinneret manufacturing industry. This research will seek to demonstrate that the expensive holographic master used in Phase I can be inexpensively mass replicated. Optical microscopy has almost always used refractive primary objectives, and 3D versions of classical refractive microscopes exploit the methods of triangulation, confocal focus accommodation, or interferometry. Here, a new concept into the technology of optical microscopy, primary objective gratings, is introduced. We have demonstrated that if an objective grating is fabricated using holography and is then configured at grazing incidence, it can be used as 3D profilometer. The demonstration microscope will be designed with features to show that it can be sold into the electronics surface mount technology inspection industry, a larger market than spinneret inspection.

This project will demonstrate the 3D capability to inspect solder paste and component insertions of sample circuit boards, and therefore will impact industrial inspection, and will provide robust field units for geology, archeology, anthropology, and paleontology. In medicine, this method has utility in endoscopy, and uses in surgery and dentistry is also foreseen. Generalized biological scientists will also be end users with the introduction of computer image processing, the availability of 3D profiles greatly expedites characterization and pattern recognition, because 3D data is immune to variations in surface shading typical of 2D image processing.

Title: SBIR Phase II: Sensory System for Autonomous Area-Wide Disease and Agriterror Detection and Reporting

Award Number: 0725388
Program Manager: Juan E. Figueroa

Start Date: September 1, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Agenor Mafra-Neto, president@iscatech.com
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Abstract:

This Small Business Innovative Research (SBIR) Phase II research project will fabricate nanosensory arrays using the Micro-Electro-Mechanical Systems (MEMS) technique. This electrochemical polymerization of biomolecule-friendly conducting polymers was developed and successfully tested to build functional, highly reliable nanosensors. This research will address key technical challenges in automating the fabrication of antibody-functionalized conducting nanowires that are individually addressable and scalable to high-density biosensor arrays for the detection of Huanglongbing (HLB). The resultant nanosensory-arrays will form the base for the development of small, effective, inexpensive, field worthy, autonomous and automated pathogen detection devices. These units will permit the unattended processing of a large number of field samples, thus increasing the temporal and geographical density of data collection, providing superior pathogen and agri-terror detection.

Current disease management techniques typically lack the data collection technologies needed to avert epidemics; diagnostic instruments are not amenable to unattended autonomous operation. Devices currently used are slow, expensive, bulky, and must interface with humans. Consequently, only few pathogen introductions are detected before causing widespread disease or epidemics. This research will increase the efficiency in detection of plant pathogens and agents of disease, allowing for preventative rather than crisis or remedial control actions. The development of this automated system can mitigate the estimated $300 billion loss due to agricultural pests.

Title: SBIR Phase II: Structurally Integrated Organic Light Emitting Device-Based Sensors for Dissolved Oxygen in Water

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| Award Number: | 0724090 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,976 |

Investigator: Ruth Shinar, rshinar@iastate.edu
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169, IA 50014
Phone: (515)292-4226

Abstract:

This Small Business Innovative Research (SBIR) Phase II project aims to develop and commercialize a novel, next-generation photoluminescence (PL)-based, palm-size and miniaturizable dissolved oxygen (DO) sensor. DO sensors are primary monitors of water quality in industrial wastewater treatment. The new sensor is based on a pioneering platform for PL-based biochemical sensors where the excitation source is a pulsed organic light emitting device (OLED) pixel array that is structurally integrated with the sensor component. The individually addressable pixels and the sensor film are fabricated on either side of the glass substrate. The photodetector is "behind" the OLED array, monitoring the PL passing between the OLED pixels. This uniquely simple structural integration enables multi-sensor fabrication on a single, compact substrate, and should therefore yield field-deployable micro-sensor arrays for simultaneous detection of various analytes.

This sensor has applicability in water quality measurements in wastewater treatment, power, pulp and paper, chemical, food, beverage, brewing, and pharmaceuticals plants, fish farms, fresh water, coastlines, and the oceans. Current sensors suffer from key drawbacks that limit their utility and application. Electrochemical sensors require frequent calibration and maintenance, and are typically slow to respond. PL-based sensors are expensive due to intricate design. The proposed sensor will be reliable, require very little maintenance/calibration, and will be inexpensive, with a flexible design and size. The proposed device will be uniquely simple, initially palm-size and eventually micro-size, autonomous, fast, miserly on power consumption, and inexpensive. It will be structurally integrated and will operate in a pulsed PL-lifetime mode, eliminating the need for optical components and frequent calibration.

Title: SBIR Phase II: Efficient, High-Resolution Fast-Neutron Detector

Award Number: 0724503
Program Manager: Juan E. Figueroa

Start Date: August 1, 2007
Expires: July 31, 2009
Total Amount: $500,000

Investigator: Jay Cremer, ted@adelphitech.com
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Phone: (650)598-9800

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop a fast-neutron imaging detector capable of high resolution and efficiency. Traditionally, fast neutron detection has required a thick, low resolution scintillator material. The proposed research will instead use light-channeling micro-capillaries filled with liquid scintillants. The capillary diameter and length that will yield optimal resolution and efficiency will be determined using a state-of-the-art image-intensified CCD camera capable of creating short time-interval images, in which noise can be identified and filtered out. The detector system will be tested using a new, revolutionary fast neutron source that is being fabricated and sold by the company. Because fast neutrons are highly penetrating, they have the possibility of imaging and interrogating large, high-density objects. The new high-resolution fast-neutron detector will be used with a high-brightness fast neutron source being developed under another program to form a fast-neutron radiographic system.

This system will serve the nondestructive testing interests of commercial and military aircraft, public utilities and petrochemical organizations. The detector and generator combinations will increase the safety, reliability and efficiency of nuclear and other power plant facilities. The discovery of fatigue cracks and piping integrity without the removal of insulation, and possibly the detection of aging in polymeric cabling materials will be possible. The imaging system will be portable, permitting imaging inside of thick steel, lead or even uranium for voids, corrosion and cracks. The proposed detector and neutron generator has a large market for screening for contraband, weapons, and explosives.

Title: STTR Phase II: Novel Deposition Rate Sensors for Real-Time Thickness Control of Plasma Spray

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| Award Number: | 0724382 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | August 1, 2007 |
| Expires: | July 31, 2009 |
| Total Amount: | $499,983 |


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| Investigator: | Gregory Reimann, Reimann@gmail.com |
| Company: | Cyber Materials<br>166 Melrose St.<br>Auburndale, MA 02466 |
| Phone: | (857)636-8339 |


Abstract:


This Small Business Technology Transfer Research (STTR) Phase II research project will develop a robust, commercial ready sensor that enables the first viable implementation of real-time control for plasma spray, reducing the cost for existing spray applications and enabling advanced coating applications that require tighter tolerances. The sensing scheme, based on a high speed solid state array, is superior to existing sensors because it can sense individual particles across the entire plume and can filter out non-molten particles that don't contribute to the coating. For the first time, a sensor will provide the basis for real-time, closed loop control for coating thickness of plasma sprayed parts. The Phase II research will develop production models of the sensor and the related closed loop control module, as well as establish proof of concept for advanced versions of the sensor.

Plasma spray is a high-throughput, economical, low environmental impact process that can be used to custom engineer coating microstructures to meet specific performance requirements, primarily in the form of thermal barrier coatings for gas turbines used in power generation and aircraft engine applications as well as emerging applications such as the electrolyte coating for fuel cells. Currently, the plasma spray process is run open-loop with respect to the critical deposition physics that determine coating quality and is characterized by large variations in coating thickness and structure.

Title: SBIR Phase II: Ultra-Low Power Microcontroller Design

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| Award Number: | 0724361 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | August 1, 2007 |
| Expires: | July 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Alexander Ishii, alexander.ishii@cyclos-semi.com
Company: Cyclos
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Berkeley, CA 94704
Phone: (510)665-1341

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will investigate novel integrated circuit design technologies for the realization of ultra-low-power microcontrollers. The main objective of this project is to investigate the deployment of novel charge-recovery circuitry for the design of an ultra-low-power leading-edge commercial microcontroller core. The resulting charge-recovery core is expected to dissipate 25-30% less power than its conventional counterpart. In conventional circuit design, capacitors are switched abruptly between supply and ground, dissipating all their stored energy as heat across resistive devices. In charge recovery design, on the other hand, capacitors are switched gradually, returning any energy that remains un-dissipated back to the power supply. The significant potential of charge recovery to reduce power consumption has so far remained untapped in the commercial world, primarily due to the lack of support for such a new design style that deviates from established design practices.

The results of the proposed research are commercially applicable to the realization of a broad class of computer systems and consumer electronic devices that are subject to power efficiency requirements. Microcontrollers are essential elements of every System-on-Chip (SoC) and typically account for a substantial fraction of overall chip power, since they remain on most of the time. Embedded microcontrollers are key components of semiconductor chips for mobile devices such as cell phones and personal digital assistants. Generating a commercial microcontroller core with substantially reduced power consumption will lead to a broad variety of next-generation computer and communication systems with enhanced features, longer battery life, and improved performance.

Title: SBIR Phase II: Particle Metrology and Diagnostics using Microchannel Resonators

Award Number: 0724350
Program Manager: F.C. Thomas Allnutt

Start Date: July 15, 2007
Expires: une 30, 2009
Total Amount: $499,142

Investigator: Ken Babcock, ken@affinitybio.com
Company: Affinity Bio
75D Robin Hill Rd
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Phone: (805) 455-0181

Abstract:

This Small Business Innovation Research (SBIR) Phase II program develops an instrument capable of measuring micron-scale particles using their weight as the measured parameter. At the instrument''s core is a novel microfabricated sensor containing a vibrating microchannel. The target particles are suspended in fluid as they pass through the channel, causing channel vibration frequency to change with a sensitivity of less than a picogram.

The broader impact of this research will to provide a method for particle size analysis that in addition to size gives mass. Manufacturing processes in many industries could benefit from this type of instrument to improve their processes and thereby lower production costs as well as improving product quality when used in a quality assurance program.

Title: SBIR Phase II: Development of a Broad Spectrum Differential Mobility Aerosol Analyzer for Aerosol Size Distribution Measurements

Award Number: 0646182
Program Manager: Muralidharan S. Nair

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $500,000

Investigator: Fredrick Brechtel, fredbmi@sbcglobal.net
Company: Brechtel Mfg. Inc.
1789 Addison Way
Hayward, CA 94544
Phone: (510)732-9723

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will support the continued development of a new Synchronous Differential Mobility Analyzer (SDMA) aerosol sizing and counting system that is simple to use, inexpensive, and allows rapid observations of ambient particle number size distributions over the 0.005 to 0.4 micron diameter range. The new technology will largely eliminate the cost, size, weight, and operator-expertise limitations of currently available sizing technologies. Prototypes of the particle sizing, growth and optical detection systems will be fabricated and the instrument will be tested side-by-side against standard instruments in the laboratory.

Broader impacts of the proposed research include satisfying the need for increased spatial and temporal coverage of ambient aerosol data while creating a measurement technique accessible to a more general group of users through reduced cost and ease of use. The broader application of the new technology will serve as an educational tool for students and investigators leading to more widespread understanding of how particle concentration varies with size in ambient, laboratory and industrial settings. Increased understanding of the variability of the ambient aerosol number size distribution will serve as important information for investigators in the areas of aerosol global climate and particulate pollution health impacts.

Title: SBIR Phase II: RFID Tags for Cardiopulmonary Monitoring in Clinical Setting

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| Award Number: | 0646422 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $499,998 |


Investigator: Ronald Salesky, salesky@jerseymicro.com
Company: New Jersey Microsystems
211 Warren Street, M/S 31
Newark, NJ 07103
Phone: (973)297-1450



Abstract:

This Small Business Innovation Reseach (SBIR) Phase II research project will develop an RFID system with sensor tags. This work focuses on design and implementation of a custom CMOS integrated circuit which contains hybrid analog-digital circuits on a micro-power tag. The biomedical application is vital signs monitoring including heart and lung sounds. The sensor tag operates within an RFID environment. Micro-electromechanical systems technology is used to fabricate an optimized sensor together with CMOS circuitry on the RFID-compatible tag. Heart sounds are presented as time-varying waveforms and processed algorithmically for feature extraction. Micro-power designs are used throughout the planned system.

The commercialized product with disposable tag sensors can replace the jungle of wiring currently used with direct-wired sensors or, for wireless pods, the need to replace batteries frequently. The system provides a patient monitoring capability that is very convenient, highly-cost effective, capable of chronic use, and does not interfere with nearby heart pacers. The ease of application makes this system ideal as a teaching tool for medical students and specialists with both visual waveforms and sound presented to the operator simultaneously. The system will be used in hospitals, clinics, medical offices, and for outpatients in the home.

Title: SBIR Phase II: Atmospheric Pressure Microplasma Emission Spectrometer

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| Award Number: | 0646415 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $500,000 |


Investigator: Chris Doughty, cdoughty@verionix.com
Company: Verionix
251 Granville Lane
North Andover, MA 01845
Phone: (617)905-0015



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop a miniature atmospheric pressure plasma spectrometer using a source which generates a highly confined, high-density discharge (kW/cm3). The source would be based on a high frequency ring resonator structure and would utilize low cost widely available IC power amplifiers and drivers, would have extremely low cost in moderate volume production, and would consume <2 W rf power, allowing for portable operation. The compact size of this discharge should allow straightforward coupling to fiber optic spectrometers, and intense optical emission.

This research will substantially add to the scientific knowledge base and lead to fundamental understanding of the physics and engineering of these high-power-density, small and highly non-equilibrium plasmas. The source technology to be developed here will enable the miniaturization of a variety of chemical and gas analysis technology. This technology, by dramatically lowering the cost (10-100x), form factor (100x), and portability of the analytical equipment will provide economic benefits to customers in industrial settings, enhance worker and workplace safety, and allow for wider environmental monitoring.

Title: SBIR Phase II: Electronic Pills for Medication Compliance

Award Number: 0646491
Program Manager: Muralidharan S. Nair

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Neil Euliano, neil@conveng.com
Company: Convergent Engineering
4817 SW 34th Street, Suite 4
Gainesville, FL 32608
Phone: (352)378-4899

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project shall evaluate the use of electronic pills for medication compliance monitoring. Medication compliance monitoring is critical in pharmaceutical clinical trials, geriatrics, and mental health /addiction medicine. The only proven method for accurately determining medication compliance is directly observed therapy where personnel are present during
ingestion by the patient. This technique is labor intensive, but effective. In vivo biotelemetry and monitoring is a rapidly growing field that may provide the next critical breakthrough in medical monitoring. This research will focus on the development of these two solutions, namely a UHF resorbable antenna printed on the outside of an existing capsule or pill with or without a chip designed to improve signal to noise ratio and provide ID capability. The antennas will be printed with standard ink-jet technology. A handheld RF communication device will sense the presence of the pill in the GI tract and positively confirm that the medication regimen was followed appropriately.

Electronic pill technology and R&D will help expand the rapidly growing field of in vivo telemetry. The development of biodegradable low power miniature circuits will be an important step to future bio-implantable chips and sensors. Additionally, the field of medication compliance is tremendously important in many areas of medicine. In particular, better compliance monitoring can greatly reduce the costs associated with FDA approval of pharmaceuticals as well as provide dramatically improved data for accurate determination of low probability side effects.

Title: SBIR Phase II: Balloon-Based Instrument for Measurements of Atmospheric Water Vapor and Methane

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| Award Number: | 0646479 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | February 15, 2007 |
| Expires: | January 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Mark Zondlo, mzondlo@swsciences.com
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1570 Pacheco St Ste E11
Santa Fe, NM 87505
Phone: (505)984-1322



Abstract:

This Small Business Innovation Research ( SBIR) Phase II research project will develop, test fly, and inter-compare a balloon-based sensor for measuring atmospheric water vapor and methane. The chemical sonde is based upon low power vertical cavity lasers, compact optical cells, and noise-lowering data analysis algorithms. Water vapor is the most important radiative gas in the atmosphere, but accurate measurements of it in the upper troposphere and lower stratsophere are limited to custom, one-of-a-kind instruments. Methane is the second most important anthropogenic greenhouse gas, photochemically breaks down into water vapor in the stratosphere, and is a useful tracer for troposphere-stratosphere exchange. In combination, the water vapor and methane balloon based sensor offers more accurate insight into atmospheric chemistry (e.g. recovery of the ozone layer), atmospheric dynamics, and the Earth's radiative budget.

Improved data on water vapor and methane in the upper troposphere and lower stratosphere will help to better understand and predict how climate will change in the future. The costs of action and inaction on climate change are expected to be large, and it is imperative that society implement policies that maximize environmental protection while minimizing economic costs. More accurate assessments of climate change will indirectly benefit the economy by giving society time to prepare and adapt to potential changes in future climate.

Title: SBIR Phase II: High Power Deep UV LED-Based Lamps

Award Number: 0620525
Program Manager: Juan Figueroa

Start Date: August 29, 2006
Expires: August 31, 2008
Total Amount: $499,704

Investigator: Thomas Katona, tkatona@s-et.com
Company: SET
1195 Atlas Rd
Columbia, SC 29209
Phone: (803)647-9757

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will result in solid-state high power UV LED based lamps for use in water/air/food sterilization/purification, bio-aerosol detection, bio-medical instrumentation, and laboratory measurement systems. Currently there are no portable, rugged, long-lifetime, non-toxic sources of ultraviolet radiation for integration into increasingly important UV water and air purification (particularly residential), bio-aerosol detection, and food sterilization systems. The predominant sources of UV radiation are low-pressure, medium-pressure and amalgam Hg based lamps. These high voltage lamps are large, non-directional, ozone-producing sources of radiation with radial emission from a tube source. This restricts the design flexibility of purification systems because of the geometrical constraints imposed by the lamp. High power deep UV LEDs require packaging designed to dissipate several watts of power, be stable under UV illumination, reflect UV light, and enhance UV extraction. The team proposes to develop manufacturing innovations in the packaging of high power UV LEDs to extend the range of applications that UV LEDs are suitable for including high power package/LED design, and the manufacturing processes required to fabricate these packages. Deep UV LED based lamps with output powers ranging from 50-100 mW are expected from this developmental effort.

If successful these Deep UV LED-based lamps will penetrate existing markets using UV radiation sources as the efficiency of the devices increases, as well as creating new markets previously unattainable due to the inherent limitations of current UV sources. The merits of UV radiation for sterilization/purification applications are beginning to be widely publicized. Several of the primary markets are: 1) Sterilization/Purification for Water, Air, and Food Preparation/Storage, 2) UV Spectroscopic Laboratory Analysis Equipment, 3) Bio-medical instrumentation, and 4) Biological weapons detection using UV fluorescence. This expertise will expand the technology base of the U.S. semiconductor manufacturing sector. In addition, low power point-of-use purification systems enabled by this technology will meet a crucial humanitarian need.

Title: SBIR Phase II: Development of an Imaging X-Ray Spectrometer

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| Award Number: | 0620578 |
| Program Manager: | Murali Nair |
| Start Date: | July 5, 2006 |
| Expires: | February 28, 2007 |
| Total Amount: | $644,000 |

Investigator: Michael Feser, mfeser@xradia.com
Company: Xradia
177 Balboa St.
Mayaguez, PR 00681
Phone: (787)834-5700

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project addresses the development of a novel real-time bio-aerosol machine for detecting and identifying harmful bio-aerosols present in the environment. The system will use the time of flight method to determine the aerodynamic size, and the Multiphoton Laser Induced Fluorescence (MLIF) method for the identification of the fluorescence spectrums. The novelty of the detection machine lies in the use of in-line, non-invasive techniques to measure these two important parameters. The system will consist of a compact laser source, a laser diode, a spectrometer, fiber optics couplings, a series of lenses and filters, pumps, flowmeters and pressure transducers. The sensor will be driven by two printed circuit boards and by computer software both uniquely designed for the proposed detector.

The need for the proposed instrument is of high priority in current times due to the extreme concerns about air quality issues and the high probability of terrorist attacks in large urban settings. The initial target markets for this product are "first emergency response" civilian agencies, medium to large size hospitals, and the armed forces.

Title: SBIR Phase II: An Improved Multi-Sensor Manufacturing System for Scrap Metal Sorting

Award Number: 0548698
Program Manager: George Vermont

Start Date: January 23, 2006
Expires: January 31, 2008
Total Amount: $499,991

Investigator: David Spencer, dbswte@aol.com
Company: wTe
7 Alfred Circle
Bedford, MA 01730
Phone: (617)275-6400

Abstract:

This Small Business Innovation (SBIR) Phase II project combines two technologies (XRF and Laser Induced Breakdown Spectroscopy) into a single processing system for high speed sorting of scrap metal. The proposed new technology has the potential to revolutionize the way nonferrous metals from recycling facilities are handled. Instead of disposing of the metals in a landfill or selling them as low priced metal mixtures, they can be used directly in commercial applications.

This project is aimed at validating small scale results on titanium and aluminum alloys from Phase I, and designing and constructing a prototype unit to demonstrate commercial feasibility.

Title: SBIR Phase II: Thick Film Planar Magnetooptic Garnet Faraday Rotators

Award Number: 0450470
Program Manager: Juan E. Figueroa

Start Date: September 15, 2005
Expires: August 31, 2007
Total Amount: $443,775

Investigator: Vincent Fratello, vjfratello@integratedphotonics.com
Company: Integrated Photonics, Inc
2920 Commerce Blvd
Birmingham AL, 35210
Phone: (908)281-8000

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project addresses the device and market opportunity for thick magnetooptic garnet Faraday rotator films with planar anisotropy to be operated in the near infrared. Magnetic and electromagnetic field sensors could be developed at a variety of near-infrared wavelengths including the 800 nm, 1310 nm and 1550 nm bands. These sensors can be made much less expensively, in much smaller sizes and with much less weight than current technologies such as current transformers. They have a potential for immediate impact in reliability of electric power distribution through failure anticipation and prevention and conservation of electric power through monitoring and control. Planar materials have much higher switching speeds than conventional perpendicular Faraday rotators and as such would permit a magnetooptical approach to packet switching. Such films are an innovative solution to device problems that require high-speed, continuously-varying polarization rotation with applied field. The project will work on improving properties and performance of such thick planar films and incorporate them into devices. Specific materials tasks are directed to improving sensitivity, linearity and temperature range of operation.

If successful these sensors will have applications such as wheel and turbine rotation, electric power distribution, monitoring, metering and control, and battlefield sensors. The electric power application in particular has potential to revolutionize catastrophic failure prevention in the power grid and reduce power costs at a variety of levels by enabling autonomous reconfiguration. The lack of electrical connectors in fiber optic sensors for explosive, flammable and high-voltage environments represent a significant improvement in safety. New photonic devices not currently realizable will be enabled for telecommunications and military applications such as variable optical attenuators, polarization controllers and increased speed magnetooptic switches. Photonic devices include polarization controllers, variable optical attenuators, switches and new innovative devices. Smart ships and buildings would find utility both for conservation and efficiency.

Title: SBIR Phase II: Portable Sequential Injection (SI)-High Performance Liquid Chromatography (HPLC) Analyzer

Award Number: 0522319
Program Manager: Muralidharan S. Nair

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $500,000

Investigator: Garth Klein, garth@flowinjection.com
Company: FIAsolutions
14450 NE 29th Place, suite 113
Bellevue WA, 98007
Phone: (425)376-0450

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project is aimed at the development of a portable and fully automated chromatographic based analyzer. This analyzer will integrate several proven technologies to produce an automated instrument that is compact, robust and easily implemented for on-line, at-site, or field-ready use, especially where complex HPLC (High Performance Liquid Chromatography) analyses is needed. Based on both Sequential Injection (SI) protocol and HPLC instrumentation, this device will be fully automated and provide an integrated approach with respect to sample collection, pre-treatment, chemical modification, separation and detection of target analytes. This chemical analyzer will exploit several novel technologies including sequential injection, portable high-pressure syringe pumps and sol-gel HPLC columns in its development.

The proposed SI-HPLC instrument will find applications in on-line process control, at-site environmental monitoring or as a multipurpose field-ready analyzer for medical, law-enforcement and military use. Sequential Injection technologies make this analyzer ideally suited for use by untrained personnel or for remote autonomous analysis since sample handling and preparation can be completely automated. Initial targeted use for the SI-HPLC will be for online bioprocess control (e.g. pharmaceuticals) to provide real-time feedback for Quality Control or optimal product yield.

Title: SBIR Phase II: Novel Radial Magnetic Field Actuator for Fully Flexible Electromechanical Valve

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| Award Number: | 0522170 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | September 1, 2005 |
| Expires: | August 31, 2007 |
| Total Amount: | $462,429 |

Investigator: David Cope, dcope@engineeringmatters.com
Company: Engineering Matters Inc
375 Elliot St Ste 130K
Newton MA, 02464
Phone: (617)965-8974

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop a novel radial magnetic field actuator for fully flexible electromagnetic automotive engine valves. Electromagnetic valve actuators are rapidly emerging as the technical solution for improved emissions, fuel consumption and greater engine performance. Dramatic improvement in engine performance and reduction in environmental impact is possible with this technology. A fully electronically controlled inlet/exhaust valve actuating system eliminates camshafts and other mechanical components completely, thus (1) allowing optimization of the gas-exchange process across the whole engine speed and load range, and (2) eliminating the packaging restrictions placed upon an engine by conventional camshaft profiling.

The primary application of the actuator is automotive internal combustion engine valves. The ability to alter the lift and timing (opening and closing) of automotive engine valves will create more powerful engines that require less fuel and create fewer emissions. In fuel savings alone, an estimated 15% savings can be achieved, which equates to saving approximately 475 million barrels of oil per year for US consumption worth approximately $21 billion per year. Improving fuel economy is a worthy national goal: it will reduce America's dependence on imported oil, cut the carbon emissions that contribute to global warming, and increase automotive competitiveness.

Title: SBIR Phase II: Assessment of Manufacturing and Fatigue Damage Effects in Titanium Alloys Using Induced Positron Annihilation

Award Number: 0521901
Program Manager: Muralidharan S. Nair

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $446,385

Investigator: Jagoda Urban-Klaehn, klaehn@physics.isu.edu
Company: Positron Systems, Inc.
6151 N Discovery Way
Boise ID, 83713
Phone: (208)672-1923

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop a prototype Induced Positron Manufacturing Damage System (IPMDS) to be used to assess initial component quality, and manufacturing damage effects for Ti-6Al-4V and IN738 components. The IPMDS is based on the Induced Positron Annihilation technologies whose capabilities to assess alpha inclusion and fatigue damage effects have been previously demonstrated. The IPMDS is an innovative damage assessment tool that will be developed with support from Precision Cast Corporation (PCC) as a manufacturing quality control and damage assessment tool to be used to reduce costs in place of current destructive methods, which are expensive and do not provide adequate sensitivity to either manufacturing or operational damage effects. The IPMDS will contribute to extended use component designs, cost savings, and efficient operations for the titanium and nickel super-alloy industries.

Commercial applications of IPMDS will be targeted at the structural and turbine engine industries, which extensively utilize expensive titanium and nickel super-alloy components. The IPMDS has a high potential for becoming a critical and necessary inspection tool in these industries due to its potential for minimizing manufacturing variability, assessing operational damage, optimizing maintenance requirements, reducing costs, and improving safety. The IPMDS capability is expected to extend inspection applications to a wide range of industries where improved knowledge of manufacturing variability, induced damage effects, minimization of inspection and replacement costs, and component life extension are important

Title: SBIR Phase II: A Reversible, Colorimetric Hydrogen Safety Sensor Using Tailored Xerogels

Award Number: 0521760
Program Manager: Muralidharan S. Nair

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,999

Investigator: Kisholoy Goswami, kisholoy.goswami@innosense.us
Company: InnoSense LLC
2531 West 237th St, Ste 127
Torrance CA, 90505
Phone: (310)530-2011

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will optimize performance of an optical safety sensor for integration with the hydrogen economy infrastructures. Feasibility of the sensing approach was demonstrated by developing a sol-gel-titania-based indicator formulation, which showed complete reversibility, and response and recovery time of less than a minute with 4% hydrogen. Safety remains a top priority since leakage of hydrogen in air during production, storage, transfer and distribution creates an explosive atmosphere for concentrations between 4% (v/v) - the lower explosive limit (LEL) and 74.5% (v/v) - the upper explosive limit (UEL) at room temperature and pressure. Being a very small molecule, hydrogen is prone to leakage through seals and micro-cracks. The sensor will be further improved with regard to its dynamic detection range, response and recovery times, sensitivity, accuracy, resolution and reduced interference from temperature fluctuations, and atmospheric gases including humidity.

Hydrogen economy is new; public acceptance of hydrogen fuel would require the integration of a reliable safety sensor. Global energy consumption is projected to increase by 50% over the next 20 years. Failure to develop alternatives to oil would heighten growing reliance on oil imports, raising the risk of political and military conflict and economic disruption. The acceptance of hydrogen by the general public as an alternative fuel requires a safety sensor for mitigating the explosion risks due to hydrogen leakage at unacceptable levels

Title: SBIR Phase II: Ultrasensitive, Real-Time Explosives Sensor

Award Number: 0521652
Program Manager: Muralidharan S. Nair

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $483,725

Investigator: James Scherer, jjscherer@novawavetech.com
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Redwood City CA, 94065
Phone: (650)610-0956

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project seeks to develop a new, ultrasensitive laser based explosives detection system (EDS). The system will be capable of rapidly detecting and discriminating among common explosives materials in a timescale commensurate with that of existing passenger screening systems that are presently used in airports. The proposed EDS technology is based on a combination of a new, rapidly and widely tunable laser system with a novel optical cavity enhanced absorption method. The research effort comprises constructing and testing a bench top version of the system that is suitably configured for use in the middle infrared, where explosives can be detected via their characteristic spectral signatures. If successful, the instrument will be capable of significantly exceeding the sensitivity level of existing commercial EDS sensors, as well as potentially providing an orthogonal sensor platform.

The sensor will be suitable for passenger, baggage, and cargo screening applications, and will be engineered specifically for integration as a plug-in replacement or parallel technology to existing screening systems. In addition to advancing laser technology, the project has the potential to benefit society by assuring safer transportation to the general public. The ability to rapidly scan the middle infrared spectral region with high absorption sensitivity will enable the rapid detection of numerous trace chemical species including toxic industrial chemicals, chemical warfare agents, and industrial pollutants.

Title: SBIR Phase II: Oxygen Sensor for Aircraft Fuel Tanks

Award Number: 0522239
Program Manager: Muralidharan S. Nair

Start Date: July 15, 2005
Expires: June 30, 2007
Total Amount: $474,135

Investigator: Travis Martin, tmartin@dakotatechnologies.com
Company: Dakota Technologies Inc
2201 12th St N Ste A
Fargo ND, 58102
Phone: (701)237-4908

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will complete the development of an oxygen sensor that can be deployed inside aircraft fuel tanks. Such a sensor will be needed after the Federal Aviation Agency (FAA) mandates the use of nitrogen-enriched air to prevent explosions like the one that destroyed TWA flight 800. Currently available oxygen sensors cannot withstand the harsh environment and meet the accuracy, longevity, and cost requirements. The technical objectives are to completely characterize and understand the permeation properties of the polymer matrix; examine alternative formulations of the polymer; completely understand the photochemical, leaching, and spectroscopic properties of the phosphorescent dye, examine other candidate dyes, and conduct long-term testing.  A flight test of the oxygen sensor is planned.

This research will ultimately benefit society by making air travel safer. It will also serve as a model for the interplay between fundamental science, applied science, and the engineering disciplines during product development. The work will open the door for development of other luminescent sensors that can be deployed in comparably harsh chemical environments, including the measurement of water in fuels and alcohols.

Title: SBIR Phase II: Sensor Technology Enabling Large Array Based Sensors

Award Number: 0450583
Program Manager: Muralidharan S. Nair

Start Date: June 1, 2005
Expires: May 31, 2007
Total Amount: $480,705

Investigator: Tony Ragucci, tony.ragucci@lynntech.com
Company: Lynntech, Inc
7607 Eeast Mark Dr. Ste 102
College Station TX, 77840
Phone: (979)693-0017

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project involves an innovative gas sensor (DiskFET) based on a commercially available hard drive mechanism, proprietary polymers for sensing, and a modified Field Effect Transistor (FET). The device as envisioned is small, handheld, lightweight, low power, and applicable to a diverse range of chemical sensing fields. The DiskFET operates by applying an electric field between a polymer coated rotating disk and stationary FET, which is "floating" a fixed distance above the disk surface, the field strength will be affected by the interactions of the analyte with the polymer coating on the disk. This change in field strength is measured by the FET. By combining the signal responses of all of these relatively non-specific sensors, a "fingerprint" for the analyte is constructed. Using Artificial Neural Network analysis, the concentration and identity of the analyte can be recognized based on a database of the sensor response characteristics.

Personal safety and air quality monitoring is on the rise. More and more workers are becoming conscious of the dangers of their work environments and are demanding adequate monitoring technologies as evidenced by the long-term, steady increase in chemical detector sales. This device will be used for the detection of chemicals such as Ammonia and VOC's with detection limits below current OSHA accepted levels.

Title: SBIR Phase II: Automated Foam Index Test Instrumentation

Award Number: 0450405
Program Manager: T. James Rudd

Start Date: April 1, 2005
Expires: March 31, 2007
Total Amount: $463,748

Investigator: John Stencel, john@triboflow.com
Company: Tribo Flow Separations, LLC
1525 Bull Lea Blvd
Lexington KY, 40511
Phone: (859)259-0011

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a prototype Automated Foam Index Test (AFIT) instrument for measuring foam indices of mineral admixtures used in concrete; and, a prototype AFIT instrument for controlling dosage of air entraining agents into mineral admixtures and concrete. AFIT instruments take advantage of the physical behavior of foams to identify bubble stability and breakup activity. The Phase I project confirmed concepts behind AFIT to measure air entrapment. The Phase II project creates a commercial-ready instrument. The Phase II research objectives are to (1) construct, test and then refine the tabletop AFIT and the automated sampling, control AFIT prototype instruments; (2) confirm correlations between the foam index/air content values from AFIT prototypes and visual/ASTM measurements; (3) install an AFIT at a partner company and verify its efficacy within a industrial setting; and (4) commercialize these instruments for the concrete industry.

Commercially widespread application of AFIT for the concrete industry would promote replacing cement with less expensive mineral admixtures up to specification limits of 30%. On a worldwide view, the potential cost reduction associated with this replacement is greater than $5 billion per year. Significant societal benefits also accrue. First, because cement production is approximately 10 times more energy intensive than the average of all other industrial activities, green house gas emissions worldwide are decreased significantly when cement is replaced by a less energy-intensive substitute. Second, because the primary mineral admixture used is coal combustion ash, and because it is now predominantly landfilled, environmental impacts and land usage issues are ameliorated.

Title: SBIR Phase II: Infrasonic Avalanche Identification

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| Award Number: | 0449731 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | April 1, 2005 |
| Expires: | March 31, 2007 |
| Total Amount: | $500,000 |

Investigator: Ernest Scott, scotte@imlinc.com
Company: Inter-Mountain Laboratories, Inc
555 Absaraka St
Sheridan WY, 82801
Phone: (307)674-7506

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to produce a working prototype sensor array monitoring system that detects, identifies, and localizes the infrasound generated by snow avalanches. The goal of the project is to bring to commercial form automated monitoring systems that improve the safety and welfare of those impacted by avalanche activity. Avalanche-generated infrasound signals can propagate miles from their origin, and provide a basis for automated monitoring and warning systems. Previously developed single sensor infrasound monitoring systems can detect and identify avalanche-generated infrasound in an automated near real-time manner, but performance suffers when avalanche signal amplitudes are small and/or during high wind noise periods. By advancing and refining array-based signal processing algorithms, sensor array monitoring can provide spatial information that greatly improves avalanche signal identification in varying signal and noise conditions while also providing the geographic location of the avalanche signal origin.

Identification of avalanche occurrences will improve safety in avalanche prone terrain and minimize direct and indirect costs associated with avalanche activity. Automated notification of unexpected avalanche activity will provide a prompt for early response activities. Knowledge garnered through this project will advance the field of applied infrasonic sensor array monitoring, an infant science. Innovative hardware and software components that are designed and proven will be available for other infrasound monitoring applications such as tornadoes, volcanoes, flash floods, ocean storms, calving glaciers, aura borealis, ridgeline winds, explosions, and aircraft.

Title: SBIR Phase II: Development of an Optical Sensor for Instantaneous Detection of Bioaerosols

Award Number: 0450546
Program Manager: Muralidharan S. Nair

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $512,000

Investigator: Luis Alva, ctt@vitec2.com
Company: Caribbean Thermal Technologies
177 Balboa St.
Mayaguez PR, 681
Phone: (787)834-5700

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project addresses the development of a novel real-time bio-aerosol machine for detecting and identifying harmful bio-aerosols present in the environment. The system will use the time of flight method to determine the aerodynamic size, and the Multiphoton Laser Induced Fluorescence (MLIF) method for the identification of the fluorescence spectrums. The novelty of the detection machine lies in the use of in-line, non-invasive techniques to measure these two important parameters. The system will consist of a compact laser source, a laser diode, a spectrometer, fiber optics couplings, a series of lenses and filters, pumps, flowmeters and pressure transducers. The sensor will be driven by two printed circuit boards and by computer software both uniquely designed for the proposed detector.

The need for the proposed instrument is of high priority in current times due to the extreme concerns about air quality issues and the high probability of terrorist attacks in large urban settings. The initial target markets for this product are "first emergency response" civilian agencies, medium to large size hospitals, and the armed forces.

Title: SBIR Phase II: Development of an Automated Ballast Water Exchange Monitoring System Using 'Through-the-Hull' Acoustic Modems

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| Award Number: | 0450355 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | March 1, 2005 |
| Expires: | February 28, 2007 |
| Total Amount: | $497,767 |

Investigator: Kushal Talukdar, kushal@harrisacoustic.com
Company: Harris Acoustic Products Corporation
141 Washington St
East Walpole MA, 02032
Phone: (508)850-3101

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project is aimed at building the first prototype of an automated ballast water exchange (BWE) monitoring and reporting system. The system will use acoustic modems that use ultrasonic acoustic energy through metal structures as the means of communication. Wireless networking based on radio frequencies (RF) is not very effective within enclosed metal structures such as the hulls of ships. The acoustic modems can be used to overcome such limitations and can establish a local wireless network for data transfer among sensors located in various parts of the vessels. The through-the-hull communications technology is at a nascent but proven state. Existing modems transfer data at 20 bits per second. The Phase-I research showed that a data rate of 500 bits per second (or higher) would exceed the data throughput requirement for BWE monitoring.

Ballast water management is a global issue. The foreign micro-organisms not only destroy the bio-diversity in the native coastal eco systems but create problems for regional economies as well. The impact from the introduction of Zebra mussels in great lakes is estimated at over four billion dollars. Therefore developing an effective and inexpensive technology for monitoring the ballast water has a broader impact on the society. It has the potential to save economies that depend on coastal resources and ensure the preservation of the local eco-systems for future generations without placing excessive restrictions on international maritime trade.

Title: SBIR Phase II: Miniature Mass Spectrometer for Liquids Analysis

Award Number: 0450512
Program Manager: Muralidharan S. Nair

Start Date: February 15, 2005
Expires: January 31, 2007
Total Amount: $458,475

Investigator: John Grossenbacher, grossenbacher@griffinanalytical.com
Company: Griffin Analytical Technologies, Inc.
3000 Kent Ave
West Lafayette IN, 47906
Phone: (765)775-1701

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop novel instrumentation based on electrospray ionization (ESI) coupled with mass spectrometry for identifying and quantifying chemical species in liquid-phase samples in the field. The goal of this project is to employ an existing Minotaur miniature mass spectrometer (MS) to develop a portable, easy-to-operate detector that will provide real-time and highly sensitive detection of a broad range of chemical compounds in liquid samples in the field. The objectives of the research are to construct, integrate, and optimize an innovative miniature ESI source into the instrument to receive liquid samples and introduce the target analytes to the detector, while minimizing interference from background matrix constituents, and to fully develop and qualify the analytical characteristics and ease-of-use of the instrument during field operations.

Commercially this development of the first field portable, miniaturized ESI-mass spectrometer will have commercial applications in several governmental and commercial sectors, and has the potential to impact society broadly by providing improved monitoring of water resources and protection of the public from chemical exposure resulting from hazardous material accidents or acts of terrorism. If successful, this research will lead directly to developments allowing for determination of compounds of biological origin, e.g. biomarkers, which will provide additional dimensions of information as to the content of analytical samples.

Title: SBIR Phase II: Advanced Phased Array Ultrasound Instrument for Nondestructive Evaluation (NDE)

Award Number: 0450553
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $481,841

Investigator: Vincent Lupien, vincent.lupien@acousticideas.com
Company: Acoustic Ideas Inc.
27 Eaton St
Wakefield MA, 01880
Phone: (781)621-8228

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project strives to develop an Advanced Ultrasonic Beamformer that is unparalleled in its scalability and signal processing features. The ultrasonic beamformer architecture will be unique in its breadth of features. The architecture was developed as the superset of features across several fields including medical imaging, medical therapy, bone density measurement, vascular imaging, and materials characterization. This approach provides each field with an instrument capable of operating outside the normal performance envelope, thereby presenting opportunities for the development of new uses of ultrasound. The benefits of this array include better frame rates, crisper images, and more accurate surgery.

The higher frequencies used in materials characterization, when brought to medical imaging, will allow array transducer to be used where only conventional, single element probes could used in the past, for example in intra-cardiac imaging for surgical instruments, and also for tumor ablation. By design, the proposed architecture encompasses the abilities of many different fields. Each field then enjoys performance capabilities beyond what is normally available, providing a general-purpose tool for research.

Title: SBIR Phase II: Reflectance Sensitive Image Sensor for Illumination-Invariant Visual Perception

Award Number: 0450554
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $499,997

Investigator: Vladimir Brajovic, brajovic@intriguetek.com
Company: Intrigue Technologies, Inc.
513 Harrogate Rd
Pittsburgh PA, 15241
Phone: (412)223-2443

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project proposes to develop an adaptive CMOS image sensor that estimates and largely eliminates illumination variations in sensed optical images thus reporting electronic images that are indicative of the reflectance of the viewed scene. By eliminating illumination-induced variations from the raw optical images the proposed sensor will eradicate the vision system's vulnerability to illumination variations and signal loss due to high dynamic range. The core innovation is in a signal processing technique for estimating the illumination field from sensed images. The technique efficiently implements as a dense on-chip massively parallel analog processor distributed among the photo-detectors to produce a reflectance sensitive image sensor. By compensating for illumination, the proposed image sensor inherently addresses the wide dynamic range problem, that routinely causes conventional cameras to over or under expose producing inadequate images. Even when illumination conditions do not saturate an image sensor, the vision system has to account for object appearance variations caused by illumination.

The proposed research has the potential to broadly impact computer vision performance and reliability. Most present and future vision applications including automotive, biometric, security, and mobile computing applications operate in unconstrained environments and have to cope with unknown and widely varying illumination conditions. Image sensors are rapidly finding their way into people's cars, cell-phones, personal digital assistants, medical and diagnostic equipment, automated drug discovery, cutting edge security, surveillance and biometric systems.

Title: SBIR Phase II: A Device for Measuring Electric Field Strength from Dropsondes and Radiosondes

Award Number: 0450497
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $499,970

Investigator: R. Paul Lawson, plawson@specinc.com
Company: SPEC, Inc.
3022 Sterling Circle
Boulder CO, 80301
Phone: (303)449-1105

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will provide research-aircraft and weather-balloon flight tests a new, novel device for measuring the electric field strength of thunderstorms and hurricanes. Electric field strength is a significant factor in the development of precipitation and lightning, and may even play a role in influencing the intensity of precipitation from thunderstorms. Research aircraft flights that typically measure electric field strength in thunderstorms and hurricanes are difficult and potentially dangerous because of the hazardous conditions, such as lightning, hail and turbulence. However, the new device, called an electric field module, can be contained in a device called a dropsonde and dropped through thunderstorms from aircraft flying above the storm, or attached to weather balloons called radiosondes that are released from the ground.

Since over 7,000 dropsondes and 400,000 weather balloons are routinely deployed each year, adding electric field measures to these devices represents a substantial commercial market. Measurements using the new E-field modules deployed by the SPEC Learjet research aircraft will be unique and open a new realm for analyzing the structure of electric fields in storms. A more realizable goal is improved aviation safety, by virtue of a better understanding of lightning discharges from clouds associated with thunderstorms, particularly anvil clouds, where commercial aircraft are often struck by lightning.

Title: SBIR Phase II: Multi-Coil Surface NMR Instrumentation and Software for 3-D Groundwater Imaging

Award Number: 0450164
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $500,000

Investigator: David Walsh, davewalsh@vista-clara.com
Company: Vista Clara Inc
8849 47th Pl W
Mukilteo WA, 98275
Phone: (425)353-8494

Abstract:

This Small Business Innovation Research (SBIR) Phase II research proposal aims to develop a commercial multi-Coil Magnetic Resonance Sounding (MRS) system for 3-D groundwater imaging and characterization. The principal innovations are the use of multi-coil arrays and the development of coherent signal processing methods to reconstruct 3-D images. The feasibility of this system concept through computer simulation, analysis, and by acquiring experimental (very low SNR) multi-coil NMR data has been established. It is now proposed to design and assemble a field-scale multi-coil MRS prototype instrument with surface coil diameters on the order of 50-100 meters, and to field test this prototype extensively with the U.S. Geological Survey and a groundwater -consulting firm. This multi-coil MRS system enables a critical performance improvement in the area of spatial resolution (3-D vs. 1-D) and at least an order of magnitude improvement in sensitivity (effective SNR).

Inadequate access to clean, safe, and reliable sources of drinking water is a primary cause of disease in the developing world. Inadequate access to groundwater resources, and inadequate understanding of the long-term effects of groundwater use, pose fundamental limitations on economic and agricultural development in much of the developed world, including the United States. As an inexpensive, low-energy, and non-invasive groundwater exploration method, the proposed technology could have significant positive impacts on world health, natural resource management, and economic development.

Title: SBIR Phase II: 2D Transducer Array for 3D High-Resolution Ultrasound Imaging

Award Number: 0450493
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $488,109

Investigator: David Lemmerhirt, dlemmerh@soneticsultrasound.com
Company: Sonetics Ultrasound Inc
4890 Troon Ct
Ann Arbor MI, 48103
Phone: (734)260-4800

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop Micro-electro-mechanical systems (MEMS) based, fully populated two-dimensional (2D) ultrasonic transducer array for three dimensional (3D) imaging in real time. Current 2D ultrasound systems employ a linear array of transducers to accumulate images. A planar array is universally acknowledged as the ideal approach for 3D image acquisition; however, multiple challenges must be overcome to make this practical, including: limitations in existing piezoelectric transducer technology, connecting an array with many elements (e.g., > 16,000) to front-end electronics, and processing large amounts of image data in real-time. The highly collaborative Phase II effort will build upon design and simulation results from the The system architecture will provide substantial flexibility in applying digital processing techniques, including adaptive beamforming, synthetic apertures, and phase aberration correction.

The developed technology could bring many new capabilities to medical imaging, including volumetric flow, and real-time 3D imaging for tumor evaluation, image-guided surgery, and fetal echocardiography. Some of these include a breakthrough planar array technology overcomes a key bottleneck in the state-of-the-art in ultrasound, with spillover contributions to non-ultrasound fields (e.g. other MEMS, sonar, other medical imaging, nondestructive testing).

Title: SBIR Phase II: A Novel Clamp-On Self-Powered Flowmeter

Award Number: 0422033
Program Manager: Muralidharan S. Nair

Start Date: November 1, 2004
Expires: October 31, 2006
Total Amount: $496,929

Investigator: Robert McKillip, Jr., bob@continuum-dynamics.com
Company: Continuum Dynamics, Inc.
34 Lexington Ave
Trenton NJ, 8618
Phone: (609)538-0444

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will produce a prototype low-rate fluid flow instrument for nuclear power plants that incorporates several novel features that permit its use as a clamp-on measurement device having minimal installation costs and complications. By utilizing waste heat on piping lines, and wireless data links, the flow sensor system avoids the requirement for an extended wiring system that interconnects and powers the instrumentation within the containment vessel. Accurate and reliable measurement of critical flow systems will ensure piping thermal stresses remain below design limits, for safe continued generation of electric power.

The broader impact of the proposed flow sensor should significantly enhance nuclear power plant system safety by providing a robust, self-contained, zero-maintenance, zero-power instrument for monitoring in-plant piping systems. In addition, the platform for the flowmeter instrument may serve as a basis for a new family of monitoring systems for nuclear power plants and other environments where instrumentation wire runs are costly or prone to failure.

Title: SBIR Phase II: Development of a Low-Cost Harsh Environment Vibration Sensor

Award Number: 0422069
Program Manager: Murali S. Nair

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $475,190

Investigator: Jonathan Geisheimer, jong@radatec.com
Company: Radatec, Inc.
75 Fifth St NW
Atlanta, GA 30308
Phone: (404)526-6048

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop an inexpensive sensor for measuring mechanical vibration and displacement of rotating machines using 5.8 GHz communications components. Current sensing technologies cannot operate in the high temperature and dirty environments often found inside these machines. Major problems often first develop in these unmonitored areas. By providing a new source of information, failures and degradation can be detected earlier.

The broader impacts of the proposed research result from the ability of engineers and scientists to more accurately characterize the internal workings of large rotating machinery (e.g. hydroelectric generator, power generation gas turbine, and DC motor) within the harshest environments. Designers and machine operators will have data in critical areas where failure modes most often occur, allowing for earlier warning of performance degradation and more accurate machine condition monitoring.

Title: SBIR Phase II: Composite Structural Damage Self-Sensing via Electrical Resistance Measurement

Award Number: 0422146
Program Manager: Murali S. Nair

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $498,010

Investigator: Jaycee Chung, jayceechung@sbcglobal.net
Company: Global Contour Ltd.
1145 Ridge Road West
Rockwall, TX 75087
Phone: (214)514-4085

Abstract

This Small Business Innovation Research (SBIR) Phase II project is aimed to capitalize on the Phase I success of an innovative self-sensing of composite structural damage utilizing the electrical conductivity of carbon (graphite) composite materials for structural health monitoring (SHM). The Phase II project is intended to provide a full-scale development (FSD) technology for composite a structural self-diagnostic (CSSD) system/technique. The necessary hardware/software and implementation procedures, such as microchip-based nodal electrical conductivity acquisition electronic circuitry, composite structural self-monitoring computer hardware and software will be incorporated in the CSSD device. The CSSD technology should prevent the catastrophic failures of aircraft and rotorcraft by predicting impending failures of flight-critical composite structural components. The system hardware/software will be demonstrated on new commercial passenger jet aircraft and military aircraft. The application of the CSSD technology should reduce the maintenance cost of the aircraft and rotorcraft due to automated structural health monitoring and diagnostic feature.

Title: SBIR Phase II: Low-Pressure Microplasma Gas Analyzer

Award Number: 0422076
Program Manager: Murali S. Nair

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $500,000

Investigator: Chris Doughty, cdoughty@verionix.com
Company: Verionix
251 Granville Lane
North Andover, MA 01845
Phone: (617)905-0015

Abstract

This Small Business Innovation Research (SBIR) Phase II research project will develop a miniaturized gas analyzer for use in industrial process control, fault detection and monitoring. The gas analyzer proposed here would be able to identify the chemical components of the gas and quantify their partial pressures down to part-per-million (ppm) levels. It will be sensitive to a range of gas species, and be small, have low power consumption and low cost.

The broader impact of this research project will be to advance the nation's scientific and intellectual knowledge base by developing and demonstrating novel plasma emission sources and their applications. It will advance the nation's economic competitiveness by enhancing industrial productivity and the ability of the US semiconductor capital equipment industry to compete worldwide.

Title: SBIR Phase II: A Sensitive Integrated Multi-Speckle Laser Interferometer for Industrial Applications

Award Number: 0422028
Program Manager: Murali S. Nair

Start Date: July 1, 2004
Expires: June 30, 2006
Total Amount: $499,934

Investigator: Bruno Pouet, bpouet@bossanovatech.com
Company: Bossa Nova Technologies LLC
606 Venice Boulevard
Venice, CA 90291
Phone: (310)577-8113

Abstract

This Small Business Innovation Research (SBIR) Phase II project describes an innovative Approach for development of a high sensitivity laser ultrasonic receiver for Application in industrial environment. A high sensitivity classic reference beam interferometer with the ability to efficiently overcome the limitation caused by the speckle light generated from the reflection from rough surface will be developed. The interferometer should be well suited for demanding industrial applications where low cost, sensitive and rugged receiver is needed. Because the proposed interferometer takes advantage of the high integration level of current state-of-the-art in electronic packaging, the system can be made very compact and will be the key element of an ultrasonic system. The robustness, high sensitivity and lower cost of this ultrasonic receiver is hoped to enable laser based ultrasonic inspection to become a cost effective and reliable solution.

The commercial market for this type of laser ultrasonic receiver is targeted at process control and in-service inspection applications where high reliability and low inspection cost is required. The steel industry has expressed strongly a desire to have a system dedicated to the in-process wall-thickness measurement of seamless tube.

Title: SBIR Phase II: Improved Magneto-Optical Imaging Films Employing Surface Plasmon Resonance

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| Award Number: | 0349694 |
| Program Manager: | Murali S. Nair |
| Start Date: | March 1, 2004 |
| Expires: | February 28, 2006 |
| Total Amount: | $498,774 |

Investigator: Jeff Lindemuth, jlindemuth@lakeshore.com
Company: Lake Shore Cryotronics, Inc
575 McCorkle Boulevard
Westerville, OH 43082
Phone: (614)891-2243

Abstract:

This Small Business Innovative Research (SBIR) Phase II research project is to develop an improved magneto-optical (MO) visualizer based on a laser-scanning polarimeter and a MO imaging film (MOIF) utilizing surface plasmon resonance. In Phase I, the feasibility of substantial improvements in spatial and magnetic field resolutions and imaging bandwidth over existing methods were demonstrated. In Phase II, the MO material quality and sensor design will be further optimized. The visualizer will be adapted to maximize the many advantages offered by the improved MOIF material. Software will be developed to provide automatic system control and conversion of the acquired image into the quantitative spatial magnetic field distribution. The capabilities of the prototype systems and sensors will be evaluated in terms of magnetic field resolution, spatial resolution and speed through the imaging of electrical current patterns and data storage devices.

Commercial market needs include sensors, instruments and systems for improved magnetic field imaging. Applications include magnetic character reading, magnetic code reading for security, superconductor research, spin valve and magnetic RAM research and manufacturing, integrated circuit electrical current imaging, structural composite stress imaging using magnetic and magnetostrictive materials, flaw detection in metals, biomedical tagging and identification of cancer and other cells, research and testing of MEMS actuators and devices.

Title: SBIR Phase II: Self-Imaging Transmitters for Remote Sensing

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| Award Number: | 0349771 |
| Program Manager: | Murali S. Nair |
| Start Date: | March 1, 2004 |
| Expires: | February 28, 2006 |
| Total Amount: | $458,011 |

Investigator: Iain McKinnie, iainm@ctilidar.com
Company: Coherent Technologies, Inc.
135 S. Taylor Ave
Louisville, CO 80027
Phone: (303)604-2000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and demonstrate self-imaging laser technologies for eyesafe remote sensing applications. Laser based remote sensing applications require a variety of output formats, including amplitude modulated (AM) and frequency modulated (FM) continuous wave (CW) lasers; and pulsed lasers. There are currently no eye safe technologies available with the adaptive waveform capabilities to satisfy these requirements. At eye safe 1.5-micron wavelengths, bulk solid-state lasers are not capable of high average power operation; and conventional fiber laser systems are not capable of handling high peak powers due to optical damage and nonlinear effects. A patent-pending diffraction limited self-imaging waveguide laser technology has been developed that use an adaptive waveform that has the potential to satisfy the average and peak power requirements simultaneously. There are two objectives for the Phase II research- 1) to design a self-imaging laser system with adaptive waveform capability, and 2) to demonstrate an adaptive waveform 1.5-micron laser transmitter. It is anticipated that >20 W of diffraction limited, eye safe average laser power will be achieved with adaptive waveform capability demonstrated. This eye safe self-imaging waveguide laser module is targeted as an enabling technology with broad reaching impact.

The specific markets include remote sensing markets of wind and aerosol detection and 3- D imaging. This technology should have a significant impact because current sensors are complex and costly. Other applications include hazard alerting for windshear, gust front, and turbulence detection; wake vortex detection, tracking, and measurement; and detection and tracking of hazardous bioaerosols.

# Geoscience Instrumentation

Title: SBIR Phase II: Gamma Ray Detector for Geophysical Exploration

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| Award Number: | 0522021 |
| Program Manager: | Murali Nair |
| Start Date: | October 28, 2005 |
| Expires: | October 31, 2007 |
| Total Amount: | $479,410 |


Investigator: Gerald Entine, GEntine@rmdinc.com
Company: Radiation Mon Devices Inc
44 Hunt Street
Watertown, MA 02472
Phone: (617)668-6801



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to produce a radiation detector technology that will be able to provide a completely new level of performance for demanding industrial applications. Three different scintillator materials - $LaBr_3$, $LaCl_3$ and $CeBr_3$ - have been shown in Phase I to provide outstanding results even when subjected to high temperatures. This trait makes these materials well suited for geologic well logging applications where radiation measurements must be in environments where temperatures exceed 175 C. The keys to furthering these materials are tailoring their chemical composition through dopants, producing ingots of larger sizes and packaging them to resist such environments.

Producing more accurate well-logging tools should be a direct outcrop of this project. These tools should in turn enable the geology researcher to more efficiently conduct experiments, and to reduce some of the uncertainties in the otherwise highly speculative field of oil exploration. The broader impacts of this program will encompass both a better understanding of this family of scintillator materials and their use in other applications for which temperature performance is not a key issue. Applications include nuclear science to medical imaging to security and monitoring.

Title: SBIR Phase II: Digital Correlator Imaging Spectrometer For Submillimeter Astronomy

Award Number: 0521830
Program Manager: Muralidharan S. Nair

Start Date: January 1, 2005
Expires: August 31, 2007
Total Amount: $434,230

Investigator: Steven Kaplan, steve.kaplan@hypres.com
Company: HYPRES, Inc.
175 Clearbrook Rd
Elmsford NY, 10523
Phone: (914)592-1190

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop technology to significantly improve digital-auto-correlator spectrometer bandwidths and clock rates. Astronomers are increasing their reliance on digital auto-correlators for receiving sub-millimeter-wavelength signals buried in noise. For larger red-shift sources, bandwidths of tens of GHz are required. Digital spectrometers are also required to manage communications spectrum for wideband wireless software-defined radio systems. These systems under development are based on a radically new wireless-communications paradigm: the analog wireless signal is converted directly to the digital domain at RF frequencies. Wideband superconducting digital-RF hardware will result in extremely robust systems, with revolutionary new opportunities for handling complex waveforms (e.g. the Wideband Networking Waveform).

Astronomers need compact spectrometers to study sources such as planetary atmospheres, molecular clouds, and extragalactic objects. Distant sources have very small signals that are red-shifted by as much as tens of GHz. Therefore, spectrometer bandwidth and sensitivity must be better than present instruments offer. Applying these technology elements to communications enables software-defined all-digital radio systems. Improvements in wireless communications are helping the U.S. to become more productive and socially active. Power efficiency and sensitivity will be orders of magnitude greater than conventional systems, while enabling software functionality and upgrades, at a fraction of the cost.

Title: SBIR Phase II: Advanced Unified Oceanographic Data Logger

Award Number: 0450461
Program Manager: Muralidharan S. Nair

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $495,716

Investigator: Thomas VanZandt, thomas.vanzandt@geosense.com
Company: GEOSense, LLC
409 N. Pacific Coast Hwy., #427
Redondo Beach CA, 90277
Phone: (818)388-2826

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to complete the development of a fully-characterized, commercial prototype, Advanced Unified Oceanographic Data Logger (AUDL). This system aims to provide a new commercial standard for standalone data recording within existing and future oceanographic applications. The same technology will also provide best-in-class performance within the larger markets of terrestrial environmental monitoring. One key feature is that the AUDL will provide a nearly universal sensor interface. It will record data transparently from analog, serial-asynchronous, and digital sensors and instruments. This will enable GEOSense to target a wider range of applications and customers, with a single, low-cost system.

GEOSense will provide a commercial solution that significantly lowers the cost of technical data acquisition within a number of research and engineering applications. By reducing the overall cost of data recording, it is expected that the technology will enhance both the scientific return, and the educational opportunities, from limited research funds. It is hoped that the widespread application of this technology will increase the scope of expertise in oceanographic instrumentation.

Title: SBIR Phase II: Ultra-fast Broadband Imaging Spectroscopy for Geosciences Applications

Award Number: 0422094
Program Manager: Murali S. Nair

Start Date: August 15, 2004
Expires: July 31, 2006
Total Amount: $400,732

Investigator: Qiushui Chen, qchen@bostonati.com
Company: Boston Applied Technologies, Incorporated
150-H New Boston Street
Woburn, MA 01801
Phone: (781)935-2800

Abstract

This Small Business Innovation Research (SBIR) Phase II project is aimed to capitalize on our Phase I success of ultra-fast tunable optical filter technology for the applications of hyperspectral imaging, environmental monitoring and optical communication. During Phase I period, the feasibility of ultra-fast tunable filters based on electro-optical effect have been demonstrated through prototyping. State-of-the-art filter characteristics have been achieved, including ultra-fast response (< 500 ns), wide tuning range (> 80nm at 1550nm), narrow line width (< 0.1nm) and broad working spectral band (from visible to middle infrared continuously). Based on the successful Phase I execution, the major effort of Phase II will be developing an advanced tunable filter platform. At which several commercial products are expected to emerge. Such as ultra-fast hyperspectral imaging systems suitable for geosciences and medical diagnostics, high frequency wavelength modulators for high sensitivity spectroscopic detection of trace-gas and wide-range fast-tuning optical filters for spectroscopy and wavelength-division-multiplexing (WDM) optical communication Hyperspectral imagery has many existing and potential applications in agriculture, forestry, emergency response/disaster management, insurance, national security, oil and gas exploration, medical imaging, and military surveillance.

The proposed components and system, featuring in lightweight, fast action, broad wavelength band, and low cost, is needed for airborne hyperspectral imagery. The tunable add/drop is promise to reduce network complexity and cost by eliminating expensive optical-electrical-optical conversion and reducing inventory of fixed-wavelength devices. A fast wavelength modulation, combined with synchronized detection, can form a very sensitive spectroscopic analytic instrument for trace-gas sensing. These gases usually have characteristic absorption lines in infrared (IR) band, where no other fast tunable filter existed. It has seen a growing demand from the largest application areas, such as chemicals, petrochemicals, power generation, national security and environmental monitoring.

Title: SBIR Phase II: Pipeline Integrity in Natural Gas Distribution and Transmission Systems

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| Award Number: | 0422171 |
| Program Manager: | Murali S. Nair |
| Start Date: | September 1, 2004 |
| Expires: | August 31, 2006 |
| Total Amount: | $499,984 |


Investigator: Paul Lander, paull@flowmetrix.com
Company: Flow Metrix, Incorporated
2 Clock Tower Place, Suite 425
Maynard, MA 01754
Phone: (978)897-2033



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will solve challenging problems in processing, tracking, and communicating vibration recordings from remote locations in pipelines to determine whether a pipeline has suffered an integrity breach. The solutions include design of new battery-powered, wireless-enabled, rugged field instruments for the harsh pipeline environment, and the development of advanced signal processing methods to characterize and interpret the complex acoustic energy in pipelines.

The broader impact of this research project will be to provide the industry with state-of-the-art, cost-effective equipment that will allow owners and operators to protect their investment in pipeline infrastructure and to meet the mandated pipeline integrity management regulations safely, efficiently and effectively. The societal impact will be increased personal safety through faster and more accurate inspection methods and the preservation of continued affordable energy transportation into the future.

Title: SBIR Phase II: Integrated Electric and Magnetic Free-Space Sensor for Geosciences

Award Number: 0349333
Program Manager: Murali S. Nair

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $499,607

Investigator: Andrew Hibbs, andy@quasarusa.com
Company: Quantum Applied Science and Research
5764 Pacific Center Blvd
San Diego, CA 92121
Phone: (858)373-0232

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to integrate a new, free-space electric field (E) sensor with a recently introduced, miniaturized magnetic induction (B) sensor to form a compact six-channel sensor system. The proposed new E-field + B-field sensor should offer a completely new instrumentation capability for geosciences, providing for the first time measurement of all components of the electromagnetic (EM) field vector at low frequency in a single package without contact to the ground or any other physical object. The Phase II objectives are to develop a system prototype with sensitivity and bandwidth suitable for the majority of applications in geophysical surveying, lightning detection, electromagnetic sounding for detection of buried objects, and for general EM research. A side-by-side comparison with state-of-the-art conventional technology will be performed for magneto-tellurics and lightning detection in collaboration with academic and industry experts.

This technology should help develop products for the stand-alone electric and magnetic sensors, as well as a new class of bio-electrode that shares the same basic technology as the E-field sensor. Applications for the bio-electrodes are for human physiologic monitoring such as the electrocardiogram (ECG) and the electroencephalogram (EEG).

# MEMS

Title: SBIR Phase II: Automotive Nanocomposites

Award Number: 0822808
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $500,000

Investigator: Joel Dulebohn, jidulebohn@comcast.net
Company: Claytec Inc.
5901 Sleepy Hollow
East Lansing, MI 48823
Phone: (517) 862-3928

Abstract:

This Small Business Innovation Research (SBIR) Phase II proposal aims to commercialize a new mesoporous silicate nanoparticles for the reinforcement of thermoplastic polymers used in the manufacture of U.S. cars and light trucks. Whereas nanoparticles, in general, provide some polymer reinforcement benefits, they typically lack the ability to provide strength as well as stiffness. Also, they normally require extensive organic surface modification for dispersion in the polymer matrix. Organic modifiers limit nanoparticles thermal stability and compromise their suitability for nanocomposite manufacturing through cost-effective melt processing methods. The purely inorganic mesoporous silicates this project plans, circumvent all of the limitations caused by organic modifies by providing a unique combination of surface polarity, mesopore size, surface area, and pore volume which optimizes interfacial interactions between the particles and the polymer matrix for effective dispersion and reinforcement. In addition to providing stiffness at particle loadings, the mesoporous silicates provide strength, which allows the amount of polymer needed to produce an automotive part to be reduced in proportion to the added strength. The polymer savings alone allow users of the technology to reduce the weight of the vehicle, achieve stiffness, and improve fuel economy at no added cost.   The broader impact/commercial potential of automotive nanocomposites can directly impact the US energy economy, as well as environmental quality. The combination of reduced vehicle weight and increased fuel economy translates into a reduction in petroleum consumption and green house gas emissions. The process for producing mesoporous silicate nanoparticles is neither energy-intensive nor environmentally harmful. Based on aqueous sol-gel chemistry, this project's nanoparticles are manufactured in yields at a temperature of with no harmful waste released to the environment.

Title: SBIR Phase II: MEMS for Secure RFID Applications

Award Number: 0823009
Program Manager: Muralidharan S. Nair

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $500,000

Investigator: Joshua Cross, jdc47@cornell.edu
Company: Cerberex Technologies, Inc.
507 East Buffalo Street, #2
Ithaca, NY 14850
Phone: (607) 227-9539

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will demonstrate a working ?alpha? prototype of a MEMS-based approach to security for RFID and other electronic security applications. MEMS resonators have very narrow bandwidths and high frequencies which vary from resonator to resonator. This natural frequency variation can be used to uniquely identify a resonator, and makes cloning a specific signal extremely difficult ? in essence creating a ?voiceprint?. This approach to RFID security overcomes the drawbacks of encryption which include more complex and expensive tags and the need to manage encryption keys. MEMS resonators for RFID tags are unique, secure, cost effective, CMOS compatible, and fast to read, with low power requirements and low overhead. This research project will demonstrate in a real environment with material temperature swings, working vacuum encapsulated MEMS chips with attached antennas, a low-cost prototype reader with maximum 10cm read range, and reader and system software to extract MEMS response signals to compare with stored signals for chip identification. This project will have broad impact on the security of identification of both people and goods. For example, the RFID tags used in the implementation of US passports were recently cloned which calls into question the security of those documents. Since MEMS resonators cannot be cloned, they can provide significant security assurance to economically validate a given passport. MEMS resonators can also be used to economically authenticate pharmaceuticals since counterfeit drugs are increasingly prevalent (the World Health Organization projects a $75 billion counterfeit market in 2010) and have caused deaths.

Title: SBIR Phase II: Control System Development for Microelectromechanical Systems (MEMS) Segmented Deformable Mirrors

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| Award Number: | 0750521 |
| Program Manager: | Gregory T. Baxter |
| Start Date: | March 1, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $474,995 |


Investigator: Carl Kempf, carl.kempf@irisao.com
Company: Iris AO, Inc.
2680 BANCROFT WAY
Berkeley, CA 94704
Phone: (510) 849-2375



Abstract:

The Small Business Innovation Research (SBIR) Phase II project aims to develop an integrated control system for adaptive optics (AO) systems based on microelectromechanical systems (MEMS) deformable mirrors (DM). Under ideal circumstances, the resolution of an optical system is limited by the diffraction of light waves. Due to imperfections in optical components however, the limits are never achieved. AO is a technology that enhances the performance of optical systems such as telescopes and microscopes by reducing distortion. It can lead to significantly sharper images which can approach the theoretical diffraction limit. The increase in image sharpness also allows additional gains in contrast, thus allowing detection of faint objects. Although AO has been significantly used for improving the performance of telescopes, an AO system based on MEMS deformable mirrors for use in biomedical applications has not. It would significantly improve image quality and would likely find multiple applications. As such, it would lead to the adoption of AO in a variety of biological imaging settings and would be of benefit to scientists engaged in such research.

Title: SBIR Phase II: Advanced MicroDisplay Engine for Full Windshield Transparent Display

Award Number: 0724453
Program Manager: Juan E. Figueroa

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Jianqiang Liu, jq.liu@compass-innovations.com
Company: Compass Innovations
3001 Winchester Blvd, Suite 3
Campbell, CA 95008
Phone: (408)866-6836

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a revolutionary miniature projector engine for automotive full windshield display (FWD). The invention allows high quality images with rich graphics to be displayed directly on automobile windshields. The mini-projector engine can be integrated with a rearview mirror. It can be interfaced to the on-board electronics or other communication devices using standard protocols. Based on Micro-Electro-Mechanical Systems (MEMS) fabricated micromirror devices, the proposed display engine provides 4X faster display speed than state-of-the-art vector display devices. Its size is less than 1 in3 and consumes less than 1W of energy. It can be mass produced at low cost and is the most suitable for automotive applications.

If successful the outcome of this project will provide the most effective method to convey information to driver without causing distraction. Unlike traditional HUD, it can display information on the entire windshield. As augmented information display, it can effectively reduce road accidents and save thousands of lives every year! When implemented, even a small 10% of deployment, the market size for this display engine will be 6 millions of units annually in the 60 millions global vehicles market. It will generate hundreds of millions dollars of tax and hundreds of jobs for the United States and bolster the economy.

Title: SBIR Phase II: Wafer-Scale, Hermetic Packaging of Intelligent MEMS-Based Systems

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| Award Number: | 0724340 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Sonbol (Sarah) Massoud-Ansari, sonbol@mems-issys.com
Company: Integrated Sensing Systems
391 Airport Industrial Drive
Ypsilanti, MI 48198
Phone: (734)547-9896

Abstract:

This Small Business Innovation Research (SBIR) Phase-II project continues to address development of a novel packaging method for wafer-scale hermetic packaging of intelligent Micro-Electro-Mechanical Systems (MEMS). Packaging of MEMS along with their requisite electronics is one of the main technical barriers to commercialization of these devices. Packaging methods are often expensive, have long development cycles, and may adversely affect device performance and reliability. In cases where direct media access is required and the MEMS device needs to operate in harsh environments, protecting the electronics from the media provides a huge challenge. The proposed packaging approach consists of extending the MEMS device and etching a deep cavity into the substrate to house the electronics. A wafer-level hermetic bonding method will then be used to cap the electronics while allowing electrical connection between the electronics and the device. This Phase II project will focus on development of hermetic lead transfer using buried metal layers, and expansion of the packaging method to include wireless applications. Wired and wireless pressure sensor/electronics testbeds will be fabricated to verify overall system integration and evaluated both internally and by external customers.

The potential commercial value of this Small Business Innovation Research proposal will be in several areas. The most immediate area will be revenue from sale of foundry services for packaging and integration of MEMS and their associated electronics. Through its existing Foundry Services Division, ISSYS will provide a packaging platform for wired and wireless MEMS sensor/electronics subassemblies. The second source of revenue is product sales, where off-the-shelf MEMS pressure sensor subassemblies (wired and wireless) will be sold to customers in various medical and industrial fields. The long-term vision is use of this packaging platform for a variety of MEMS-based devices. According to Yole Development, the worldwide MEMS market is forecast to grow from $5.1 Billion in 2005 to $9.7 Billion in 2010. The main product families in this market are inkjet heads, pressure sensors, microphones, accelerometers, gyroscopes, optical MEMS, microfluidics, RF MEMS and micro-fuel cells. The proposed packaging technology will be highly beneficial to pressure sensors, microphones and microfluidic devices, with a combined market forecast of $2.5 Billion in 2010.

Title: SBIR Phase II: Microelectromechanical (MEMS) Mirror Arrays for Bioimaging Applications

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| Award Number: | 0548508 |
| Program Manager: | F.C. Thomas Allnutt |
| Start Date: | February 7, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $511,290 |


Investigator: Tom Tsao, ttsao@umachines.com
Company: Umachines
2400 Lincoln Ave
Altadena, CA 91001
Phone: (626)296-6282



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will advance the state of the art in MEMS deformable mirror arrays. The research will address the key technology bottlenecks in the production of affordable, high performance adaptive optics systems. The objective is to further expand the proof of concept and to successfully fabricate and package the MEMS arrays.

The mirror arrays will play a key part in the understanding, diagnoses, and treatment of the leading causes of progressive vision deterioration and blindness in humans. Having improved retinal resolution will allow physicians to detect diseases and prescribe treatment earlier than current technologies allow. This will allow for increased preservation of eyesight and increase in lifestyle. Further, improved resolution will allow for increased research into various pathologies for additional scientific and medical advancement in a more efficacious time frame.

Title: SBIR Phase II: Lead Zirconate Titanate (PZT) Multimorph Micro-Opto-Electro-Mechanical Systems (MOEMS) Deformable Mirror

Award Number: 0522321
Program Manager: Juan E. Figueroa

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,798

Investigator: Michael Helmbrecht, michael.helmbrecht@irisao.com
Company: Iris AO, Inc.
2680 Bancroft Way
Berkeley CA, 94704
Phone: (510)849-2375

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to deliver a dramatic advance in microelectromechanical system (MEMS) deformable mirror performance. Deformable mirrors are the key active component in adaptive optics (AO) systems that provide vastly improved resolution through turbulent air, water, and biological samples. The lack of low- cost, high-deflection (stroke), and low-voltage deformable mirrors has prevented the widespread deployment of AO in a range of fields including biotechnology, ophthalmology, and national security. Phase I successfully demonstrated a new actuation approach for shaping MEMS deformable mirrors. The new approach combines piezoelectric actuation with MEMS deformable mirror technology. The piezoelectric actuators are a true breakthrough as deformable mirror actuation voltage may be reduced from 100-200 volts down to 10-20 volts - a full order of magnitude reduction. The use of smaller, less expensive, safer, and more reliable low-voltage electronics opens the door for a host of applications. The goal of Phase II is to build on the Phase 1 actuator designs to manufacture complete deformable mirror arrays with groundbreaking high stroke, low voltage, low cost, high speed, coupled with superb optical quality.

The high resolution and contrast enhancement enabled by adaptive optics (AO) using deformable mirrors is poised to dramatically advance astronomy, ophthalmology, biology, and national security. Yet for the full potential to be realized, miniature deformable mirrors with high stroke, low voltage, and low cost are critical. If successful the proposed mirror will address the key requirements vital for moving AO into mainstream scientific laboratories and commercial markets. This will have enormous social and commercial impact. Biological microscopes that have far higher resolution, ophthalmoscopes that can image single cells in a living retina, laser microsurgery with precise beam control, and telescopes that can image through atmospheric turbulence will push the boundaries of science. The health and well being of millions will be directly improved as commercialization moves early eye disease detection, customized vision correction, and new medical treatments into doctor offices across the nation. Free space optical communication, and long-range surveillance applications will also reap the benefits of this technology.

# Nanostructured Materials

Title: STTR Phase II: Low-Cost Nanoparticles for Enhanced Heat Transfer

Award Number: 0823112
Program Manager: William Haines

Start Date: August 15, 2008
Expires: July 31, 2010
Total Amount: $480,409

Investigator: Yanming Liu, y.liu@amadinc.com
Company: Advanced Materials & Devices Inc
4451 Lynnfield Way
Reno, NV 89519
Phone: (775) 826-8868

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project is to develop and commercialize copper nanofluids for heat transfer enhancement applications. The low cost nanoparticle production methods developed will produce quality nanoparticles for this application. Success of this STTR project will benefit a wide range of applications for heat transfer enhancement including: electronics, HVAC, transportation, textile and paper manufacturing, and energy production systems. The project will also provide educational impact by offering opportunities for student recruitment, research and training, and curricula design at the University of Nevada, Reno.

Title: SBIR Phase II: Chemical Aerosol-flow Synthesis of Nanometals

Award Number: 0823029
Program Manager: William Haines

Start Date: August 15, 2008
Expires: July 31, 2010
Total Amount: $499,986

Investigator: Yuri Didenko, info@utdots.com
Company: UT Dots, Inc.
115 Paddock Dr.
Savoy, IL 61874
Phone: (217) 390-3286

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop new scale up methods for the synthesis of surface stabilized metal nanoparticles from aerosol. The advantage of chemical aerosol-flow synthesis is in its simplicity in procedure and experimental setup, low cost and scalability. The method allows for the synthesis of high quality nanoparticles in continuous flow regimen. Phase I results proved feasibility of the method for the synthesis of high quality silver nanoparticles with high yield. This Phase II project will focus on increasing manufacturing capabilities to decrease the cost of nanoparticles significantly. Low cost, printed electrical conductors are expected to be a rapidly growing market for flexible electronics and solar cells. Reducing processing temperatures and material costs are key enablers to these growing applications. The low cost production of nanometals will contribute to these trends.

Title: SBIR Phase II: High-Efficiency Nanocomposite Photovoltaics and Solar Cells

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| Award Number: | 0822652 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $492,740 |


Investigator: Valery Rupasov, anteosinc@aol.com
Company: Anteos, Inc.
105 Hartford Turnpike
Shrewsbury, MA 1545
Phone: (508) 754-3548



Abstract:

This Small Business Innovation Research (SBIR) Phase II project is focused on development of an innovative technology for fabrication of high-efficiency thin film nanocomposite photovoltaic materials and solar cells taking advantage of the recently discovered effect of carrier multiplication in semiconductor nanocrystals. The proposed concept employs smart design of the solar cells providing fast and effective spatial separation of electrons and holes photo-generated in the nanocrystals. The proposed reach nanotechnology platform solves the challenging problem of electrical communications with nanoscale objects, such as nanocrystals, nanorods, nanowires, nanotubes, etc. It can be employed for development of many other nanocomposite optoelectronic devices having numerous commercial and military applications. If successful the development of new generation of high-efficiency photovoltaic materials and solar cells based on the demonstrated technology will have broad impact on the entire solar energy industry resulting in considerable energy savings and environmental protection. The technology has great commercialization potential and niche market. The proposed all-inorganic, high-efficiency, thin film, flexible nanostructured photovoltaic materials and solar cells, which can operate in extreme environment conditions and offer significant mass and volume savings, are ideally suitable for numerous applications, including power generating residential rooftops, power supplies for utility grid, emergency signals and telephones, water pumps, activate switches, battery chargers, residential and commercial lighting, etc.

Title: SBIR Phase II: Development of Cadmium-Free, Water-Soluble and Multicolor Quantum Dots by Chemical Doping

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| Award Number: | 0823040 |
| Program Manager: | William Haines |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $500,000 |


Investigator: Lin Song Li, lsli@oceannanotech.com
Company: Ocean NanoTech, LLC
700 Research Center Blvd
Fayetteville, AR 72701
Phone: (479) 871-0707



Abstract:

This NSF Small Business Innovation Research (SBIR) Phase II project is to synthesize cadmium-free, water-soluble, and multicolor quantum dots (QDs) by chemical doping. The project will focus on the synthesis of high quality doped ZnSe QDs using a newly developed phosphine-free approach. From these cadmium free doped derivatives with high quality blue, green, and red emissione will be produced. Then the doped core/shell QDs will be processed to make them water-soluble and biocompatible through proprietary methods for biomedical applications. Successful development of the proposed techniques will result in a new generation of biolabels and make significant advances in biomedical applications of such cadmium-free doped QDs. The "green" nature of the production methods, mineral precursors, natural surfactants, non-toxic and nonvolatile solvents and cadmium free QDs, will assist to maintain a sustainable environment, in addition to delivering high performance end products to the public.

Title: SBIR Phase II: Dual Substrate MEMS switch

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| Award Number: | 0750536 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $511,945 |

Investigator: Jaquelin Spong, jackie@imtmems.com
Company: Innovative Micro Technology
75 Robin Hill Rd
Santa Barbara, CA 93117
Phone: (805) 681-2800

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop manufacturing capabilities for MEMS electrical switches with a novel dual substrate design approach. The approach consists of dividing the switch components between two substrates, with the moving portion on an upper substrate, and the stationary contacts on a lower substrate. The moving portion will be formed from a stress-free layer of single crystal silicon, and so has no tendency to warp or distort. Using two substrates allows the contacts to be fully exposed throughout processing, and cleaned just before the substrates are bonded together to form the switch, thereby minimizing the contact resistance of the switch. Because the contacts are exposed, they can be effectively cleaned just prior to sealing in the hermetic seal between the two wafers, thereby reducing the contact resistance of the junctions. This Phase II effort will take the improved design into volume manufacturing to produce higher power, higher frequency, lower contact resistance and/or smaller footprint switches than competing ones while being produced at lower costs. If successful, the approach described here will be used to produce MEMS cantilevered switches for a broad range of applications, from DC power handling applications to RF and radar applications. Because of their high current-carrying, high frequency characteristics with small size and low cost, the MEMS switches may serve as viable replacements for FET switches or micro relays in a wide range of devices. The approach may also be applicable to other sorts of MEMS devices, such as sensors and actuators, which may have a movable component suspended over a substrate which interacts with a fixed component on the substrate. This approach may therefore fundamentally alter how these devices are manufactured, and open up a wide range of applications not presently served by MEMS devices.

Title: SBIR Phase II: Advanced Materials for Hybrid Electrochemical Capacitors

Award Number: 0750183
Program Manager: Cheryl F. Albus

Start Date: February 15, 2008
Expires: January 31, 2010
Total Amount: $467,171

Investigator: Christopher Rhodes, chris.rhodes@lynntech.com
Company: Lynntech, Inc
7610 Eastemark Dr
College Station, TX 77840
Phone: (979) 693-0017

Abstract:

The Small Business Innovation Research (SBIR) Phase II project involves the development of a nanostructured electrode material for high energy and power density hybrid electrochemical capacitors also called ultracapacitors or supercapacitors. Symmetric electrochemical capacitors that consist of two identical electrodes currently utilize flammable, non-aqueous electrolytes to improve the energy density. Hybrid or assymetric configurations that utilize different electrodes result in significantly higher energy densities and can operate in aqueous rather than non-aqueous electrolytes. The objectives of the Phase II project are to optimize the material's synthesis, further characterize the material, perform electrochemical testing to evaluate the energy density, power density and cycle life of the material, optimize the electrode fabrication process and electrolyte composition, and develop a low-cost, large-scale manufacturing process to produce the material. The anticipated result of the project is the development of a new, commercially viable electrode material that enables hybrid electrochemical capacitors with improved energy density, lower cost, and improved safety over current technologies. The development of low cost, high performance electrochemical capacitors has a substantial impact on the development of electric and hybrid vehicles, consumer and industrial electronics, and telecommunications devices. The broad impact of this technology is to enable the manufacturing of next generation electrochemical capacitors that will have higher energy densities, lower cost, and improved safety compared with current electrochemical capacitors. Hybrid electrochemical capacitors that have high energy densities as well as power densities result in improved performance power systems for numerous medium, high, and pulse-power applications. The ability of the hybrid ultracapacitor to operate in benign aqueous electrolytes reduces the cost of the device and has significant environmental and safety impacts, since current non-aqueous electrolytes are flammable and can emit toxic gases.

Title: SBIR Phase II: Spatially-Resolved Swept-Laser Spectroscopic System for Gold Nanoparticle Sensing


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| Award Number: | 0724231 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | November 15, 2007 |
| Expires: | October 31, 2009 |
| Total Amount: | $499,939 |



Investigator: Kevin Hsu, khsu@micronoptics.com
Company: Micron Optics Inc
1852 Century Pline
Atlanta, GA 30345
Phone: (404) 325-0005



Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to develop a spatially-resolved bio-sensing technology based on spectroscopic swept-source optical coherence tomography (S-SSOCT) and gold nanoparticles as bio-sensors at 1060nm spectral region. The proposed system will advance contrast-enhanced molecular imaging of diseased tissue. The project will explore several contrasting agents for imaging applications, among these are; the traditional florescence and absorption dyes, to the latest semiconductor quantum dots and metallic nanoparticles. The recently engineered gold nanoparticles possess superior light scattering and absorbing characteristics as well as long-term stability, and when bound to antibodies, can enable high-contrast molecular and cellular imaging of various diseases. The advancement of biotechnology and nanotechnology will benefit greatly from the ability to perform spatially-resolved and sensitive imaging of diseases in molecular and cellular levels through contrast enhancing agents. One expected outcome of this project is to make it possible to track the effectiveness of pharmaceuticals, treat disease, monitor responses to therapies, as well as to provide novel pairing of therapeutic and diagnostic processes. A particular goal of this project is to advance cancer diagnostic technology by developing a high-speed, high-resolution bio-medical imaging modality using gold nanoparticle as bio-conjugated sensors. This market is driven by synergy between various imaging methods (optical, nuclear, and magnetic) and new types of imaging agents.

Title: SBIR Phase II: Integration of Nanostructured Electrodes with Organosilicon Electrolytes for High Energy-Density Supercapacitors

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| Award Number: | 0724469 |
| Program Manager: | Rathindra DasGupta |
| Start Date: | September 15, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $496,384 |


Investigator: Robert West, rwest@silatronix.com
Company: Silatronix
University Research Park, Inc
Madison, WI 53719
Phone: (608)441-2700



Abstract:

The Small Business Innovation Research (SBIR) Phase II project proposes the development of ultracapacitor devices that combine the use of nanostructured carbon electrodes with organosilicon electrolytes. These innovative ultracapacitor devices are expected to provide higher working voltages than existing devices, yielding significantly increased energy and power density. This Phase II project will use laboratory results to develop prototype devices and address issues associated with scale up and development of procedures for creating prototype devices. These ultracapacitor devices will be characterized for long-term use by evaluating their physical properties and stability.

The size of the ultracapacitor market, already surpassing $200M, continues to grow at a compound annual growth rate of more than 15%. The development of improved ultracapacitor energy storage devices should accelerate this growth by facilitating the commercial development of low-emission vehicles, which should reduce the overall demand for energy. Organosilicon-based electrolytes should improve the overall safety profile of ultracapacitor devices due to their low flammability and low vapor pressures. The improved safety and improved physical characteristics will expand opportunities for the use of ultracapacitors as robust energy storage devices in consumer electronics and industrial applications. This work will also assist in the development of a trained workforce by involving graduate students and postdocs in the research and development effort.

Title: SBIR Phase II: Nanostructured Materials and Process for Improved Electrochromic Device Performance

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| Award Number: | 0724375 |
| Program Manager: | William Haines |
| Start Date: | September 15, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Douglas Weir, dweir@sage-ec.com
Company: SAGE Electrochromics Inc
One Sage Way
Faribault, MN 55021
Phone: (507)331-4902

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project is to develop full size electrochromic (EC) window glazings with superior performance and durability due to the incorporation of sputtered nanocomposite thin film materials. These window glazings can be electronically darkened to control solar light and heat in buildings and vehicles. The new materials and processes will be tested for prototype glazings followed by the development of a robust manufacturing process with optimum product yield and reliability. Numerical simulation techniques will be used to model how process input variables impact product attributes with a goal of minimizing device variation and optimizing performance.

The performance and reliability improvements achievable from this SBIR project are essential for widespread acceptance of electronically tinted windows. The improved transmission properties and more neutral coloration obtainable with nanostructured materials are highly desired commercial features. A successful project will lead to widespread adoption of EC windows and enable annual energy savings of up to 0.7 quad to occur sooner. This corresponds to a reduction in carbon emissions of ~10.5 million metric tons per year. In addition to architectural windows, deposition technologies for nanostructured films can improve the performance of transportation windows, flat panel displays, and alternative gate oxides for advanced CMOS technology.

Title: SBIR Phase II: Developing Advanced Ultracapacitors Using Carbon Nanomaterials and Environmentally Friendly Electrolytes

Award Number: 0724468
Program Manager: Rathindra DasGupta

Start Date: August 1, 2007
Expires: July 31, 2009
Total Amount: $499,993

Investigator: Wen Lu, wenl@adatech.com
Company: ADA
8100 Shaffer Parkway
Littleton, CO 80127
Phone: (303)792-5615

Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop advanced ultracapacitors for hybrid electric vehicles (HEV). The proposed research combines the unique properties of carbon nanotube (CNT) electrodes with those of environmentally friendly ionic liquid electrolytes to develop ultracapacitors possessing high performance (energy and power densities) and long life for HEVs. The proposed research will focus on optimization of CNT materials, production of selected CNT electrodes on a larger scale, and fabrication and evaluation of packaged prototype ultracapacitors.

Advanced vehicular ultracapacitrs are extremely useful in achieving better fuel economy, decreasing harmful emissions, and reducing the nation's reliance on foreign sources of petroleum. More generally, ultracapacitors are essential components in consumer electronics (ex: notebook computers, cell phones, pagers, video cameras), medical electronics (ex: drug delivery units), and military and defense systems (ex: spacecraft probes, missile systsms). In addition to ultracapacitors, research in the proposed project will also have a broad impact on the applications of carbon nanomaterials to other electronic and electrochemical devices.

Title: SBIR Phase II: Quantum Dot / Fluoropolymer Composites: A New Approach for Enhancing Performance in Light Sources

Award Number: 0646322
Program Manager: Juan E. Figueroa

Start Date: March 1, 2007
Expires: February 28, 2009
Total Amount: $499,997

Investigator: Earl Wagener, ewagener@bellsouth.net
Company: Tetramer
657 S Mechanic Street
Pendleton, SC 29670
Phone: (864)653-4339

Abstract:

This Small Business Innovation Research (SBIR) Phase II project describes an innovative approach to encapsulating nanocrystals (quantum dots and rare earth doped inorganics) using functionalized perfluorocyclobutyl (PFCB) polymers. This project will expand the range of ligands synthesized in Phase I specifically designed to enhance the encapsulation of nanocrystals currently being developed for commercialization in the rapidly growing light emitting diodes, displays, planar infrared amplifiers and photovoltaic markets. In Phase I, the company developed a significant competitive advantage by increasing nanocrystal loading to unprecedented levels with uniform distribution and little or no loss of performance. Further competitive advantages over current encapsulating polymers such as silicones, epoxies, and polycarbonates are Tg's above 250 0C, optical clarity at 800, 1330 and 1550 nm, and no free radicals or by-products during polymerization. This encapsulating performance creates an excellent competitive advantage since it meets a critical enabling need in the field of nanophotonics. The technical objectives for this project are 1) Synthesize 7 new functionalized polymers 2) Work with nanocrystal and device manufacturers to commercialize new nanocrystal composites for the markets shown above 3) Down select and scale up the best materials for commercialization. The Tetramer team has over 50 years of successful specialty polymer commercialization.

If successful the results of this project will enhance scientific and technical knowledge in the very active field of quantum dot and rare earth doped inorganic nanocrystals. In particular, the interaction between the unique functionalized PFCB polymers and the nanocrystal surface will provide new fundamental technical insights for the origins of performance of these materials in LED's, displays, infrared amplifiers, and photovoltaic devices. Improvement of devices in these markets has the potential for strong societal and commercial impact. For example, light emitting diodes replacing incandescent lighting alone could decrease national energy consumption by 29%, while more efficient, lower cost solar cells would reduce the US dependence on foreign oil. Use of these new encapsulating materials will enable new device designs for these high priority markets. This in turn will lead to improved cost performance therefore accelerating commercialization and the subsequent societal benefits of reduced energy usage and improved communications.

Title: SBIR Phase II: Titania-Loaded Silicone with High Refractive Index for Light-Emitting Diode Encapsulation

Award Number: 0646439
Program Manager: Juan E. Figueroa

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Jong Kim, TroyResearch@nycap.rr.com
Company: Troy Research Corporation
18 Ledgewood Drive
Troy, NY 12180
Phone: (518)271-2044

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the development of a new class of materials, namely polymeric nanomaterials with a very high refractive index, which will closely match the refractive index of inorganic semiconductors. The encapsulant materials consist of titania-nanoparticle-loaded silicone and epoxy. Titania (TiO2) has a refractive index of 2.68 and the admixture of TiO2 with a polymer would result in an increase of the refractive index. The well-known problem of excessive optical scattering will be overcome by proper use of surfactants and an encapsulation structure that employs thin films, with a thickness that is less than the average distance between scattering events.

If successful the development of a new high-index encapsulant will have a tremendous impact on SSL technology because virtually all SSL devices made of inorganic semiconductors are packaged and encapsulated. A successful completion of the program will result in a worldwide paradigmatic shift in the packaging and encapsulation of optoelectronic devices. The broad deployment of efficient LED technology for general lighting applications would also result in electrical energy savings in the TWh range per year within the United States alone.

Title: SBIR Phase II: Supercritical Fluid Processing of Polymer/Clay Nanocomposites

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| Award Number: | 0646447 |
| Program Manager: | William Haines |
| Start Date: | January 1, 2007 |
| Expires: | January 31, 2009 |
| Total Amount: | $498,536 |

Investigator: Steve Horsch, steveedwh@hotmail.com
Company: nSEC
6942 Lakemont Circle
West Bloomfield, MI 48323
Phone: (313) 550-8523

Abstract:

This Small Businesss Innovation Reseach (SBIR) project will address a major technological barrier to producing superior nanocomposites by overcoming the
difficulty of dispersing nano-fillers uniformly in a host matrix to derive the maximum surface area advantage. When effective filler dispersion is coupled with improved polymer-clay interactions, a significant technological gap in the field of polymer nanocomposites can be addressed. The company, nanoSEC has licensed, developed, and 'validated' (lab scale) a supercritical fluid-based dispersion (SCFP) technology, that produces significant clay dispersion using a simple, versatile, environmentally friendly process that utilizes the unusual properties of supercritical CO2. During Phase I, the clay dispersion conditions were optimized and showed significant property improvements in the resultant nanocomposites that were appreciably better than those in literature. During Phase II, these technical accomplishments will be translated towards commercial success by: (1) producing and benchmarking pilot-scale polystyrene/clay, polyethylene/clay, polypropylene/clay nanocomposites for mechanical and barrier property improvements, with applications in automotive and food packaging industries; (2) scaling up the pilot production process to produce 200 lbs/week of dispersed clay in Year 1, and to produce 1 million lbs/year of polymer-clay nanocomposites (at 10% clay loading) by Year 3; (3) developing specific joint development agreements with business customers for faster adaptation of nanoSEC's technology in actual products.

Commercially, nanoSEC's technology addresses a key need in nanocomposites, which could single-handedly revive the packaging technology applications of nanocomposites. Several companies have expressed strong interest in joint development agreements. Working closely with Wayne State, and end users like Ford, Daimler Chrysler, and GE Plastics will enable nanoSEC to advance both on research and commercial sides to produce a revenue of close to $ 8 million by the end of 2008. The Phase II project will enable pilot-commercial scale validation for rapid development and nanoSEC's location in the state-of-the- art NextEnergy building in Detroit, and the familiarity of the participants with the automotive and food packaging industry will enable unique applications to be achieved in a timely manner. The 'top down' strategy to partner with end users will enable fast implementation upon validation.

Title: SBIR Phase II: Synthesis and Processing of High Performance Polymer Nanocomposite Foams

Award Number: 0620502
Program Manager: James Rudd

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Guojun Xu, xu96@yahoo.com
Company: NIL
1109 Millcreek Lane
Columbus, OH 43220
Phone: (740)522-6617

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and scale-up a new group of light-weight, high-strength and fire-resistant polymeric foams by using innovative nanotechnology. The project explores the synthesis of nanocomposites using both plate-like and fiber-like nanoparticles with high carbon dioxide (CO2) affinity. Polymer blends including a minor phase with high CO2 solubility are used as the matrix material. To improve fire-resistance, surfactant-free and water-expandable polymer/clay nanocomposites are also prepared by suspension polymerization of inverse emulsion. Since low molecular weight surfactants are not needed, there is no fire hazard problem. These polymer blend nanocomposites are then used to produce high performance foam products aimed at both insulation and structural applications. The presence of nanoparticles in polymer blends allows better control of cell morphology and foam density in the manufacturing processes. Ultra-low-density foams with thermal insulation properties better than the existing insulation materials and high-density microcellular foams with mechanical properties close to those of solid polymers are achieved. The materials and processing conditions will be optimized to obtain better foamability and mechanical properties of these novel nanocomposites foams.

Commercially, nanocomposite reinforced foams have the potential in structural applications to replace solid polymers. The U.S. market for polymer foams was more than 7.4 billion pounds in 2001. Currently, their applications are limited by poor mechanical strength, surface quality, thermal stability and fire retardance. Furthermore, traditional chlorofluorocarbon (CFC) blowing agents cause ozone depletion and will be banned by 2010. As environmentally benign blowing agent CO2 is used to replace CFCs, the success of this project will be extremely valuable for environmental protection. A successful implementation of this novel technology can lead to significant impact on energy saving, material saving, and environmental protection that are critical to our nation's economy and societal health.

Title: SBIR Phase II: Commercial Scale Production of High Quality and Affordable Fe3O4 Nanocrystals for Nano-Biomedicine

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| Award Number: | 0620323 |
| Program Manager: | Murali Nair |
| Start Date: | August 8, 2006 |
| Expires: | July 31, 2008 |
| Total Amount: | $499,997 |


Investigator: Yongcheng Liu, ycliu@nn-labs.com
Company: NN-Labs
513 Harrogate Rd
Pittsburgh, PA 15241
Phone: (412)223-2443



Abstract:

This Small Business Innovation Research (SBIR) Phase II project intends to finalize commercial production protocols for high quality, highly stable, bio-compatible, bio-accessible, and yet affordable Fe3O4 nanocrystals and related magnetic beads. Current state-of-the-art methodology for making Fe3O4 nanocrystals for biomedical applications has many critical deficiencies including poor ability to control size, broad size distribution, difficult/complicated surface chemistry, high cost and low solubility in solutions. This technology will produce high quality of Fe3O4 nanocrystals. The company's products have excellent control of size and size distribution and offer super stability and friendly surface chemistry so that they are completely dispersible in solutions due to their simple processing and manufacturing technique. Their terminal groups are ready to conjugate various bio-molecules so that they can be used in various biomedical applications.

The primary application for this technology will concentrate on the life science research. Specific applications include (1) Magnetic bio-separation, (2) Magnetic resonance imaging (3) Drug delivery, and (4) Biomedical treatment. The biomedical applications related to the Fe3O4 magnetic nanocrystals cover many aspects of biomedical fields, ranging from diagnostics, detection, therapy, separation, and pollution control. The environmentally benign nature of this technology helps to achieve a sustainable environmentally-aware business paradigm.

Title: SBIR Phase II: Lithium Reservoir Nanocarbons for Lithium Ion Batteries

Award Number: 0548708
Program Manager: Rosemarie Wesson

Start Date: January 27, 2006
Expires: January 31, 2008
Total Amount: $462,455

Investigator: Ronald Jacobsen, rljacobsen@mlpc.com
Company: Applied Sciences, Inc
141 W. Xenia Ave.
Cedarville, OH 45314
Phone: (513)766-2020

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop Li-ion battery anodes that exploit the unique morphology of low cost carbon nanofibers (CNF). Primary efforts will focus on reduction of irreversible capacity, through a variety of nanofiber surface modification techniques, characterization of the upper limits of anode discharge rate, and development of a new type of compound anode material that combines CNF with elements that form high energy alloys of lithium. The latter effort has the potential to combine the high rate capability of CNF with the higher operation voltage of alloys in a manner that synergistically increases the reversible capacity of both components of the compound anode.

Safe, rechargeable, inexpensive Li-ion batteries are enjoying a growing customer base in diverse markets from consumer electronics to space vehicles. The unique morphology of carbon nanofibers and the fact that these materials can readily be transitioned into an existing client base of Li-ion battery producers and users, holds great promise for this cutting-edge research.

Title: STTR Phase II: Benign Thin Film Composite Particles for Protection from UVA/UVB - Rays

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| Award Number: | 0548739 |
| Program Manager: | George Vermont |
| Start Date: | January 9, 2006 |
| Expires: | December 31, 2007 |
| Total Amount: | $448,225 |

Investigator: Karen Buechler, buechler@aldnanosolutions.com
Company: ALD NanoSolutions, Inc.
580 Burbank St, Unit 100
Broomfield, CO 80020
Phone: (303)318-4145

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project provides for the commercialization of surface-passivated composite titania/zinc oxide particles for benign protection from UVA and UVB radiation. The composite particles are manufactured via novel atomic layer deposition (ALD) technology. These materials are targeted at use in sunblock skin care formulations; the inert coating will allow easy dispersion of the particles in a variety of formulations, and will prevent direct contact between active titania or zinc oxide and the skin. The major health problem of sun-induced skin cancer could be helped with the introduction of new, more effective UVA/UVB protection in a wider variety of skin care products.

This Phase II project will focus on refining the material design, production at larger scale, and proving the effectiveness of these composites in formulations for UVA/UVB transmittance and sun protection factors.

Title: SBIR Phase II: Quantum Confined Atom Based Nanophosphors for Future Efficient Lighting

Award Number: 0521948
Program Manager: T. James Rudd

Start Date: September 15, 2005
Expires: August 31, 2007
Total Amount: $424,693

Investigator: Rameshwar Bhargava, rbhargava@nanocrystals.com
Company: Nanocrystals Technology Limited Partnership
235 Elm Rd
Briarcliff Manor NY, 10510
Phone: (914)923-1142

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will involve quantum confining a single atom in 2 to 5 nm size nanocrystal of ternary semiconductor, from which new and efficient nanophosphors will be developed. The band-gap engineering of nanophosphors allows improvement in the luminescence characteristics such as absorption and emission spectra, half-width, efficiency, life-time, etc. Indeed the role of conventional activators (rare-earths and transition metal impurities) in nanophosphors can be re-evaluated for different applications. Specifically, ternary wide band gap semiconductors such as ZnCdS with dopants like Ag, Cu, Mn offer very efficient broad-band visible spectra that is close to white light. The possibility of band-gap engineering in nanocrystals of ternary semiconductors, similar to that catapulted the optoelectronic devices from III-V semiconductors, opens the door to design of new nanophosphors that match well with the excitation spectra of LED's and compact fluorescent lamps. This development would lead to a new class of white light sources in this Phase II project. By developing different nanophosphors that can be excited by blue/UV LEDs, it successfully demonstrates that nanophosphors can significantly enhance the performance of not only white LEDs but also can improve the performance of compact fluorescent and arc lamps.

Commercially this technological breakthrough of engineering of nanophosphors when used with current efficient lamps, is expected to enhance the efficiency of LED's by 40% and lamps by 15%, respectively. These improvements in overall power efficiency of these lamps, will significantly lower the cost of energy used and it is projected will help to save energy costs equivalent to $25 billion by 2025.

Title: SBIR Phase II: Carbon-Coated Nano-Structured Electrodes for Next-Generation Lithium-Ion Batteries

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| Award Number: | 0522287 |
| Program Manager: | Rosemarie D. Wesson |
| Start Date: | July 1, 2005 |
| Expires: | June 30, 2007 |
| Total Amount: | $476,850 |

Investigator: Timothy Spitler, tspitler@altairinc.com
Company: Altair Nanomaterials Inc
204 Edison Way
Reno NV, 89502
Phone: (775)858-3742

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will demonstrate superior power-delivery, rapid-charge, and long cycle-life performance of prototype carbon-coated, nanoparticle-based electrodes for use in inherently safe, moderate-to-large sized lithium ion batteries of various commercial designs. The primary innovation is the use of optimally sized, arranged and assembled carboncoated nanoparticles that preserve the intrinsic performance characteristics of the bare nanocrystalline materials when fabricated into thin-film electrode structures for use in advanced power sources. Phase I focused on improving performance of nanostructured aggregates of 20nm lithium titanate (n-LTO, used in anode service) via carbon coating for better electrical and ionic connectivity. Phase II will develop appropriate carbon-coated nanomaterials for cathode service designed to match the n-LTO anode performance; providing matched Li-ion host anode-cathode pairs for next-generation performance

There are demonstrated market for fast-charge, long-life batteries in a broad range of consumer applications. Markets require that it be possible to reliably and economically recharge remote devices, including portable computers; hand tools, lawn mowers and medical devices; electric cars, motorcycles and mopeds in a matter of minutes rather than hours, and faster discharge rates translate immediately to higher power per unit weight.

Title: SBIR Phase II: Carbon Nanotubes Field Effect Transitors (FET) Platform for Electronic and Sensors Applications

Award Number: 0450648
Program Manager: T. James Rudd

Start Date: April 1, 2005
Expires: March 31, 2007
Total Amount: $499,999

Investigator: Jean-Christopher Gabriel, jcgabriel@nano.com
Company: Nanomix, Inc.
5980 Horton St.
Emeryville CA, 94608
Phone: (510)428-5313

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to design and develop a molecular nano-sensor platform for researchers developing new chemical and bio-sensors. The principal component of these devices will be an array of single-wall carbon nanotube transducers on a silicon chip. The product itself will be a sensor development kit comprised of a set of sensor chips, an electronics module with a standard PC interface, adaptors for gas and liquid sensing, data reduction and analysis software, and directions for product use. General guidelines for the additional of specialized functionalization chemistry and biology to the sensor chip will be included. The project objectives include developing a set of 5-10 different chip architectures for gas, liquid and biosensing together with modules for sensing in both gases and liquids. The CMOS mask design will include as many as ten different architectures suitable for different types of experiments and functionalization layers. The sensor chips themselves will be manufactured on 4-inch silicon wafers and set into a standard CERDIP package that fits into the top of the electronics module. Signal processing electronics and software systems will be designed and integrated to deliver digital sensor output to LabView(TM) on a PC. The research involved in meeting these goals encompasses the design, prototyping and experimental testing of each component of the development platform. At the culmination of Phase II, the molecular nano-sensing platform will be validated by collaborative users in UCLA, UC Berkeley and UC Irvine, and positioned for market introduction.

Commercially this novel nanosensing platform will enable research and product development in molecular level phenomena related to chemical reactions and catalysis, chemical and biological sensing, and photonics. The work described in this proposal will produce a valuable new nanoelectronics research tool that will ultimately result in new discoveries and products in sensing and diagnostics. Researchers seeking to develop new direct electronic detection sensing applications and conduct charge transfer experiments at the molecular level lack a robust, inexpensive experimental platform. In most cases researchers must develop their own experimental apparatus, interfaces and software. For those wishing to take advantage of the sensitivity and flexibility of nanoelectronic arrays, fabricating the devices is a formidable and cost prohibitive challenge. This project seeks to provide a state-of-the-art nanotechnology-based solution in an ultra sensitive and flexible detection platform.

Title: SBIR Phase II: High Performance Thin Film Transistors on Plastic Fabricated from Dense Thin-Films of Oriented Semiconductor Nanowires

Award Number: 0450585
Program Manager: T. James Rudd

Start Date: March 1, 2005
Expires: February 29, 2008
Total Amount: $999,554

Investigator: David Stumbo, dstumbo@nanosysinc.com
Company: Nanosys Inc
2625 Hanover St
Palo Alto CA, 94304
Phone: (650)331-2106

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a revolutionary new high-performance thin-film-on-plastic technology that will provide single-crystal silicon, thin film transistor (TFT) performance. This technology is based on a novel thin-film semiconductor on plastic composed of a dense film of parallel nanowires with electronic properties comparable to single-crystal silicon that can be deposited at low temperatures. In Phase I, the feasibility of this innovative technology was successfully demonstrated and key device design and material processing parameters to address underlying device performance were identified. Specific developments included (1) nanomaterial deposition (2) contact technology (3) doping processes and (4) device architecture. Phase II research will build on the knowledge gained in Phase I, and focus on further optimization of device performance and the development of roll-to-roll manufacturing processes. The output of Phase II will be a prototype array of transistors on plastic. In addition, this fundamental concept can be applied to nanowire materials other than silicon, allowing the production of thin films of material that presently are impossible to produce over large areas on any substrate, including semiconductors relevant to communications (GaAs, InAs), optically active materials (GaN, InP), piezoelectric or ferroelectric materials (SrTiO3), or materials of mixed composition with newly engineered properties.

Commercially, this research will impact greatly the development of high performance TFT devices on plastic for commercial, military, and homeland security markets. These high-performance, flexible semiconducting films have the potential to replace amorphous and polycrystalline silicon in important large-area electronics applications such as displays and also radio frequency identification tags (RFID'S).

Title: SBIR Phase II: Dye Co-Sensitizer Combinations for Increasing the Efficiency of Dye-Sensitized Titania Nanoparticles in Solar Cells

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| Award Number: | 0450532 |
| Program Manager: | T. James Rudd |
| Start Date: | February 15, 2005 |
| Expires: | January 31, 2007 |
| Total Amount: | $511,977 |


Investigator: Russell Gaudiana, rgaudiana@konarka.com
Company: Konarka Technologies Inc
100 Foot of John Street
Lowell MA, 01852
Phone: (978)569-1410



Abstract:

This Small Business Innovation Research(SBIR) Phase II project aims to commercialize lightweight, flexible, affordable solar cells and modules that efficiently generate electricity from sunlight or indoor room light. These cells are based on dye-sensitized titania which is coated on a flexible substrate at high speed in a continuous coating, laminating process. The overall objective of Phase II is to raise the cell efficiency from its current 7% to 10% or higher, thereby raising the module efficiency from 5% to over 8%. To accomplish this, the ability of the sensitizing dyes to harvest a much larger number of available photons and convert them into electrons must be increased. In Phase I of this program, a new class of sensitizing dyes that cover a larger portion of the solar spectrum, have larger absorptivity than the currently used ruthenium-based dyes was discovered. In addition, materials that have similar molecular structures to those of the new sensitizing dyes, and act as co-sensitizers by boosting electron injection from the dye to the titania, are co-adsorbed with the dyes on the surface of the titania. It is anticipated that the combination of these materials will bring the cell and modules performance to the desired level.

Commercially, the project will result in an inexpensive, efficient, flexible photovoltaic (PV) technology that can be integrated into consumer products. Therefore a renewable source of energy could be used to power products, minimizing the battery capacity and disposal requirements, and ultimately delivering power to building structures, avoiding emissions associated with fossil fuels. Security is a broad benefit on two levels. First, grid instability demonstrated by widespread blackouts in 2003 emphasizes the need for distributed power in our national grid. Secondly, growing homeland security concerns underscore the importance of wireless networks of sensors, cameras, and other monitoring systems for building and border security. Photovoltaics are uniquely suited to serve these distributed applications

Title: SBIR Phase II: Nanotube-Based Electronic Pressure Sensor

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| Award Number: | 0422198 |
| Program Manager: | T. James Rudd |
| Start Date: | October 1, 2004 |
| Expires: | September 30, 2006 |
| Total Amount: | $499,260 |

Investigator: Lian Zhang, lian@monano.com
Company: Molecular Nanosystems, Inc.
977 Commercial Street
Palo Alto, CA 94303
Phone: (650)846-2519

Abstract:

This Small Business Innovation Research (SBIR) Phase II program focuses on developing carbon nanotube-based electromechanical pressure sensors. To translate the change in pressure into an electrical signal, current solutions (MEMS devices) use membranes with sensors made out of doped silicon. Silicon, however, is prone to effects of temperature changes and as a result, such devices require additional electronics for temperature compensation and more stringent packaging. They also have sensitivity limitations. The device in this work will use carbon nanotubes as strain gauges. Because nanotubes have higher sensitivity (higher gauge factor) and better temperature stability, this will result in development of devices that are easier to manufacture (fewer manufacturing steps), have superior precision, and require less stringent packaging, leading to less expensive end-product. This work will combine chemistry for synthesis of materials and microfabrication to explore important properties of a novel nano-material carbon nanotubes. Key technical innovations will include precise placement of nanotubes on thin membranes, novel approaches to avoiding membrane damage during nanotube integration, forming nanotube circuits on membranes for electromechanical pressure sensors and other integration issues.

If successful, the project will lead to the first application of carbon nanotubes in high-end electronic devices, enabling the development of nano-electromechanical systems (NEMS), which convert mechanical effects into electrical signal. Such devices, which would include pressure sensors, accelerometers, gyroscopes and acoustic sensors, could address the unmet needs in a wide range of applications, such as in automobiles, safety, medical, military and process control. Specifically, in the automobile market, a nanotube-based pressure sensor could serve as a tire pressure measuring device and could result in over $180million in annual savings for such end users as the automotive industry.

Title: SBIR Phase II: Nanocomposite Solar Cells

Award Number: 0422147
Program Manager: T. James Rudd

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $499,990

Investigator: Erik Scher, escher@nanosysinc.com
Company: Nanosys, Inc.
2625 Hanover Street
Palo Alto, CA 94304
Phone: (650)331-2106

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an innovative solar technology that combines nanotechnology with conducting polymer photovoltaics to achieve light weight, flexible solar cells that surpass current solar cell efficiencies, but can be manufactured at a fraction of the cost. Phase I, successfully demonstrated the feasibility of this innovative technology and identified key device design and material requirements to address underlying loss mechanisms limiting the nanocomposite photovoltaic performance. Specific developments included (1) controlled nanocrystal surface chemistry (2) novel nanocrystal synthesis (3) film morphology control and (4) reproducibility and control of the entire process from synthesis to device measurement. Phase II research will build on the knowledge gained in Phase I, and focus on the development of optimized optical and electronic materials and the development of an advanced stacked-intra-layer recombination device architecture. The output of Phase II will be a prototype of an optimized, light-weight, low-cost, flexible solar cell with efficiency greater than 10%; amenable to large-scale, low-temperature manufacturing by roll-to-roll.

Commercially this technology has the potential to meet the market needs to enable solar energy to become an integral and critical power generation source world-wide, providing societal benefits in the areas ranging from environment to national and economic security. Commercial applications exist for high performance, low-cost solar cells that can provide an alternative power generation source. Specific examples of use include on-grid building integrated electricity generation systems; on-grid wholesale power generation; remote off-grid power generation; portable power generation; and power generation for long-term aerospace applications.

Title:  STTR Phase II: Novel Nanocoated Ferromagnetic Materials

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| Award Number: | 0422220 |
| Program Manager: | T. James Rudd |
| Start Date: | August 1, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $469,030 |

Investigator: Karen Buechler, buechler@aldnanosolutions.com
Company: ALD NanoSolutions, Inc.
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Westminster, CO 80020
Phone: (303)460-9865

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will build on the great successes of the Phase I program by proving that the nanocoating of fine ferromagnetic particles is possible on the large scale and that such nanocomposite particles have commercial uses. The Phase I program proved that atomic layer deposition (ALD) of an alumina film can provide these properties.The objectives of the Phase II program are to prove the scalability of the process as well as to work with supporting companies to develop specific products for commercial markets. A pilot scale facility will be constructed to increase the scale of production to provide the kilogram quantities of material that most partners require for product development. This facility will be optimized to provide the best quality coatings at the lowest production cost. It is anticipated that at the close of the Phase II program, the company will have developed at least one market for full scale production with 2-4 markets still being developed. The ALD nanocoating of individual ultrafine particles to control individual ultrafine particle surface chemistry is enabling technology that is unparalleled compared to more conventional CVD, PVD, PE-CVD, or wet chemistry solution processing. The process allows for individual ultra-fine particles to be nanocoated, rather than coating aggregates of ultra-fine particles. It is independent of line of sight and provides for chemically bonded films to the substrate particle surface. It is easily scalable. It is a forgiving process where the nanocoating thickness is controlled by self-limiting surface reactions (not flux, temperature, or time of processing like CVD, etc.). Films are pin-hole free and conformal.   Commercially, fine iron particles are used in a variety of applications such as metal injection molding, radar absorption, localized drug delivery carriers, electronic devices etc. Most of these applications would benefit from a smaller initial iron particle size and reduced oxidation sensitivity. Thus nanocoating of ultrafine particles provides many opportunities. It is now possible to produce ultrafine particles with designed electrical, magnetic, optical, mechanical, rheological, or other properties.

Markets for such functionalized ultra-fine powders include microelectronics, defense, hardmetals, cosmetics, drug delivery, energetic materials, and polymer/ceramic nanocomposites, among others.

Title: SBIR Phase II: Direct Conversion of Heat to Electricity with Nanowire Antenna Arrays

Award Number: 0422219
Program Manager: T. James Rudd

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $488,855

Investigator: Lin Simpson, LSimpson@itnes.com
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8130 Shaffer Parkway
Littleton, CO 80127
Phone: (303)420-1141

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop enabling nanotechnology that collects and converts infrared radiation (IR) from heated sources into DC power using nanowire antenna arrays with monolithically integrated rectifying diodes (IR-AAID). The innovation uses scaleable (square meters), self-organizing, and inexpensive electrochemical processing with low cost materials to engineer antenna/diode systems to convert light from heat sources. IR-AAID can convert heat to electricity at over 40 percent efficiency and be adapted to different emitters simply by changing the antenna geometry. The best IR thermo-photovoltaic modules typically operate at less than 5 percent efficiency, cost more than $300 per Watt, require up to 2000 degree Kelvin emitter temperatures to match available bandgaps, and require expensive materials with chemically tailored compositions, that are temperature sensitive, to match specific energy applications. In Phase I, the team demonstrated the feasibility of forming nanometer scale IR collecting antenna/diode structures over large areas, developed unique measurements to independently evaluate antenna and diode performance, demonstrated materials and diode structures that will provide the required IRAAID performance, generated DC power from light with IR-AAID devices, and demonstrated 6 percent conversion efficiency with non-optimized diodes. For Phase II, the team will develop robust processing to form inexpensive (less than $2 per Watt), IR-AAID prototypes to efficiently convert light to DC power.

Commercially, since IR-AAID does not require prohibitively expensive advanced lithography or direct serial nano-patterning, this effort will produce low-cost nanowire arrays with high density over relatively large areas, for heat collection. These applications will vary from portable power packs that use low temperature heat, to the generation of electricity from high temperature nuclear and conventional heat sources where noise or other environmental concerns are an issue. The enabling IR-AAID features are ideally suited for heat recovery applications, a $100B resource that is virtually untapped at present due to the limitations and costs of existing technology.

Title: SBIR Phase II: Nanofluidic Reference Electrode with an Invariant Liquid Junction Potential

Award Number: 0422237
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $494,988

Investigator: Scott Broadley, sbroadley@broadleyjames.com
Company: Broadley-James Corporation
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Abstract:

This Small Business Innovative Research (SBIR) Phase II is for the development of nanofluidic-flowing liquid junction (NFLJ) reference electrodes using nanochannel glass arrays developed by the Naval Research Laboratory. While consuming electrolyte at less than 2 ml/yr, the NFLJ reference electrodes will allow a flow at velocities of over 0.1 cm/sec to impede back diffusion of sample solution into the electrode. A variety of challenging test sample solutions, potentiometric measurements made with NFLJ references varied < 0.5 mV with response times of less than 60 seconds while measurements made with conventional reference electrodes varied up to 20 mV with response times of over one hour have already been completed. The NFLJ reference electrode's exceedingly small electrolyte consumption makes possible handheld NFLJ pH sensors with significantly higher precision and longer operational life. The high impedance of NFLJ reference electrodes, when using modern commercial pH electrodes, has no measurable effect on the precision, response time, or span of the pH measurement. The nanochannel glass nanofluidic-flowing liquid junction (NFLJ) adds a new dimension to the design and construction of reference electrodes.

The unique ability of the NFLJ design to separate flow volume and flow velocity will provide scientists with a tool for investigating reference electrode behavior as a function of flow, velocity, and resistance. It should help to develop a more fundamental understanding of mass transfer effect on liquid junction potentials. Initial results indicate that velocity is the critical parameter in stabilizing the potential.

Title:  SBIR Phase II: Highly Efficient, Long Lifetime, and Inexpensive Nanocrystal Light Emitting Diodes (LEDs)

Award Number: 0349730
Program Manager: T. James Rudd

Start Date: March 1, 2004
Expires: February 28, 2006
Total Amount: $468,743

Investigator: Yongqiang Wang, awang@nn-labs.com
Company: NanoMaterials and NanoFabrication Laboratories
3468. W. Yale St.
Fayetteville, AR 72704
Phone: (479)871-0707

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will advance the performance of light emitting diodes based on semiconductor nanocrystals (NanoLEDs) to the same level of that of organic/polymer light emitting diodes (OLEDs). The key parameters of NanoLEDs targeted for this Phase-II program are 2000 hours operation lifetime, above 200 Cd/m2 brightness, and 0.5-2% external quantum efficiency. The Phase-II program will improve the performance of the NanoLEDs through a unique design of the nanocrystal thin layer in the devices. This design enables the ligands of all nanocrystals to be inter- and intra-particle cross-linked, which results in the thermally stable nanocrystal thin films required for high performance devices. The three dimensionally cross-linked ligands are short and have quasi-conjugated electronic structures, instead of the traditional long aliphatic ligands. This choice aims to dramatically improve the charge injection and charge transport in the NanoLEDs. New types of nanocrystals to be used will diminish the re-absorption and energy transfer in the densely packed nanocrystal thin films identified in literature. With the committed support from a state agency and extensive collaboration with mainstream industry it is expected to commercialize this technology in the display and lighting industry within five years.

The commercial potential of NanoLEDs is enormous. NanoLEDs possess nearly all of the advantages of OLEDs, but with readily tunable and narrow emission profiles. OLEDs are currently being used in active commercial development. The commercial goal in the Phase-II is to boost the performance of the NanoLEDs to at least the same level of that of the polymer LEDs, the low end of OLED devices. The first generation of NanoLEDs will be used in portable electronic devices. When the lifetime of NanoLEDs is extended over ten years, they will be used for other display technologies and in the lighting industry. NanoLEDs will one day change the way we see the world. Based on industry estimation, the near-term market for flexible LEDs, including NanoLEDs, will be $5 billion in 2005. After they are adapted to the mainstream of the flat panel graphics and lighting applications, the market size is going to be at least tens of billions.

# Photonics

Title: STTR Phase II: High Resolution, High Brightness Display for Virtual Reality

Award Number: 0822965
Program Manager: Ian M. Bennett

Start Date: September 1, 2008
Expires: August 31, 2010
Total Amount: $492,628

Investigator: Michael Bass, bass2703@comcast.net
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905 Sykes Court
Orlando, FL 32828
Phone: (407) 718-2843

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project focuses on new GaAs-based, low voltage technology for high definition head mounted displays (HMDs), suitable for advanced applications in immersive virtual reality and 3-D imaging. Applications for this technology include battery powered augmented reality HMDs, full color, high resolution HMDs with 3-D imaging potential, and low cost, low voltage indicators and backlights for battery powered electronics. Displays derived from this GaAs technology have superior color gamut, high brightness, resolution and efficiency compared to other approaches. The results obtained from the STTR Phase I project indicate that low cost HMD-based optical systems can be designed using these high resolution microdisplay chips at supply voltages as low as 1.5 volts. Compared to display systems based on GaN LED and OLED technology which require voltages of up to 4 volts, this technology presents a path for continued advancement to 3-D imaging systems that could reach the resolution of the human eye. This technology should impact low cost HMDs displaying low-information content data such as maps, text or line graphics that require long battery life for markets that include first responders, factory and inventory workers, and consumer appliances. The technology can be advanced to much higher resolution microdisplays and improved optics for the high-information content marketplace such as immersive virtual reality for education, medical imaging and surgery, games and videos. Commercial emphasis will be placed on the low voltage operation for battery compatibility, a key advantage for augmented reality HMDs; and one which may lead to fundamental changes in battery powered electronics having indicator lights and/or displays.

Title: SBIR Phase II: Electronic Orientation and Navigation System for People with Visual Impairments

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| Award Number: | 0822972 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | July 1, 2008 |
| Expires: | June 30, 2010 |
| Total Amount: | $500,000 |


Investigator: Michael Manning, michael@manningrf.com
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2718 Winningham Rd.
chapel hill, nc 27516
Phone: (919) 967-5438



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will design, build and test a new type of orientation and navigation (O&N) system for people with visual impairments. While GPS-based solutions show promise in outdoor environments, there are currently no widespread O&N devices that are designed for use in indoor environments. This makes it difficult for people with visual impairments to navigate through indoor public spaces. The purpose of this research will be to complete development of a new type of radio frequency identification (RFID) system, in which intelligent, variable-range active RFID beacons are programmed with information about their locations and placed through indoor environments like schools, shopping malls and museums. This information will be accessible to people with visual impairments via a small RFID receiver worn on the user?s belt. Information will be conveyed to the user via a text-to-speech interface. Results from field testing have demonstrated that the device helps people with visual impairments to navigate through an unfamiliar environment. Phase II research will complete development of the communications protocols and interface techniques that give the system its unique capabilities for delivering speech-based information to people with visual impairments. There are 10.4 million people with visual impairments in the U.S., and this research will lead to an inexpensive commercial product that will greatly enhance their ability to navigate in unfamiliar surroundings. The market for this technology includes those who will purchase the RFID receivers and the RFID beacons. This includes people with visual impairments, as well as the owners and tenants of public spaces, such as office buildings, schools, malls, museums and government facilities. Also, because of the simplicity of the interface, the system will be useful to Orientation and Mobility educators working with young children to develop spatial concepts.

Title: STTR Phase II: Hybrid Integrated Optoelectronic Systems

Award Number: 0750506
Program Manager: Juan E. Figueroa

Start Date: March 1, 2008
Expires: February 28, 2010
Total Amount: $500,000

Investigator: Lisa Dhar, lisadhar@inphase-tech.com
Company: InPhase Technologies
2000 Pike Road
Longmont, CO 80501
Phone: (217) 369-7409

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will combine advanced two-chemistry photopolymer science and 3D maskless lithography to demonstrate a solution to a ubiquitous barrier to the broader impacts of optical and optoelectronic technologies. This research will strive for a universal integration platform capable of seamlessly hybridizing electronic, micro-mechanical, opto-electronic and optic devices on a single chip to implement complex 3D systems in an environmentally robust package. Over 90% of the development cost of optoelectronic components for telecom is estimated to be packaging and the limited market penetration of MEMs products is universally blamed on packaging difficulties clearly showing the need for the proposed platform. In this program the team will optimize the photo polymerizable monomer system and adapt a multi-beam direct-write lithography platform in order to demonstrate and optimize a new class of 3D routed waveguides. Anticipated results are a new class of polymer material and an associated maskless lithography technique to support research, education and commercial production of a wide range of miniature mobile devices that are currently confined to laboratory benches. If successful the proposed multi-disciplinary materials and lithography research program has the potential to revolutionize public access to complex microdevices that are currently restricted to laboratories or expensive military systems. By providing a platform for inexpensive, robust miniaturization of systems that seamlessly incorporate optics, MEMs and electronics, a wide range of communication, medical and sensing systems become technically and economically feasible.

Title: SBIR Phase II: Wavelength-Selective Lasers for Photonic Integrated Circuits

Award Number: 0724237
Program Manager: Juan E. Figueroa

Start Date: October 1, 2007
Expires: September 30, 2009
Total Amount: $499,998

Investigator: Alan Sugg, arsugg@vegawave.com
Company: Vega Wave Systems
1275 W. Roosevelt Rd Ste 112
West Chicago, IL 60185
Phone: (630)562-9433

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will address the commercial need for novel, wavelength-selective laser diodes for 10 Gigabit Ethernet applications. The distributed feedback lasers currently used in 10 Gigabit Ethernet transceivers are fabricated using an expensive, low-yield, epitaxial re-growth process. The drawbacks of this method are the high cost of the capital equipment and of the manufacturing process. In addition, the lower yields encountered with the multiple regrowths required to fabricate complex photonic circuits make cost-effective integrated photonic components difficult to achieve. A novel laser diode design and high-yield manufacturing method that will enable the fabrication of low-cost wavelength-selective and tunable laser diodes for optical communications has been developed. This research will refine the design and fabricate both discrete and integrated devices for 10 Gigabit Ethernet applications.

The major scientific and technical benefit of this work is an improved method for fabricating lasers and other optoelectronic devices. The work should also result in arrays of novel, wavelength selectable lasers suitable for use in high-speed data communications applications. The main societal impact will be the increased availability of low-cost, high-speed data communications, which is a significant contributor to economic development. Making lower cost lasers will enable a significant reduction in the cost of transceivers, which will increase the rate at which high speed Ethernet penetrates the data network.

Title: SBIR Phase II: Compressing and Measuring Ultrashort Laser Pulses in Imaging and Spectroscopy

Award Number: 0724370
Program Manager: Juan E. Figueroa

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Aliakbar Saman Jafarpour, linda.trebino@swampoptics.com
Company: Swamp Optics
6300 Powers Ferry Rd #600-345
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Phone: (404)547-9267

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop two novel ultrashort-laser-pulse devices. Each will solve an important problem for researchers that use exciting new ultrashort-laser-pulse techniques for imaging, micro-machining, surgery, telecommunications, chemical-reaction control, time-domain spectroscopy, and many other applications. Such applications work best with the shortest pulse - but currently operate with much longer ones because such pulses naturally lengthen as they pass through the many optical components on the way to their final destination. Pulse compressors, which use four prisms (or two prisms and a mirror), solve this problem, but they are unwieldy and have a tendency to introduce other distortions, making them difficult to commercialize. This research will develop an elegant, easy-to-use single prism pulse compressor, which is much simpler, more compact, and much less expensive, and is also naturally immune to the problematic distortions of current two- and four-prism designs.

The pulse compressor will greatly benefit multi-photon microscopy - in use in over 1000 biological labs worldwide, and where it will significantly improve image sensitivity and resolution. Micromachining efforts and new ophthalmologic surgical techniques that now use ultrashort pulses also require the shortest possible pulses. In addition, telecommunications and chemistry researchers who shape their pulses into potentially extremely complex waveforms, currently cannot measure them, but this spectral interferometer, which can also measure complex shaped pulses, will fill this need, as well.

Title: SBIR Phase II: New Ceramic Sub-Microchannel Plates

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| Award Number: | 0724478 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Dmitri Routkevitch, droutkevitch@synkera.com
Company: Synkera
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Longmont, CO 80501
Phone: (720)494-8401

Abstract:

This Small Business Innovative Research (SBIR) Phase II research project proposes to develop and commercialize advanced high- resolution ceramic microchannel plates (s-MCPs) for applications in low- and night vision devices, scientific detectors and biomedical imaging. Conventional glass-fiber MCP technology has reached its fundamental limits in spatial and temporal resolution, fixed pattern noise, high count rate capabilities, thermal performance, yield and reproducibility, stability and lifetime. This is a unique approach based on nanoporous ceramics, which allows reaching ultra-high sub-micron resolution. Due their ceramic nature, the proposed s-MCPs are capable of processing temperatures up to 1000 degrees celsius, enabling direct integration of advanced photocathodes for expanded spectral range and sensitivity, and are also expected to have greater lifetime than those produced with existing methods. In addition ceramic s-MCPs can be produced at a much lower cost than glass MCPs. A robust ceramic structure with the required dimensions and resistance has been developed. The remaimimg challenge is to fabricate functional s-MCP prototypes from this structural material, along with validation of s-MCP performance.

The expected result of the proposed work is a manufacturing technology for production of commercially viable sub-microchannel plate intensifiers with better performance, longer lifetime and lower cost. This could open up new opportunities in the development of the next generation particle and photon detection systems for the infrared, UV, x-ray and gamma ray astrophysics applications. Spin-off applications for ceramic MCPs include "lobster eye" optics for x-ray detectors as well as gas avalanche detectors. Commercial applications include detectors for high-energy physics, scientific instrumentation, biomedical imaging, commercial satellite mapping, vision augmentation, as well as consumer night vision products.

Title: SBIR Phase II: A New Class of Complex Ferroelectric Liquid Crystal Mesogens for Advanced Electro-Optic Devices

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| Award Number: | 0646460 |
| Program Manager: | William Haines |
| Start Date: | June 15, 2007 |
| Expires: | May 31, 2009 |
| Total Amount: | $499,999 |

Investigator: Yongqiang Zhang, zhang@displaytech.com
Company: Displaytech Incorporated
2602 Clover Basin Dr
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Phone: (303)772-2191

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to exploit novel dimer ferroelectric liquid crystals (FLCs) to develop a new class of materials for electro-optics (EO) and non-linear optics (NLO) that offer previously unobtainable properties. This will enable advanced optoelectronic products across multiple markets, from lasers for projection television to 100GHz integrated electro-optic modulators and switches for optical interconnects and telecommunications. For over 100 years, predominant liquid crystal molecules have been variants on simple rod shapes. This innovation exploits new dimers - a side-by-side pair of conventional rod-shaped FLC molecules connected by a pi-conjugated bridge engineered to be part of a strong NLO chromophore. It is difficult and expensive to build integrated optoelectronic devices using lithium niobate, today's dominant NLO material. Organic poled-polymer NLO materials offer significant advantages for integration, but suffer performance and stability limitations due to being thermodynamically unstable and non-centrosymmetric (required to be NLO active). FLCs are intrinsically non-centrosymmetric and thermodynamically stable, offering an ideal scaffolding for creating high densities of strong, oriented, NLO chromophores. Our Phase II objectives are to develop and demonstrate prototype materials for projection television laser light sources and electro-optic modulation, and to design a product that will be used in projection television lasers.

Commercially, this SBIR Phase II project will advance the scientific and technological understanding of a new class of dimer ferroelectric liquid crystals, and will produce the first commercially significant liquid crystals not based on simple rod-shaped molecules. Consumer products will include higher image quality, lower cost, rear projection televisions and practical, bright, micro-projectors for portable electronics. Integrated electro-optic devices enabled by the NLO materials will help to expand the bandwidth of computer and telecommunication networks, and of interconnects within coming generations of faster computers.

Title: SBIR Phase II: Voltage Tunable Micro-Ring Resonators: Low-Cost, Reconfigurable Optical Add-Drops

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| Award Number: | 0646357 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | April 1, 2007 |
| Expires: | March 31, 2009 |
| Total Amount: | $499,953 |


Investigator: Scott Davis, davis@vescentphotonics.com
Company: Vescent
4865 E. 41st Ave
Denver, CO 80216
Phone: (303)296-6766



Abstract:

This Small Business Innovation Research (SBIR) Phase II project entails the design and building of polarization independent, fiberdized, wavelength selective switches using patent pending EO-waveguide micro-ring technology developed and demonstrated as a result of work carried out under Phase I. The approach is electro-optic, rather than thermo-optic, and operates with negligible power consumption (< 30 microwatts per ring demonstrated in phase I), fast switching (< 100 microseconds demonstrated), larger index modulation (dn > 0.01 demonstrated, more possible) and importantly, will enable active polarization dependent loss (PDL) compensation. This will replace thermo-optically tuned ring resonators, which have provided only limited tunability (dn/dt =~ 1.5 x 10-5/oC), slower tuning times (> 3 milliseconds typical), high polarization dependency (no active PDL compensation possible), and are prohibitively power consumptive ( ~~ 0.5 Watts per ring).

In the last century the low power transistor replaced the power hungry vacuum tube, thereby ushering in the age of integrated electronics. In a similar fashion, low-power LC-waveguides have the potential to replace high-power thermo-optics (providing a power savings of >10,000), thereby opening up applications and markets for integrated optics. In phase II we will transition our phase I feasibility demonstration into a fully functioning and packaged prototype. As computing power and bandwidth continue to grow (e.g., streaming media), low-cost electro-optical filtering and switching systems will be required to satisfy pending fiber-to-the-home and "last mile" deployment needs. Since 2002, United States and European deployment of long-haul dense wavelength division multiplexing (DWDM) systems have been almost entirely constructed from reconfigurable optical add-drop multiplexers (ROADM). A typical deployed system works by reading incoming optical signals and converting them to electrical signals, which can then be routed. Conversion back to optical is performed by an array of tunable lasers. This brute force method, while providing useful performance, is cost prohibitive for small network deployment. According to Infonetics, a leading market research firm, the ROADM-enabled equipment market size nearly reached $600 million in 2005, tripling earlier forecasts. Over all growth will be determined by affordability and reliability of ROADMs technology, especially within the metro and access space. The technology outlined in this proposal if successful will contribute a new and inherently agile all optical solution by reducing cost while maintaining performance and reliability. In addition to ROADMs, the voltage tunable micro-rings will enable a wide array of useful devices, ranging from spectral filters, to optical cross-connects, to routers, to name only a few.

Title: SBIR Phase II: Novel Monolithically Integrated Wavelength-Range-Selectable and Widely-Wavelength-Tunable Semiconductor Lasers with High Functionalities

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| Award Number: | 0646478 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $500,000 |

Investigator: Jing Ma, jma@optonetinc.com
Company: OptoNet Inc.
828 Davis Street
Evanston, IL 60201
Phone: (847)425-7585

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is focused on the use of new technology for the development of a novel wavelength selectable or wavelength tunable laser. Such lasers are central to next-generation photonic technologies and optical networks, and have a wide range of applications including instrumentations, optical sensing, medical, military, imaging, and high bandwidth DWDM optical networks. The company has recently developed a powerful integrated super-high-resolution compact curved diffraction grating (SCG) on InP chip with the highest spectral resolution and the smallest size. Applying to lasers, SCG allows combining the simple-control and high-performance advantage of "external cavity laser" with the high ruggedness and low-cost advantage of monolithic integration. The Proposed wavelength-selectable or tunable lasers will result in extended tunable laser capabilities, not achievable currently, such as simpler control electronics, direct modulation capability up to 2.5Gb/s, 10Gb.s modulation with integrated modulator, ultra-compact laser module size, lower power consumption, and lower costs via monolithic integration.

The proposed wavelength-selectable or wavelength-tunable SCG lasers will involve a number of new technological approaches such as the high-resolution Integrated Curved Diffraction Grating, Cavity-Grating Frequency Offset detector, and other integrated functionalities (e.g. integrated shutter/amplifier, integrated modulator etc). These are combined capabilities that can only be realized with chip-scale monolithic integrations, and are not available currently. IF successful the proposed solution, a single wavelength selectable SCG laser, will replace the use 40x fixed wavelength DFB lasers to cover the 40 DWDM ITU Wavelength Channels. Thus the proposed solution, WS-SCG laser, will reduce the DWDM laser inventory by 10-40x while having substantially simpler control electronics, more compact module size, lower power consumption, and higher functionalities than those of current tunable lasers, and could be engineered to give higher output and higher spectral purity. The potentially new capabilities of SCG lasers will open up many application areas including: (1)DWDM/CWDM/OCDMA Networks; (2) WDM On Chips; (3) Instrumentations; and (4) Optical sensing and medical equipments. Applications to these areas require wavelength selectable or tunable lasers with higher output, higher spectral purity, wider wavelength tunability, and lower cost.

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Title: SBIR Phase II: Development of a New High Intensity Pulsed Light Source System

Award Number: 0645824
Program Manager: Juan E. Figueroa

Start Date: March 1, 2007
Expires: February 28, 2009
Total Amount: $500,000

Investigator: Raymond Schaefer, rschaefer@phoenixsandt.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to conduct further research on the erosion properties of electrode materials under high-current pulsed operation, and demonstrate extended lifetime for a new pulsed lamp, making it economically practical. With increased lifetime, the new lamp can become the industry standard for UV water treatment and enable a new photolytic paint stripping process. Materials used for pulsed power electrodes were originally formulated for continuous or alternating current at low peak current. In Phase I a tungsten composite fabricated with a specific process eroded at one-sixteenth of the erosion of the standard electrode material. Phase II continues the research on this tungsten composite and its fabrication processes to demonstrate low erosion, with the objective of demonstrating increased lamp life that meets requirements for commercialization.

If successful the proposed research will enhance scientific understanding of the erosion of electrode materials under repeated high-current pulsed cycling. New electrode materials will expand the use of pulsed power and provide better alternatives to thoriated tungsten, which is banned in Europe because of its radioactivity. The primary goal is to enable a new commercial pulsed lamp. The lamp will replace mercury lamps, reducing mercury use and exposure of the public. The lamp also will enable commercial photolytic paint removal, replacing chemical and abrasive techniques that are labor intensive, create dust and debris, and generate toxic byproducts. The photolytic process will provide a lower cost and cleaner method of removing lead paint. This will allow abatement to replace "interim measures" currently in vogue, and support national goals to eliminate childhood lead poisoning. The commercial market for the new lamp encompasses all of UV water treatment and a wide range of paint removal applications.

Title: SBIR Phase II: Electro-Optic Photonic Bandgap Materials and Devices

Award Number: 0522177
Program Manager: T. James Rudd

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,821

Investigator: Yingyin Zou, kzou@bostonati.com
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Abstract:

This Small Business Innovation Research (SBIR ) Phase II project will develop electro-optic photonic bandgap (EO-PBG) Materials and Devices. During the Phase I project the feasibility of the proposed electro-optic PBG technology has been demonstrated. High quality EO film, La-modified PMN-PT (PLMNT), was successfully deposited using a unique metal-organic chemical liquid deposition (MOCLD) technique, a low cost and efficient manufacturing process. A large EO coefficient was achieved from PLMNT films. An innovative metallic/dielectric PBG structure was designed and studied for device applications. An electro-optic filter/modulator was developed. A two-dimensional PBG structure was demonstrated for efficient wavelength tuning through simulation. In Phase II based on this Phase I work, new generation tunable PBG material and devices, such as filters and modulators with state-of-the-art performance, will be brought to the marketplace.

Commercially photonic bandgap materials promise to give similar control of the flow of photons as there is over electrons in a semiconductor material but with even greater flexibility because there is far more control over the properties of photonic bandgap materials than the electronic properties of semiconductors. Given the impact that semiconductor materials have had on every sectors of society, photonic bandgap materials could play an even greater role in the 21st century, particularly in the optical-communications industry. Not only can this material be made into common PBG passive components, such as cavities, waveguides, or couplers, but also the active and dynamic ones, such as high-speed modulator and tunable filters. These advanced devices will have great applications in industrial, space, and military sectors

Title: SBIR Phase II: Efficient Light Out Coupling from AlGaN Light Emitting Diodes

Award Number: 0522067
Program Manager: T. James Rudd

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,961

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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop novel graded-index (GIN) structures for blue/UV light emitting diodes (LEDs). Solidstate LEDs (SSLs) are among the most efficient converters of electrical energy into light and additionally have the advantages of long lifetime, excellent reliability, low power consumption, light weight, small size and excellent resistance to mechanical shock and
vibration. These significant benefits over conventional lighting explain why, according to a recent study, the average growth rate for the SSL market is expected to be around 200% per year for the next five years.Since LEDs are narrow-band emitters, they must be coupled to an efficient downconverting phosphor in order to achieve the broad emission necessary for the generation of white light. However, even for a perfect phosphor, high efficiency will not be achievable unless there is also efficient out-coupling of radiation from the LED into the phosphor and from the phosphor to air. The resulting losses associated with outcoupling are due to the difference in refractive indices (n) of adjacent material layers that cause Fresnel Reflections and total internal reflection (TIR). In Phase I the research team has developed unique material structures and electrophoretic (EP) deposition process that are expected to realize high out-coupling efficiencies from LEDs at low costs. During Phase I, the feasibility of the EP deposition process has been successfully demonstrated and the advantage of an index-matching structure has been shown to significantly (~50%) improve the light extraction efficiency in LEDs. This fact was demonstrated both experimentally and theoretically using ray tracing simulations. In Phase II the work will focus on refining these structures for blue/UV LED's to develop the efficient down- converting technology for enabling the new solid state lighting systems.

Commercially if SSL technology can achieve this projected goal, the lighting industry would be revolutionized. Potentially an efficiency of 200lm/W is possible, more than 2X better than that of fluorescent lamps (80lm/W), and more than 10X better than that of incandescent lamps (15lm/W). If current lighting, with an aggregate efficiency of roughly 50lm/W (in between the efficiencies of fluorescent and incandescent lamps), were replaced by semiconductor lighting with an aggregate efficiency of 150lm/W (somewhat less than the target), then the electricity currently used for illumination would decrease by a factor of three, from 2,350TWh to 780TWh. This would represent a decrease in global electricity use of 13%, and a decrease in global energy use and associated carbon emissions of 2.3%. In the U.S., the potential reduction in electricity consumption due to lighting is expected to be as high as 50% by the year 2025

Title: SBIR Phase II: Development of High Performance Ultraviolet Single Photon Detectors

Award Number: 0521973
Program Manager: Juan E. Figueroa

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $500,000

Investigator: Petre Alexandrov, unitedsic@unitedsic.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to carry out the major R&D work to fully develop a 4H-SiC Single Photon Avalanche Detectors (SPADs) capable of ultra-sensitive and reliable room temperature single photon counting in the ultraviolet (UV) range with high efficiency for a wide range of applications. Existing commercial semiconductor UV avalanche photo detectors (APDs) suffer from high-dark count due to the fundamental material limitation. Unlike other wide band gap semiconductors, 4H-SiC has intrinsically more than an order of magnitude disparity in the electron and hole impact ionization coefficients, making it ideally suited for APDs and SPADs which require, as a key performance parameter, ultra low excess noise. The major research efforts will be focused on the novel design of the 4H-SiC SPADs and the development of the processing technology to manufacture the SPADs in both single element and in linear array forms. The goals are to achieve drastically improved dark count rate, quantum efficiency, and photon counting rate in comparison to the results achieved in Phase I.

Success of the project will have significant impact to the scientific understanding of cryptography for secure UV free-space communication, of fundamental quantum mechanics of single photon-molecular interaction, and of astronomy and space exploration. The results of the project are expected to lead to commercial products including hand-held or field-portable compact UV analyzers with single-molecule unmatched sensitivity, UV spectroscopy and fluorescence systems for pharmaceutical /drug development, and biowarfare agent detection. Ultra-sensitive UV and Deep UV detectors will find immediate applications in both civilian and defense industries for radar and missile detection systems, for scientific and measurement instruments and OEM, for non-invasive underground oil and mine detection and profiling, for safety protection industry (food protection, utility and power system protection/electrical arc detection, engine and fire/flame sensing and control) and for UV imaging/UV camera as well as radiative and space applications

Title: SBIR Phase II: Vertical Electroabsorptive Modulated Laser (EML) Source for High-Speed Interconnects

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| Award Number: | 0450619 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | June 15, 2005 |
| Expires: | May 31, 2007 |
| Total Amount: | $428,440 |


Investigator: Majid Riaziat, mriaziat@oepic.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to fabricate and commercialize a Vertical Electro-absorptive Modulated Laser (V-EML) for high-speed (up to 40Gbps) optical interconnects for chip-to-chip, board-to-board, and intra-rack optical applications. Compared to current electrical data buses using copper interconnects or conventional fiber optic links, the V-EML will enable the fabrication of higher speed, lower cost, lower power consumption and smaller optical transmitters for multi-channel fiber optic data buses in computer and communication networks. This technology virtually removes the modulation speed limit of VCSEL optical transmitters. At the same time it maintains high channel density at low cost. The low power consumption of the V-EML (~20 mW) and its potential low cost in volume (~$1.0) will provide a solution to the interconnect speed and power barriers in multiprocessor computers and servers. An array spacing of 50 to 100 microns will be possible with V-EMLs. This means that an 8x8 array with 2.5 Tbps of capacity has less than 1.0 mm2 of footprint. This offers substantial space savings over the existing copper interconnect technology and creates another strong incentive for transition.

This technology could provide societal benefits from the commercialization of this technology by enabling faster and more widespread deployment of broadband services. The potential for ultra-fast delivery of audiovisual information is enormous as the V-EML technology helps to remove data-com bottlenecks. Educational and scientific benefits of the V-EML development arise in the area of supercomputers with sufficient computing power for complex scientific simulations. Applications include climate modeling for better predictions, molecular level modeling such as protein folding in medicine, ecosystem modeling in agriculture, and large-scale analysis of business information and economic statistics. These computers could then operate much faster and much more efficiently when interconnect speed limits are increased.

Title: SBIR Phase II: Wavelength-Division-Multiplexed Surface-Emitting Lasers with Two-Dimensional Photonic Lattice Outcouplers

Award Number: 0450560
Program Manager: Juan E. Figueroa

Start Date: February 15, 2005
Expires: January 31, 2007
Total Amount: $498,766

Investigator: Nuditha Amarasinghe, vamarasinghe@photodigm.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II Project proposes to develop a commercially viable monolithic Wavelength Division Multiplexed (WDM) two-wavelength Grating-Outcoupled Surface-Emitting semiconductor (GSE) laser emitting near 1310 nm. Phase I demonstrated the concept of WDM GSE lasers in a cross-grating configuration emitting two wavelengths separated by 9 nm from a common two-dimensional photonic lattice (2D-PL) aperture that can be efficiently coupled to multi- and single-mode fiber. A low-cost package that can couple 2, 4 and 8 independent wavelengths from one or more 2D-PL GSE lasers directly to a single fiber without multiplexers will also be developed on this program. The knowledge required to develop these lasers requires expertise in materials, optics, gratings, nanostructures, semiconductor processing, thermal transfer, high-speed electronics, packaging, systems and telecommunications. Combining the desirable traits of both edge emitting lasers (high power, reliable material, low voltage, use of proven) and vertical cavity surface-emitting lasers (low cost, wafer level testing, simple packaging, high integration ability), the advanced research proposed is an innovative photonics technology that has broad applications in telecommunications, information processing, data communications, fiber to the business and home, scientific and medical instrumentation, and computations.

A broader impact of this project is the realization of very high data rates at very low cost, and the elimination of barriers to deploying fiber to the desktop and to (or closer to) the home, enabling ultra high bandwidth connections for business, distance learning, entertainment, and computing. Each wavelength of the 2D-PL GSE laser can presently be modulated at 3.125 Gbps and has the potential for 10 Gbps, enabling data rates of 6.25 to 80 Gbps over a single fiber from a single transmitter package. This research effort will provide an enhanced educational experience for students working on this project. Students will gain an increased understanding of materials, optics, gratings, nanostructures, semiconductor processing, thermal transfer, packaging, electronics, and telecommunications through both experimental and theoretical work.

Title: SBIR Phase II: Photonic Crystal Coherent Thermal Emission for Sensors

Award Number: 0450397
Program Manager: Juan E. Figueroa

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $495,949

Investigator: Irina Puscasu, ipuscasu@ion-optics.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to fabricate a photonic crystal, thermal mid-IR source with low divergence and low dispersion at about 0.1% the cost of competing technologies.
Phase 1 research resolved fine structure of the emission spectrum from 2-D photonic crystals showing that the high intensity, large bandwidth peak had many submodes with strong polarization and angular dependence. In a series of designed experiments the intensity and central wavelength of these submodes were varied with geometrical alterations of the photonic crystal, and theoretically were correlated to surface plasmon resonances. A computer model was developed that matched experimental data. Results imply optimization of photonic crystal structure in Phase 2 could isolate a single sub-mode resulting in very low dispersion, very low divergence emission that could be coherent. The project will support high-end computational research at a university for complex electro-magnetic modeling of photon - surface plasmon interactions. Improved structures predicted by these calculations will be fabricated at an NSF supported nano-fabrication facility. We will examine effects of altered symmetry, periodic defects, and detailed shaping of electrostatic fields.

All existing choices for coherent radiation in the mid-infrared spectral region are too expensive for widespread vapor detection. Examples are wavelength shifting of high power pulsed lasers using non-linear optical effects or quantum cascade lasers (now $5,000 each). The proposed source could sell for less than $10. Additionally, it could significantly reduce the cost of sensitive spectroscopic instrumentation allowing detection of vapors well below 1ppm concentration and application to widespread use as toxic vapor detectors for commercial, residential, and homeland defense applications. Compared to other technology, these detectors are temperature insensitive, rugged, and free of interference effects with zero maintenance and zero drift. This work will contribute towards understanding photon surface plasmon interactions within 2D photonic crystals. The field has huge implications for the microelectronics and optics industry as optical and electronic functions are combined onto single chips for applications to optical computing, communications, etc.

Title: SBIR Phase II: Ultimate Sensitivity Photodetector

Award Number: 0450605
Program Manager: Juan E. Figueroa

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $355,974

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Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a solid state photodetector with ultimate sensitivity and wide dynamic range at room temperature, capable of efficiently seeing signals from a single photon to trillions per second, featuring high speed, zero dead-time, high reliability/reproducibility, solid state robustness/compactness, and a large photosensitive area. The Phase I project proved the practicality of compatibly combining these features, and demonstrated compound semiconductor materials 1000 times quieter electrically than silicon. The project plans to model, design, layout, fab, package, test, and analyze a series of prototypes, resulting in a complete photodetector prototype for detailed evaluation and customer review; and will engage students in for-profit industrial R&D.

This project aims to revolutionize the $10 billion industrial sector for ultra-low-light analytical instruments by obsolescing bulky glass, high voltage, photomultiplier vacuum tubes ($500 million) and microchannel plates ($400 million); improving scientific instruments dependent on them; enabling altogether new instruments; and making new applications of the instruments affordable and accessible.
This product has been sought as the holy grail of photodetection for fifty years. It could make detecting light with ultimate sensitivity so practical, affordable, and ubiquitous that important scientific research and industrial instruments needing to sense extremely low light levels could be microminiaturized to eliminate bulky, thousand volt, multi-thousand dollar, high-voltage vacuum tubes, written operating plans, and the expertise & proven track record of its managers.

Title: SBIR Phase II: Liquid-Crystal Waveguides for Optical Integrated Circuits

Award Number: 0450463
Program Manager: Juan E. Figueroa

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $499,565

Investigator: Mike Anderson, anderson@vescentphotonics.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will reduce mechanical external-cavity diode lasers to a centimeter-sized waveguide chip using a novel giant electro-optic effect. The device, a waveguide external-cavity semiconductor laser (WECSL), will be environmentally robust, compact, entirely electro-optic and capable of continuous, mode-hop-free tuning over 100 nm in fewer than 5 milliseconds. The laser will also exhibit a side-mode-suppression ratio of 40 dB and a (fast) linewidth of ~200 kHz. In Phase II we will demonstrate advanced prototype WECSLs, develop critical manufacturing processes, and perform basic environmental qualifications. We will also conduct research allowing the laser to sweep over a 50 nm band at a rate of 5 kHz.

The low-cost technology platform of WECSLs, and their precision performance specifications could enable laser-based sensors to assume a prominent role in commercial applications. In biophotonics, tunable lasers can replace broadband light sources and enhance the performance of optical coherence tomography instruments that measure the tissue layers in the human retina and the vascular system. Distributed fiber sensing arrays greatly benefit from tunable lasers that probe Bragg sensors spaced along the fiber. Distributed fiber sensors needing low-cost tunable lasers are being developed for chemical and biological sensing, pressure sensing, and vibration, strain and temperature sensing for a wide variety of monitoring applications such as homeland security; civil structures such as buildings, bridges, and dams; oil wells and pipelines; electrical power lines; aircraft and spacecraft; and all-optical shipboard sensing.

Title: SBIR Phase II: Efficient Multi-Spectral Holographic Filters

Award Number: 0450478
Program Manager: Juan E. Figueroa

Start Date: January 15, 2005
Expires: December 31, 2006
Total Amount: $499,190

Investigator: Christophe Moser, moser@ondax.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will commercialize the holographic multi-spectral filter technology developed during the SBIR phase I project. The objective of this project will be the industrial fabrication of holographic multi-spectral filters by using the methods developed and demonstrated during the phase I SBIR research. There is a strong scientific and public push in astronomy to look deeper into the universe to discover and observe fascinating phenomena such as the birth of stars and exo-planets. In observations of celestial bodies from ground telescopes, the signal is faint and surrounded with unwanted optical noise from the atmosphere. The hydroxyl (OH) radicals present in the atmosphere emit light in hundreds of narrow lines that dominate the inter-line sky emission by many orders of magnitude. The multi-spectral rejection filter demonstrated in phase I discriminates the narrow spectral features of the OH emission lines from the atmosphere which increases the image sharpness by increasing the signal to noise ratio.

The narrow band grating filter technology is a core platform that has a scientific and economic impact on ground-based astronomy as well as in laser diode systems. To date $3.8 Billion has been spent deploying and maintaining the Hubble Telescope. An estimated $2.2 Billion is required to see it to its final scheduled retiring date of 2010. It is believed that the introduction of the these multi-line filters combined in some cases with adaptive optics, can boost the performance of ground based telescopes so that they can approach the performance of space telescopes at a price more than 1000 times lower.

Title: SBIR Phase II: Development of Chiral Fiber Polarizer

Award Number: 0450551
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $499,997

Investigator: Dan Neugroschl, dann@chiralphotonics.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new class of in-fiber chiral polarizers based upon chiral fiber gratings. A double helix variation of the effective refractive index will be formed by twisting fibers with a noncircular core as they pass through a miniature oven. These chiral fiber polarizers will be created from specially prepared glass performs in a low-cost, versatile, continuous process, which will not require coherent irradiation of photosensitive glass commonly used to produce fiber Bragg gratings. Chiral polarizers are true fiber devices and do not require any substrates, bulk components, or rigid package. Their pitch profile will be engineered to minimize insertion loss for the passing polarization and maximize the extinction of the orthogonal polarization over a broad spectral range. The design will implement a multi-core optical fiber to match the low numerical aperture of standard fiber with the numerical aperture of the chiral polarizer at its input and output while maintaining a high numerical aperture in the polarizing zone. Chiral polarizers will have broad application in single polarization transmission, polarization mode dispersion compensation, and test and measurement instrumentation. Polarizers are also key elements in sensors relying on optical interference such as gyroscopes and current sensors.

Polarization and frequency selective chiral fibers have applications ranging from telecommunications to sensing. The use of external modulators for high bandwidth fiber telecommunication requires that the incident wave be linearly polarized. This necessitates use of a polarizer since laser sources used in telecommunications generally have random polarization. Further, any use of polarization maintaining fiber requires that polarized light be launched into the fiber. Polarizers are also key components in polarization mode dispersion compensation systems. Since chiral polarizers may be fabricated from refractory or radiation resistive glasses and involve only mechanical deformation of glass they may function in harsh environments with high levels of radiation, high temperature, or corrosive chemicals. The fabrication techniques developed for chiral fiber polarizers will spur the development of other devices based on chiral fiber gratings. These devices, ranging from sensors and filters to in-fiber lasers will become building blocks for a new platform for passive and active in-fiber devices. The understanding of glass behavior under extreme shear stress will push the frontier of glass forming technology and stimulate new applications. Understanding polarization-selective light scattering within the nonresonant band will open the way for new devices based upon microstructured fibers.

Title: SBIR Phase II: Compact, High-Power, Terahertz (THz) Radiation Source

Award Number: 0422057
Program Manager: Murali S. Nair

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $500,000

Investigator: Hans Bluem, hans_bluem@mail.aesys.net
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Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop a tunable, compact, high-power Terahertz (THz) radiation source. The unique discriminator of the source is the projected power level, which is orders of magnitude greater than available semiconductor sources, should enable for the first time both wide field of view (FOV) imaging and high-throughput spectroscopic interrogation from a compact package. The Phase II program will complete the final design of the THz source developed in Phase I and described in the final technical report, fabricate a prototype device and demonstrate its performance at a THz research laboratory. The goal of the project is to demonstrate that the concept can deliver tens of watts of THz power from a device that is sufficiently robust and compact to be transportable and operate in the field. The THz spectral region combines many desirable features for spectroscopic and imaging applications. However, higher-powered, compact sources, such as that here, are needed to deliver practical throughput rates and the signal-to-noise ratio required for many commercial applications.

The major medical imaging applications being developed are the detection of breast and basal cell carcinomas. Pharmaceutical industry applications include drug discovery and quality assurance, DNA analysis and proteomics. In the homeland security and defense arenas, the potential applications include standoff chemical and biological agent and explosive detection. THz systems are finding increasingly widespread use in scientific and University R&D environments for non-destructive evaluation and medical applications.

Title: SBIR Phase II: Integrated Dense Wavelength Division Multiplexing (DWDM) 3D Micro-Opto-Electro-Mechanical Systems (MOEMS) Optical Switch for Dynamically Reconfigurable Network

Award Number: 0422155
Program Manager: Murali S. Nair

Start Date: September 1, 2004
Expires: August 31, 2006
Total Amount: $499,925

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Abstract:

This Small Business Innovative Research (SBIR) Phase II project will integrate Dense Wavelength Division Multiplexing (DWDM) with Micro-electro-mechanical systems (MEMS) optical switching to make the critical network element needed for reconfigurable, transparent, high capacity fiber optic networks. This technological advancement will facilitate the transition from today's point-to-point opaque networks with optical to electrical to optical (OEO) electrical switches to transparent, dynamic all optical networks. The design involves free space optical design, fiber optic design, MEMS design and optical coating design in order to make a wavelength switch which has low loss, low polarization independent loss, low temperature sensitivity, low vibration sensitivity, properly shaped pass bands (flattop with good adjacent channel rejection) and low crosstalk.

The design will be developed, constructed and tested in Phase II, significantly advancing the field of optical switching from where it is today. This integrated wavelength switch should have numerous applications in commercial and government networks. The capacity is huge: 4 fibers with 40 wavelengths each carrying 40 Gbit/s of data results in 6 Terabit/s switching capacity. This allows continued growth in the Internet, and enables a much lower cost solution to higher capacity wavelength services. Continued expansion of access to information requires continued expansion of worldwide core optical networks.

Title: SBIR Phase II: Diode-Pumped, High-Power, Cr:LiSAF-Based Ultrafast Laser and THz Source

Award Number: 0422089
Program Manager: Murali S. Nair

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $499,954

Investigator: Evgueni Slobodtchikov, slobodtchikov@qpeak.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II will develop the ultrafast laser system that could represent a significant advance in the technology of directly diode-pumped, solid state, ultrafast sources. In the initial Phase I effort, a record cw power level (> 2W) from diode-pumped Lasers were demonstrated through the use of an innovative, side-pumped design. In Phase II, this design will be further improved and utilized as the basis for a regenerative amplifier to generate high peak powers. The output of a passively mode-locked, diode-pumped laser should provide the seed pulses for the regenerative amplifier. The overall ultrafast source should be simpler, smaller and ultimately less expensive than present, power-equivalent, sapphire-based ultrafast laser systems. As a demonstration of the utility of the proposed technology, a time-domain terahertz (THz) spectrometer will be constructed, based on an optical-rectification THz source and an electro-optical detector, both driven by the laser system. The directly diode-pumped ultrafast laser represents an enabling technology, allowing ultrafast and THz systems to emerge from the laboratory and into the widespread scientific and industrial applications

The proposed ultrafast laser and THz spectrometer both could have the potential for significant scientific and commercial impact. With the lower cost (on the order of 50%) made possible by the simplicity of design, a wider range of research groups in academia and industry will be able to obtain ultrafast sources and THz instrumentation. The lower cost, simplicity, higher reliability and smaller size of the systems will also greatly expand and accelerate the use of ultrafast lasers and THz radiation in biotechnology, medical imaging, precision micro-machining, industrial process control and security systems.

Title: SBIR Phase II: All-Optical Method to Detect and Diagnose Optical Faults in Advanced Optical Networks

Award Number: 0419104
Program Manager: Murali S. Nair

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $499,226

Investigator: Paul Melman, melmanp@newtonphotonics.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a prototype optical network monitoring system based on the enabling technology demonstrated in Phase I. Optical networks must be continuously supervised to ensure high availability and reliability. Advanced networks will use optical routing for cost savings and provisioning flexibility. This trend obsoletes current optical signal quality monitoring techniques. The proposed system, designed specifically for these advanced networks, utilizes an all-optical, in-channel detection method. It not only monitors performance but also performs on-line diagnosis of optical faults. This system operates in a real network environment including the presence of polarization mode dispersion, a phenomena which has frustrated other monitoring approaches.

This technology is targeted to develop advanced networks that cost 50% less to deploy and maintain than existing systems. This represents an enormous cost savings for telecommunications carriers and ultimately all data communications consumers. The demand for telecommunications bandwidth continues to grow rapidly. The market for optical networking equipment and strong growth is predicted.

Title: SBIR Phase II: The Interfractor - A New Optical Dispersive Component

Award Number: 0420331
Program Manager: Murali S. Nair

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $500,000

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Phone: (781)569-6199

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a new type of optical dispersion element that combines a relief grating with appropriately optimized dielectric films to achieve both high dispersion and high efficiency into one diffraction order, independent of polarization. Grating efficiency is critical for wavelength management in modern fiber-optic telecommunication systems that employ dense wave-division-multiplexing (DWDM) transmission. Dynamic gain equalizers, reconfigurable channel blockers, programmable optical add-drop modules, and wavelength-selective switches all require spatial separation of the wavelengths from an input fiber, typically with a diffraction grating, which is also typically the largest source of insertion loss. Further, because the polarization of the optical signal of any particular wavelength within a fiber may change over time, the net power loss through the device must be independent of polarization. It is very difficult to achieve high grating efficiency in both polarizations. The proposed technology achieves this goal with a proprietary combination of diffractive and thin-film interference effects, and can be fabricated to be robust Over the wide temperature range required of DWDM components

The proposed use of this optical dispersion element will be to improve the insertion loss in Free-space optical wavelength-management products, such as dynamic gain equalizers and Reconfigurable channel blockers, now being deployed in modern fiber-optic telecommunication Systems. This technology will implement in other products to change in its own wavelength-management products as soon as the product can be manufactured.

Title: SBIR Phase II: Low-Voltage Poling of Waveguides in Nonlinear Optical Materials

Award Number: 0349758
Program Manager: Murali S. Nair

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $499,981

Investigator: Philip Battle, battle@advr-inc.com
Company: AdvR, Inc
910 Technology Blvd Suite K
Bozeman, MT 59718
Phone: (406)522-0388

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop the processing steps for the fabrication of highly quality periodically poled waveguides in potassium titanyl phosphate (KTP). Periodically poled waveguides enable highly efficient, quasi-phase matched (QPM), nonlinear optical wavelength conversion of continuous wave and high-peak power quasi- continuous lasers. The fabrication process, established during the Phase I effort, utilizes low-voltage pulses combined with a novel electrode configuration to periodically pole channel waveguides embedded in a KTP chip. The use of standard off-the-shelf KTP channel waveguides will significantly increase yields, allow greater design flexibility, and decrease manufacturing expenses while providing a large QPM conversion efficiency that will enable a range of commercially significant applications. Specific products include the frequency doubling of pulsed and continuous wave infrared diode lasers for use in bio- analytical instrumentation and fluorescent spectroscopy, waveguide-based difference frequency mixing modules for generating tunable, narrow band near-infrared sources for environmental monitoring, spectroscopy at hard-to-reach wavelengths, and all-optical switching in communication networks.

This project should result in efficient frequency doubling of diode lasers, which will Have beneficial impacts in medical, environmental, and scientific applications. In the Medical field, the availability of small, low power consumption, cost-competitive visible Lasers will enable the creation of portable bio-analytical instrumentation (e.g. a bedside flow cytometry system). In the environmental field, small inexpensive spectroscopically useful infrared sources will enable new and improved remote sensing systems. Additionally, the KTP waveguide technology developed in this effort is expected to contribute to advanced research in a variety of fields including ultra short pulse wavelength conversion, development of waveguide optical parametric devices, and the efficient generation of correlated photon pairs for quantum optical studies.

# Robotics

Title: SBIR Phase II: Extended Performance Red VCSELs

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|---|---|
| Award Number: | 0823022 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $485,794 |

Investigator: Mary Brenner, mhibbsbrenner@photonicdevelopment.com
Company: Mytek, LLC
15350 25th Ave N, Suite 110
Plymouth, MN 55447
Phone: (763) 746-8045

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will demonstrate significantly improved output power, temperature range of operation, and reliability of red VCSELs. Commercialization of red VCSEL technology has been plagued by the limited temperature range and output power of the devices and unknown reliability characteristics. The Phase I project demonstrated the 1) feasibility of improving output power and temperature range through a number of techniques, 2) that the fundamental limit of the temperature range is at least as high as 125°C, and 3) dramatically improved reliability. The Phase II approach proposed here breaks away from traditional models for fabricating VCSELs and consists of a variety of growth and fabrication methods allowing us to provide a high thermal conductivity path from the active region to the package. The goals and expected technical results are to demonstrate > 0.5mW single mode, and >1mW multi-mode useful output power at 670nm at 85°C, and the same power output power objectives for 655nm at 65°C on a reproducible basis. This project will also demonstrate greater than 10,000 hours device lifetime at 85°C continuous operation. Project activities consist of design, wafer growth and fabrication, performance testing, and reliability testing. To date, the only commercially available VCSELs have been at 780nm to 850nm, due to the substantial materials challenges at other wavelengths. This proposed effort is applicable to a variety of VCSEL wavelengths (similar thermal issues exist at 1310nm to 1550nm), as well as other optoelectronic devices. Commercially, a significant enhancement in red VCSEL performance can enable the migration of plastic fiber based home and auto networks to higher data rates, faster and higher quality laser printing, longer distance and more precise motion control sensing, new types of portable or wearable medical sensing, and improved robustness and cost of radiography equipment. The success of this project not only creates a significant business opportunity for a red VCSEL supplier, but also enhances the competitiveness of customers by making available a valuable new technology. The reduction in power consumption and improvement in medical technology costs address particularly important societal issues.

Title: SBIR Phase II: High-Speed Atomic Layer Disposition System for Compound Semiconductor Thin Films

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|---|---|
| Award Number: | 0750076 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $499,908 |

Investigator: Prasad Gadgil, pgadgil@atomic-precision.com
Company: Atomic Precision Systems Inc.
301 Rosemont Drive
Santa Clara, CA 95051
Phone: (408) 244-5845

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop a novel high-speed Atomic Layer Deposition technology comprising an ALD reactor and associated thin film processes for GaN thin films required for fabrication of high-brightness Light Emitting Diode (HBLED). The proposed effort is based on successful demonstration of operation of the ALD reactor in phase-I SBIR project at 5x speed of commercially available ALD reactors. The unique ALD reactor concept can process atomically thin films and also micron thick films in one chamber. Furthermore, point-of-use, safer and low-cost generation of chemical precursors combined with low temperature processing promises low defect density thin films of a variety of compound semiconductors including GaN. Low defect density, low cost GaN thin and thick films are building blocks of an HBLED. An HBLED bulb that consumes 15 Watts, lasts 10+ years and costs a few dollars can effectively replace a fluorescent tube consuming 30 Watts and an incandescent bulb consuming 100 Watts. The proposed ALD technology promises to reduce process cost, and improve the HBLED quality critical to realize ultra-large scale production of affordable HBLEDs for worldwide lighting applications leading to 50% potential electricity savings and tremendous associated environmental benefits.

Title: SBIR Phase II: Methodology for Applying Haptic Robotics to Agile Manufacturing

Award Number: 0646448
Program Manager: Muralidharan S. Nair

Start Date: April 1, 2007
Expires: March 31, 2009
Total Amount: $500,000

Investigator: William Townsend, wt@barrett.com
Company: Barrett Technology Inc
625 Mount Auburn St
Cambridge, MA 02138
Phone: (617)252-9000

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project addresses safety, user - interface, and performance challenges uncovered in Phase I while adapting a haptic robot to the manufacturing environment for medium-production-run paint spraying. Haptics is an exciting field, but industry adoption has been slow. Yet without haptics in applications like medium-run paint spraying, the two alternatives (fully automated or fully manual) are unappealing. Robots are prohibitively expensive to program for short runs, and fully manual operations endanger worker health.

The technologically revolutionary haptics field has not yet revolutionized manufacturing. Some manufacturing tasks lack good alternatives, especially in medium run production, where one must choose between high-cost, time-consuming robot programming versus poor worker health. Physical robot-craftsperson interaction will benefit these middle applications, if safe and intuitive.

Title: SBIR Phase II: Robotic Material Removal System

Award Number: 0646438
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Steven Somes, ssomes@adelphia.net
Company: Western Robotics Co
8840 Eagle Road
Willoughby, OH 44094
Phone: (440)256-2004

Abstract:

This Small Business Innovation Research (SBIR) Phase II project explores the innovation of a robot that, like biological creatures, operates by applying and sensing contact forces. Today's position-controlled robots have limited applicability to many manufacturing tasks, especially those related to material removal and surface finishing. Emulating a human's free-hand motion capability greatly advances robot capability. Such a robot could trace part contours to smooth and polish. It could feelfor part edges to discover a part's location, and compare measured geometry to a modeled ideal to detect finishing requirements. The robot could follow finishing strategies, acquiring needed information by touch as it worked.

Applications for force capable robots are ubiquitous across industry. Virtually all parts made from casting, forging, machining, or molding require some degree of surface finishing to arrive at a final desired shape and smoothness. Other prospective applications include: mechanical assembly, sorting and packaging irregular objects, and dual-arm manipulation of heavy and bulky items.

# Semiconductor & Other Materials

Title: STTR Phase II: 3D Lithography of Thick Photopolymers for Imaging and Photonic Crystal Waveguides

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| Award Number: | 0822695 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | August 15, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $499,990 |


Investigator: Jacob Kuykendall, jlkuykendall@zenwa.net
Company: Zenwa Inc
25 Hampshire Street
Sudbury, MA 1776
Phone: (508) 875-3000



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will culminate in a new form of 3D lithography capable of fabricating imaging arrays and photonic-crystal waveguides that are cheaper, higher performance, lighter, more flexible and have capabilities not currently possible with current ?stack and draw? manufacturing. For example, by directly fabricating these parts at the micron scale, perturbations such as global scaling (to implement magnifying arrays), global rotation (to implement image inverters) or local scaling (to implement modal tapers or integrated lenslets) can be created in a single process step. Unlike current methods which must draw out a minimum of km from a preform, here single parts can be cm in length. The imaging arrays have significant commercial potential as replacements for current endoscopes, fiber face plates and image inverters. They also enable new markets including inexpensive eye monitoring for clinical and public safety applications, wearable gaze-tracking for human-computer interface for paralysis victims, and ultra lightweight heads-up displays for military and consumer entertainment. The team will develop both the lithography and materials to create these all-polymer imaging cables.   The transport and manipulation of optical images is ubiquitous but nearly uniformly implemented with delicate, rigid lens trains. Discrete imaging devices such as fiber bundles are sufficient for modern digital displays and cameras and are naturally robust, but currently limited by cost and capability. By enabling flexible, lightweight transport of discrete images, the results will impact ? Education, Medical and Biological Research and Macular Degeneration. The Phase I including supplementary funding has partially funded 7graduate, 1 post-doc and two undergraduate students. An exchange of graduate students with Dublin Ireland extended this impact. The lithography system has been used in multiple undergraduate class projects and for multiple cross-disciplinary graduate research programs. Disposable endoscopes with high resolution, small diameter and large field of view exceed current capabilities at much lower costs.  Zenwa has signed a collaborative agreement with the Smith-Kettlewell Eye Research Institute to develop a lightweight customized image delivery system to restore sight to the severely vision impaired.

Title: SBIR Phase II: VLSI Clocking Using BDS Technology

Award Number: 0822830
Program Manager: Muralidharan S. Nair

Start Date: August 1, 2008
Expires: July 31, 2010
Total Amount: $499,989

Investigator: Mihai Banu, mihaibanu@ieee.org
Company: MHI Consulting LLC
22 Sulfrian Road
New Providence, NJ 7974
Phone: (908) 464-6893

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project intends to demonstrate a unique circuit method for GHz clock distribution inside CMOS chips, which provides state-of-the-art performance and is modular, scalable, and reusable. The theoretical foundation of this technology is the Bi-Directional Signaling (BDS) principle implemented over on-chip transmission lines. The project covers the design, fabrication, and evaluation of a comprehensive test chip aimed at validating key aspects of this new method such as the practical accuracy of a long distribution system, the realization of inexpensive high-quality integrated transmission lines, and the design of low power high precision active circuits for local clock generation. If laboratory tests confirm the expected performance and features, this method will be the basis of a valuable new VLSI Very Large Scale Integration (VLSI) technology. The demonstration of scalable and reusable circuit Intellectual Property (IP) for clock distribution will cause a major simplification in the VLSI design methodology with substantial benefits to the manufacturers of integrated circuits. The semiconductor industry will be able to produce faster processing, lower power, and lower cost VLSI components for systems such as computers and communication devices.

Title: SBIR Phase II: Novel Deposition of Silicon Carbide Boules

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|---|---|
| Award Number: | 0750064 |
| Program Manager: | William Haines |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $522,000 |


Investigator: Joshua Robbins, josh.robbins@sicsystems.com
Company: SiC Systems, Inc.
400 Corporate Circle, Unit B
Golden, CO 80401
Phone: (303) 216-2656



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel processing technique to form silicon carbide (SiC) boules for wafer production. The technique uses high-purity gas precursors and has the potential to economically produce large diameter SiC boules with low contamination levels and reduced defect levels. In this project, SiC boule growth using gas-phase precursors will be developed for commercialization of 150 mm SiC wafers. SiC is a wide bandgap compound semiconductor with high thermal conductivity, high breakdown electric field strength, thermal stability and chemical inertness. SiC-based electronics are of great interest because they can significantly outperform conventional semiconductors under high-temperature, high-power, high-radiation, and corrosive conditions. Potential products based on SiC include engine control eletronics, turbine engine sensors, power switching devices, microwave electronics, and many others.

Title: STTR Phase II: Germyl Silanes - Enabling Precursors for Chemical Vapor Deposition of Advanced CMOS Substrates, CMOS-Integrated MEMS, and Nano-Scale Quantum-Dot Silicon Phot

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| Award Number: | 0750479 |
| Program Manager: | William Haines |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $481,557 |

Investigator: Matthew Stephens, mstephens@voltaix.com
Company: Voltaix, Inc
197 Meister Avenue
North Branch, NJ 8876
Phone: (908) 231-9060

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will demonstrate pilot scale manufacture of germyl silane precursors and their use to create prototype semiconductor devices and thin films under low temperature and selective growth processing conditions. The project addresses a critical need for precursors and processes that deposit such films under low temperature conditions with throughput rates that are significantly higher than those offered by existing processes. The potential market for devices made with these technologies is predicted to exceed several billion dollars per year and exhibit double-digit growth rates over the next five years. Ge-rich SiGe films will enable higher clock speeds in microprocessors, lower power consumption in cell phones, silicon-based photonics, and more efficient solar cells.

Title: SBIR Phase II: Ultra High Thermal Conductivity Aluminum/Graphite Composites from Low Cost Natural Graphite

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|---|---|
| Award Number: | 0750180 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | February 1, 2008 |
| Expires: | January 31, 2010 |
| Total Amount: | $499,994 |

Investigator: James Cornie, jcornie@mmccinc.com
Company: Metal Matrix Cast Composites, LLC
101 Clematis Avenue
Waltham, MA 2453
Phone: (781) 893-4449

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop and present for commercialization natural graphite (NG) reinforced Al (AlGr). In this project, inexpensive natural graphite flake (NGF) will be manufactured into a preform and pressure infiltrated with Al-Si alloys to form composites with thermal conductivities (TC) from 600 W/mK to 750 W/mK and corresponding thermal expansion (CTE) from 7 to 4 ppm/K. CTE is specified by controlling volume fraction of NGF. TC is 1.5 to 1.9 times oxygen free high conductivity (OFHC) Cu at 25% of the mass and comparable volumetric cost to Cu with customized CTE enabling thermally efficient direct die attach. High TC results from reaction of Si from the alloy with NGF surfaces to form low thermal impedance SiC interface. These properties result from innovative preform architecture. In addition, quasi-isotropic TC values (~700 W/mK) are achievable through further preform design. For every 10C decrease in operating temperature, the life of an electronic device is doubled. Conversely, more efficient cooling schemes enable devices to be manufactured with higher performance at higher power densities and in smaller spaces. The materials developed in this project would enable such performance enhancements, and at lower cooling costs. The proposed technology would reduce the dependence on copper for electronic thermal management applications and would find serious application in space and military radar and communication systems as well as laser diode heatsinks, heat spreaders for notebook computers and other consumer electronics.

Title: SBIR Phase II: Diffractive Electrode Structure for on Chip Embedded Passive Components.

Award Number: 0724467
Program Manager: William Haines

Start Date: October 1, 2007
Expires: September 30, 2009
Total Amount: $499,027

Investigator: Ronald Kubacki, kubacki@ionic.com
Company: Ionic Systems Inc
2161 Otoole Ave Ste H
San Jose, CA 95131
Phone: (408)435-2680

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a method for tuning the capacitance of on-chip capacitors. The Phase I effort demonstrated an optical diffractive electrical electrode structure that permits the penetration of deep ultra-violet (DUV) radiation into an underlying dielectric. This was used to precisely tune dielectric constant and capacitance. The DUV radiation incites a photochemical reaction altering the dielectric constant of the spacer material in the capacitor.

This project, if successful, will enable compact, precision capacitors embedded on chip to replace external discrete capacitors in electrical circuits. Moving passive components on chip in the same fabrication process is a reduction of manufacturing effort. By precisely trimming electrical values with resistor trimming equipment a significant simplification of the manufacturing process may be achieved. The successful results of Phase II will result in the demonstration of a molecularly engineered nanocomposite for use in millimeter and micro wave monolithic integrated circuits that can be photo-optically tuned for precise value to embed precision capacitors on chip. Incorporation of this technology can result in reduced size and cost for a wide variety of high frequency applications.

Title: SBIR Phase II: New N-Type Polymers for Organic Photovoltaics and other Electronic Devices

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| Award Number: | 0724875 |
| Program Manager: | William Haines |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Silvia Luebben, silvia@tda.com
Company: TDA Research, Inc
12345 W 52nd Ave
Wheat Ridge, CO 80033
Phone: (303)940-2301

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a new family of n-type conjugated semiconducting polymers for use in plastic photovoltaics and other organic electronic devices. New n-type semiconducting polymers with good solubility, environmental stability, and high charge carrier mobility are needed to fabricate efficient organic solar cells and other electronic devices. During the Phase I project several n-type semiconducting polymers were fabricated via simple reactions. In Phase II the polymers will be optimized to improve their solubility and charge mobility. Partnership with a major developer of organic photovoltaics will allow the materials to be optimized for use in organic solar cells.

The further development of these n-type semiconducting polymers will result in the manufacture and sale of these materials as specialty chemicals to the organic electronic industry for the fabrication of a variety of organic devices including photovoltaic devices, thin film transistors, organic light emitting diodes, and others. The novelty of this chemistry over the chemistry of current n-type organic semiconductors has the potential for significant academic and scientific value and could lead to a cascade of new discoveries and technology advancements, in addition to the primary objective of creating a new business.

Title: SBIR Phase II: Ultra Low Cost, p-i-n OLED Lamps for Specialty Lighting

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| Award Number: | 0724204 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | July 15, 2007 |
| Expires: | June 30, 2009 |
| Total Amount: | $497,242 |

Investigator: Melissa Kreger, melissak@add-vision.com
Company: Add-vision
1600 Green Hills Rd. Suite #100
Scotts Valley, CA 95066
Phone: (831)438-8192

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will analyze the limiting factors in performance and commercialization obtained through printed polymer organic light emitting diode (P-OLED) research and development as well as customer engagement. Utilizing this basis, a set of materials, device and process development tasks have been devised. These include continued lifetime improvements and development of an encapsulation process. During Phase-I, the impact of light-emitting layer morphology and cathode interactions on device performance was identified. This has allowed a prioritization of these issues for final development. Technical objectives include exceeding the commercialization threshold and achieving greater than 1000 hour product lifetimes with a flexible encapsulation process adaptable to small and large scale manufacture. This includes advanced light-emitting polymers (LEP) formulations, cathode development, and device structure optimization to meet performance milestones along with encapsulation adhesive, getter materials and lamination process trials and optimization.

If successful the outcome of this project includes benefits for mobile electronic product designers and consumers using low cost and low energy manufacturing in the U.S. display and lighting industries. Furthermore, the science and engineering work compliments R&D efforts in related materials technologies. The proposed technology is uniquely attractive among OLED lighting technologies currently under development in that it allows for low manufacturing set-up and operating expenses, and therefore early commercial adoption. Because of this cost structure, which is radically different from conventional, high capital, glass-based OLED processing, there is a significant early commercialization opportunity in mobile backlighting products and other specialty lighting applications. In these product areas, the proposed technology''s voltage, brightness, DC drive, and form factor makes it preferable to existing inorganic approaches. The low capital cost structure and dependence on advanced materials technology also provides opportunities for distributed manufacture in the U.S. away from the centralized Far East display manufacturing base. Outside of the organic display and lighting industries, this research would enhance the scientific understanding for other emerging printable and organic electronics technologies including organic photovoltaics, thin film transistors and memory, where low cost manufacturing of high-efficiency devices are paramount for commercial success.

Title: SBIR Phase II:  Thick Film Garnet Materials for In-Plane Propagation Magnetooptic Devices

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| Award Number: | 0646272 |
| Program Manager: | William Haines |
| Start Date: | April 1, 2007 |
| Expires: | March 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Vincent Fratello, vjfratello@integratedphotonics.com
Company: IPI
2920 Commerce Blvd
Birmingham, AL 35210
Phone: (908)281-8000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the device and market opportunity for in-plane propagation of light in-planar anisotropy magnetic garnet films for high sensitivity, high speed magneto-optic sensors, switches and modulators. Traditional perpendicular propagation devices require perpendicular magnetic fields and magnetization processes. These are limited in speed and sensitivity by the current materials and the energy required to magnetize the garnet in the perpendicular direction. In the plane of the film, there is almost no energetic barrier to domain rotation. In this project, Integrated Photonics, Inc. (IPI) proposes to reduce that barrier to near zero to make devices of unprecedented sensitivity and speed. The goal is to attain pico-tesla field sensitivities in sensors and gigahertz device frequencies. The latter will enable small, low-power magneto-optic light modulators that are truly a disruptive technology by comparison to current large dimension electro-optic technologies. In Phase I, a materials growth and characterization capability was established and limitations on speed and sensitivity were removed by optimizing material parameters. In Phase II the process will be optimized to achieve the highest optical quality for commercial devices and sensor, switch and modulator devices will be realized in collaboration with customer-partners.

Commercially, in-plane propagation in planar thick film Faraday rotators would enable unique new devices. High speed magneto-optic modulators open the door to system integration architecture for wideband communications and software defined radios. In-plane propagation materials have much higher switching speeds than conventional perpendicular Faraday rotators and as such would permit a magneto-optical approach to packet switching. Reduced costs would permit wide deployment in FTTP. High speed, low field magneto-optic switches are attractive for military applications.  In-plane propagation magnetic field sensors can be optimized to give unprecedented high sensitivity speeds much higher than can be attained with conventional perpendicular propagation. These sensors would have applications such as wheel and turbine rotation, electric power distribution, monitoring, metering and control and battlefield sensors. The electric power application in particular has potential to revolutionize catastrophic failure prevention in the power grid and reduce power costs at a variety of levels by enabling autonomous reconfiguration. The lack of electrical connectors in fiber optic sensors for explosive, flammable and high voltage environments represents a significant improvement in safety. Smart ships and buildings would find utility both for conservation and efficiency.

Title: STTR Phase II: Improved Boron Nitride Materials for Enhanced Thermal Management

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| Award Number: | 0646556 |
| Program Manager: | William Haines |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $500,000 |

Investigator: John Ferguson, john.ferguson@aldnanosolutions.com
Company: ALD NanoSolutions, Inc.
580 Burbank St, Unit 100
Broomfield, CO 80020
Phone: (303)318-4145

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project builds upon the successful Phase I results to develop surface modified boron nitride (BN) filler materials for electronic thermal management applications. Novel Atomic Layer Deposition (ALD) nanocoating is used to selectively functionalize edges only or edges/basal planes to improve wetting of BN platelets with resin encapsulants. The improved wetting allows for reduced viscosity of BN/resin mixtures during processing so that increased BN filler particle loadings can be achieved, resulting in higher thermal conductivity electronic packages. These improvements are best realized using an ultra-thin (nm thick), conformal, pin-hole free, chemically bonded silica nanofilm selectively placed on the edges of primary BN platelets. Coating the edges of platelets only provides for a low cost impact since edges being nanocoated represent less than 10% of the available platelet surface area. Higher BN loadings in filled composites allow for improved heat dissipation in electronic packaging materials, particularly in the case of glob top coatings and potting compounds. Proposed Phase II R&D is focused on working with potential customers to develop applications of particle ALD surface modified BN fillers for their specific moulding compound systems. Film chemistry and thickness will be developed for their specific applications.

Commercially, the ALD nanocoating of individual ultrafine particles to control their surface chemistry is enabling technology that is unparalleled compared to more conventional CVD, PVD, PE-CVD, or wet chemistry solution processing. The process allows for individual ultra-fine particles to be nanocoated, rather than coating aggregates of ultra-fine particles. It is independent of line of sight and provides for chemically bonded films to the substrate particle surface. It is easily scalable. It is a forgiving process where the nanocoating thickness is controlled by self-limiting surface reactions (not flux, temperature, or time of processing like CVD, etc.). ALD films are pin-hole free and conformal. The potential impact of successful large scale processing extends far beyond this proposed microelectronics packaging application. It is now possible to produce ultrafine particles with designed electrical, magnetic, optical, mechanical, rheological, or other properties. Markets for such functionalized ultra-fine powders include microelectronics, defense, hardmetals, cosmetics, drug delivery, energetic materials, and polymer/ceramic nanocomposites, among others.

Title: SBIR Phase II: A New Production Method for Ta Fibers for Use in Electrolytic Capacitors with Improved Performance and Packaging Options

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| Award Number: | 0646417 |
| Program Manager: | William Haines |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $500,000 |


Investigator: William Nachtrab, wnachtrab@supercon-wire.com
Company: Supercon Inc
830 Boston Tpke
Shrewsbury, MA 01545
Phone: (508)842-0174



Abstract:

This Small Business Innovative Research (SBIR) Phase II project is intended to develop a new process for manufacturing tantalum (Ta) metal fibers for use in producing tantalum capacitors, and advance this process to the stage of commercialization. This technology, which has been demonstrated in Phase I, could lead to capacitor products having higher performance and greater volumetric efficiency than any currently available. The use of fibers in place of metal powder allows the production of thin anode bodies leading to improved packing options and component performance. The innovation underlying the technology is bundle drawing of Ta filaments in a copper matrix. A composite consisting of Ta filaments in a copper matrix is drawn is a series of reduction steps until the filaments are less than about 10 microns in diameter. The drawn wire is rolled to produce ribbon-type filaments that are 1 micron or less in thickness. The copper composite matrix is chemically dissolved without attacking the Ta to produce metallic Ta high surface area, ribbon-fibers. The fibers are formed into thin mats, which are sintered to produce porous metal strips from which high surface area capacitor anodes are made. A significant aspect of this approach is that fiber morphology can be varied over a wide of fiber thicknesses unlike powder. This allows the morphology of the fibers to be optimized for the particular voltage rating and use requirements in order to maximize the performance of the capacitor.

Commercially, nearly all medical, automotive, military and many consumer electronic devices utilize Ta electrolytic capacitors due to their outstanding performance, reliability and volumetric efficiency. Solid electrolytic capacitors are currently made from Ta metal powder. Several million pounds per year of Ta powder are consumed in manufacturing Ta capacitors for these applications. The trend in electronics is toward high powder
components and increased miniaturization. Combined with the need to lower materials
and manufacturing costs, these considerations have created an opportunity for new
method of producing solid electrolytic capacitors. Fiber metal technology has the potential to both lower manufacturing costs, improve capacitor performance, and improve
packaging options, which could enable the development of new product that are either
currently very difficult or very expensive to make using current technology base on metal powder.

Title: SBIR Phase II: A Novel Microwave Technique for Rapid Thermal Processing of Silicon Carbide Wide Bandgap Semiconductor

Award Number: 0646184
Program Manager: William Haines

Start Date: March 1, 2007
Expires: February 28, 2009
Total Amount: $500,000

Investigator: Yonglai Tian, ytian@cox.net
Company: LTT
3819 Charles Stewart Drive
Fairfax, VA 22033
Phone: (703)620-0963

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a unique solid-state microwave technique capable of reaching ultra-high temperature (up to 2150 deg C) and ultra-fast thermal processing of large wide band gap semiconductor wafers. It is widely recognized that the existing post-implant anneal process is a bottleneck limiting the performance and reliability of wide band gap semiconductor devices. This technique lowers the sheet resistance and surface roughness of the implanted semiconductor, enabling the fabrication of higher performance, more power efficient devices at lower cost. As part of the Phase I research, the microwave annealed samples showed a record low sheet resistance and surface roughness in both p-type and n-type implanted SiC. The Phase II research is to extend microwave-based rapid thermal processing (RTP) to other wide band gap materials such as GaN and to allow for RTP of larger sized wafers. The prototype system will be upgraded from a single-heating-head system to a system with an array of multiple heads and multiple sensors. Computer-based automated control will be developed to regulate wafer temperatures uniformity and stability. The research is anticipated to show feasibility of microwave-based RTP in commercial use for large SiC wafers. The technology improves post-implant anneal process to minimize sheet resistance and surface roughness of SiC and GaN, which consequently reduces the device power consumption and lowers the thermal budget. Lower surface roughness improves SiC sub-micron device reliability, consequently improving yield and reducing manufacturing cost.

Commercially, this is an enabler technology that will make better and lower-cost compound semiconductor devices in areas such as power devices, light emitting diodes (LEDs), high temperature and high frequency electronics. The societal and commercial impact of the technology can be enormous. LED technology, for example, can potentially reduce the percentage of energy required for lighting in the U.S. from 22% to 7%, saving $17 billion per year and reduce CO2 emissions by 155 million tons. Manufacturers of LED devices are looking for enabler technologies such as RTP to reach this goal. Recognizing the technological and the commercial significance of the research, Cree, GE Research and ARL are supporting the research effort by providing the technological expertise, test wafers, access to equipment, and other in-kind services.
<br>Furthermore, the technology can be extended to other applications such as RTP of ultra-shallow junction for nano-scale CMOS devices, wafer bonding, MEMS as well as processing of SiC nano-materials.

Title: SBIR Phase II: Germanium Liquid Crystals for Perfect Displays

| | |
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| Award Number: | 0522304 |
| Program Manager: | James Rudd |
| Start Date: | December 13, 2005 |
| Expires: | October 31, 2007 |
| Total Amount: | $400,000 |

Investigator: Michael Wand, mdwand@gmail.com
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Longmont, CO 80503
Phone: (303)772-2191

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop germanium-containing ferroelectric liquid crystals (Ge-FLC's), a fundamentally new class of LC materials that enable migration of microdisplays into camera and automotive applications with billion-dollar available display markets. Ge-FLC mesogens synthesized during Phase I demonstrated breakthrough layer shrinkage properties that will solve the longstanding bistability problem in FLC's, thereby raising the achievable brightness of FLC-based projection displays to commercially viable levels. Phase II research tasks include: (1) the synthesis and characterization of a library of approximately 100 new Ge-FLC compounds, (2) the formulation from this library of FLC mixtures engineered for three specific approaches to bistable switching, and (3) development of alignment layers conforming to the device physics requirements of the three bistable approaches. These tasks support the overall project objective of demonstrating robust engineering-prototype bistable FLC devices with characteristics appropriate for commercial microdisplay products.

Commercially, the project furthers the emerging technology of silicon-based microdisplays with very large potential commercial impact. The company's previous success commercializing SBIR-funded technology into a rapidly-growing $40-million business provides a foundation for growth into billion-dollar markets for camera and automotive microdisplays enabled by the Phase II innovation. Success in these markets will generate outstanding returns for the company's shareholders, and will provide higher-performing, lower-cost electronic cameras and safer and more convenient automobiles to U.S. consumers.

Title: SBIR Phase II: Integration of Advanced Power Electronics through the Packaging of High Temperature Silicon-Carbide (SiC) Based Multichip Power Modules (MCPMs)

Award Number: 0522272
Program Manager: T. James Rudd

Start Date: August 1, 2005
Expires: July 31, 2007
Total Amount: $441,918

Investigator: Alexander Lostetter, alostet@apei.net
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Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop highly miniaturized power converters by developing a functional, scaled-down hardware prototype of a high-temperature multichip power module (MCPM). To achieve this goal, the company has taken advantages of the key benefits of silicon carbide (SiC) semiconductors which include high-temperature operation, high switching frequencies, low switching losses, and high power densities. While Phase I of the project was focused upon successfully proving the feasibility of high-temperature MCPM's, Phase II will be focused on developing full prototype modules. The Phase II project will further develop high-temperature packaging techniques and investigate long term reliability issues associated with high-temperature operation. At the conclusion of Phase II, the company will deliver two high-temperature MCPM modules. The first prototype delivery will be a fully functional 4-hp 3-phase motor drive MCPM capable of 250 degrees C operation, and the second prototype will be a 30 kW 3-phase motor drive that demonstrates an order of magnitude miniaturization over modern state-of-the-art silicon based systems. Since current silicon electronics are typically limited to approximately 150 degrees C maximum temperature of operation, the high-temperature research proposed in this project has the potential to greatly enhance scientific understanding of high-temperature failure mechanisms, thermal induced electronic packaging stresses, and long-term interconnect reliability issues, in addition to technical advancement of state-of-the-art power electronics systems.

The commercialization of SiC based MCPM's has the potential to find benefit in nearly every electric motor drive, power supply, or power converter conceivable. The application of such MCPM's could save electrical energy consumption worldwide, due to the improved electrical efficiency of SiC power switches alone. Furthermore, an immediate commercialization application is possible in the development of high-temperature geological petroleum exploration instrumentation and also in industrial motors. Other long term benefits would be found with application to complex weight critical power systems (such as in spacecraft), high-temperature systems (such as fuel cell electronics or electric vehicle motors), and other high efficiency power systems.

Title: SBIR Phase II: Miniature Cooling System for Laptop Computers

Award Number: 0522126
Program Manager: T. James Rudd

Start Date: August 1, 2005
Expires: July 31, 2007
Total Amount: $500,000

Investigator: Daniel Schlitz, dschlitz@bellsouth.net
Company: Thorrn Micro Technologies, Inc.
2345-2 Yeager Road
West Lafayette IN, 47906
Phone: (770)931-8528

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a compact, light-weight and noiseless cooling system for laptop computers. The product will be an air cooled, micro-channel heat sink with an electro-hydrodynamic (EHD) pump integrated within the channels. Research will focus on the development of a heat sink with a large parallel array of micro-channels to provide optimal thermal resistance. The second major area of development will be the EHD air flow device; a modification to the corona wind technique will be used to provide air flow through the heat sink. Other tasks include power supply development, system integration, manufacturing process development and reliability improvement. As the speed and performance of laptop computers increases, the power density in the microprocessors rises and they dissipate more heat. The proposed project addresses the fact that laptop computer cooling systems will be required to dissipate upwards of 40 Watts while maintaining the microprocessor below 85 degrees C.

Commercially, the proposed cooling system is being developed for the growing laptop computing market. More than 235 million personal computers will be sold in 2007; roughly one-third of which or about 80 million will be laptop computers. The proposed product's small size and excellent heat dissipation capabilities will enable laptop computer manufacturers to incorporate faster processors while simultaneously reducing the overall size and weight of their products. Besides cooling applications, electro-hydrodynamic pumping technology can be used as a means of providing precise control of small amounts of liquid. This has application as an insulin delivery mechanism for diabetics and in the so-called laboratory-on-a-chip.

Title: SBIR Phase II: Iptymer Low-k Dielectric Materials

Award Number: 0450507
Program Manager: T. James Rudd

Start Date: April 15, 2005
Expires: March 31, 2007
Total Amount: $500,000

Investigator: Lawrence Hancock, lhancock@nomadics.com
Company: Nomadics, Inc
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Phone: (405)372-9535

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop and introduce new low-dielectric constant polymers as a new dielectric material for the fabrication of interconnect systems in integrated circuits. The continuing drive for denser integrated circuits and faster interconnects requires the development of new interlayer dielectric materials. The proposed materials rely on newly defined, so called Iptymer molecular design concepts, to create intrinsic free volume within the material. This approach is distinctly different than the current methods under investigation that introduce extrinsic pores into a material to lower its dielectric constant. The standout thermal stability, mechanical strength, and processability of Iptymer materials will enable facile integration into semiconductor fabrication processes. The research objectives of the Phase II program will introduce and supply Iptymer materials into semiconductor fabrication process development programs. This effort builds on Phase I results that demonstrated scaled synthesis of key Iptymer monomers and polymers and validated the dielectric performance, mechanical strength and processability of Iptymer polymers. The Phase II program will demonstrate pilot production of Iptymer materials that possess a dielectric constant less than 2.0 and have superior mechanical and thermal integrity. In addition integration of Iptymers in semiconductor fabrication processes will be demonstrated.

Commercially, the impact of reliable low-k dielectric materials is considerable. Higher bandwidth processing and communication for the same cost will be possible with improved materials. Present day microprocessors have a range of clock speeds determined from post-fabrication testing. Superior low-dielectric materials will not only increase the ultimate clock speeds, but will also improve the yield of the highest speed devices. Every country, economic group, and industry will benefit from such advances. The societal benefits realized through the extension of electronic tools into areas where their use is now impractical or not affordable will be tremendous. Widespread availability of computers throughout primary and secondary education will reap tremendous gains in education.

Title: SBIR Phase II: Lead-Free Solder Process

Award Number: 0450408
Program Manager: T. James Rudd

Start Date: April 15, 2005
Expires: March 31, 2007
Total Amount: $501,925

Investigator: Holly Garich, hollygarich@faradaytechnology.com
Company: Faraday Technology, Inc
315 Huls
Clayton OH, 45315
Phone: (937)836-7749

Abstract:

This Small Business Innovation Research Project (SBIR) Phase II project will advance the development of an electrochemical process, addressing the need for elimination of the use of lead-based finishes and solders in the printed circuit board, electronics packaging and semiconductor industries. This technology utilizes pulsed electrolysis to deposit a lead-free tin solder with the desired grain size, matte finish and control of internal stresses, to avoid whisker growth which can lead to component failure. The Phase II objectives/research tasks include: 1) pilot-scale facilities design and modification for electro-deposition of lead-free solder onto full size printed circuit boards and wafers, 2) demonstration and optimization of the process to deposit lead-free solder for chip and wafer scale packaging, 3) development of analysis methods to characterize deposit properties and evaluate the correlations between the process and deposit properties, 4) demonstration of qualification and reliability tests for tin whisker evaluation and characterization of corresponding acceleration factors, and 5) comparison of the data to that obtained by other alternatives lead-free materials, e.g. tin-silver. The anticipated results of the Phase II program are a marketable manufacturing process/manufacturing tool in the form of an electrochemical module incorporating the lead-free process.

Commercially the project addresses the needs of the printed circuit board and semiconductor industry, to minimize chemical waste and environmental impact and at the same time increase cost-effectiveness.

Title: SBIR Phase II: High Resolution Infrared Imager

Award Number: 0450487
Program Manager: Juan E. Figueroa

Start Date: March 15, 2005
Expires: February 28, 2007
Total Amount: $484,140

Investigator: Conor Rafferty, conor.rafferty@nobledevice.com
Company: Noble Device Technologies Corporation
211 Warren St.
Newark NJ, 7103
Phone: (973)242-0979

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to leverage new materials technology to drive a revolution in infrared imaging. Silicon imagers are widely used, from supermarket scanners to the ultra-sensitive charge-coupled devices (CCDs) used in astronomy. Germanium is photo-sensitive over a wider spectrum, from visible to well into the infrared. Combining this new spectral capability with fine-line silicon manufacturing brings high resolution, high reliability and lower costs to infrared imaging, enabling new applications, especially in dentistry and medicine. Short-wave infrared (SWIR) imagers today using exotic materials have limited resolution and are too costly for widespread use. This SBIR Phase II project proposes to design a prototype silicon-imaging array for use with integrated germanium pixels.

The proposed project has broad impact. The short-wave infrared (SWIR) spectral range from 800 to 1600 nanometer (nm) holds considerable scientific and applied interest. The human eye does not focus wavelengths past 1.4 micron, so that infrared imaging using active illumination with bright flashes is possible without endangering safety. The most promising immediate application is dental imaging, where the transparency of tooth enamel at 1300 nm allows improved diagnostics through infrared imaging.

Title: SBIR Phase II: High Surface Area Tantalum Powder for Capacitor Applications

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| Award Number: | 0450598 |
| Program Manager: | T. James Rudd |
| Start Date: | February 15, 2005 |
| Expires: | January 31, 2007 |
| Total Amount: | $500,000 |


Investigator: Harvey Gershenson, kappastl@aol.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will scale-up a new technology for producing high-surface area tantalum powders for the electronic capacitor industry. The existing technology is over 30 years old and cannot keep pace with the needs of smaller electronics, which require tantalum particles in the nanometer size range. In addition, environmental factors are driving the industry away from the fluorinated precursors that are presently used to make tantalum. The proposed technology employs the Sodium Flame Encapsulation (SFE) technology to address this problem by producing nano-tantalum powders encapsulated in sodium chloride. In-situ encapsulation allows for control of morphology and prevents oxidation of the nano-tantalum by air or moisture. The technology has been shown to produce state-of-the-art capacitor materials with an environmentally-friendly process. Nonetheless, the present process is a two step process involving post-processing of the nanopowders into the agglomerated structure needed by capacitor manufacturers. This program will specifically develop the flame technology so that the post-processing step is unnecessary. In this way powders can be produced with the appropriate morphology such that they only need to be washed and re-encapsulated to be a drop in replacement for existing materials. The results will be a less expensive, higher efficiency, higher surface area material that is produced by a green technology.

Commercially, this technology will enable smaller, more versatile electronics by ensuring that the tantalum capacitor industry can continue to reduce its package size in line with the rest of the industry.

Title: SBIR/STTR Phase II: A Semiconductor Device for Direct and Efficient Conversion of Radioisotope Energy

Award Number: 0450338
Program Manager: T. James Rudd

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $510,050

Investigator: Larry Gadeken, larrygad@betabatt.com
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Houston TX, 77077
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will fabricate a prototype betavoltaic battery in a form factor the size of a quarter coin. The goal will be to generate approximately 100 microwatts of electrical power in a volume less than half a cubic centimeter from a tritiated energy source. Research conducted for the Phase I portion of this project established the feasibility of constructing a semiconductor device that directly and efficiently converts the energy released from radioactive decay directly into electric current. Three dimensional (3D) diodes were constructed in macroporous silicon by placing p-n junctions along the walls of all the pores. These junctions formed the betavoltaic conversion layer for beta particles (electrons) emitted by gaseous tritium (the radioisotope of hydrogen with a half life of 12.3 years) that was distributed throughout the pore space. Measurements of the current-voltage responses for this novel 3D geometry demonstrated an order of magnitude efficiency increase compared to conventional 2Dplanar diodes. In the 3D diode nearly every decay electron entered the p-n conversion layers. The focus of the Phase II research will be to enhance the performance of the 3D diodes to maximize conversion efficiency. Also, the source energy density will be increased markedly by developing a tritiated solid that can be easily and routinely dispersed in the pore space. This research will lead to the development of a practical nuclear battery.

Commercially, betavoltaic batteries will be useful in a wide variety of sensors and devices used for remote and extended missions in many inaccessible locations. Successful commercialization of this nuclear battery with its order of magnitude increase in useful life is to increase significantly the utilization of self-powered devices and sensors. Stringent efforts will be made to ensure the radiological safety of these nuclear batteries at every step in the development, manufacturing and commercialization processes.

Title: SBIR Phase II: Power-Aware Statically Speculative Microprocessors

Award Number: 0450165
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $500,000

Investigator: Csaba Moritz, andras@bluerisc.com
Company: BlueRISC Labs
28 Dana Street
Amherst MA, 1002
Phone: (413)545-2442

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will develop energy-aware compiler techniques to reduce power and energy consumption in microprocessors, without affecting performance. A key principle behind this approach is to use speculative information available at compile time to reduce power and energy consumption. The key qualifier is speculative: the information does not have to be provably correct. Speculative information that turns out to be correct will enhance energy reduction; if it is incorrect, the worst that will happen is that a penalty (in terms of energy) will have to be paid. The use of such speculative compile-time information opens up a largely unexplored dimension in compilers and computer architectures, to target energy efficiency.

Over the past few years, energy consumption by computers has emerged as a major area of intellectual and commercial activity. These techniques if successful will permit substantial savings in energy consumption. The outcome of the proposed effort will not merely be a set of products, but also a vastly increased understanding of the means by which compile-time information can be exploited for energy savings. With the increasing prevalence of battery-powered computing devices such as PDAs, mobile telephones, and notebooks, power-aware computing is becoming increasingly important commercially.

Title: SBIR Phase II: Microdisplays Based on III-Nitride Wide Band Gap Semiconductors

Award Number: 0450314
Program Manager: T. James Rudd

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $479,672

Investigator: Zhaoyang Fan, zyfan@3N-Tech.com
Company: III-N Technology, Inc
2033 Plymouth Rd
Manhattan KS, 66503
Phone: (785)341-4484

Abstract:

This Small Business Innovation Research (SBIR) Phase II project's goal is to bring the demonstrated Gallium Nitride (GaN) microdisplay technology to industrial maturity and to final commercialization levels. The project's goal will be accomplished by further optimizing the microdisplay device structural design and fabrication process based on the demonstrative results obtained in Phase I. Based on high-efficiency semiconductor micro-light-emitting diode (microLED) array technology, the GaN microdisplay is the first of its kind based on semiconductor LEDs. Specifically, by the hybrid integration of GaN microLED arrays with Si CMOS driver circuits through flip-chip bonding, active matrix addressable GaN microdisplays will have a compact size and will be able to support more information content and movie display due to their high pixel filling factor, uniformity, luminance, and power efficiency. The unique intrinsic properties of GaN microLEDs - high brightness (> 10 microwatt optical output power for microLEDs of 18 micrometer in diameter), wide viewing angle (~ 160 degrees), fast response time (< 1 ns), and high thermal and vibrational resistance, make GaN microdisplays a perfect solution for environmentally demanding applications such as head-up displays (HUD) in modern vehicles and aircrafts, head-mounted displays (HMD) for firefighters and other rescue operatives, and hand-held mini-projectors for field applications.

Microdisplays have a small size (typically less than 1 inch diagonal) with a resolution from low end to above XVGA format. They are magnified by optics to form enlarged virtual or projected images for viewing by a user. Microdisplays can be used in a variety of devices such as head-mounted displays, video headsets, camcorder viewfinders, projection TV, head-up displays, etc. and have many commercial applications. GaN microdisplay, with its superior performance over other microdisplay technologies, is especially suitable for environmentally demanding applications that require high brightness, high reliability, and wide operating temperature range. With a slight modification of the material composition, GaN microLED arrays developed here can vary the emitted wavelength from the green to the ultraviolet range, which is very suitable for fluorescence analysis used in new type chemical-biology agent detector array or DNA/protein microchips. The GaN microLED array also has the potential for applications such as optical links and parallel computing. Other applications also include spatially resolved optical studies of biological, medical, and health care systems. The research will also enrich the general knowledge of wide bandgap semiconductor micro- and nano-photonics

Title: SBIR Phase II: Yb:KGW for High Power and Ultrafast Lasers

Award Number: 0450570
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $499,979

Investigator: Barry Wechsler, bwechsler@novaphase.com
Company: Nova Phase Inc
43 Sparta Ave
Newton NJ, 7860
Phone: (973)579-6682

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on developing methods to improve the power and performance of an exciting new diode-pumped solid-state laser crystal. Laser crystals are superior to any other candidate material in the emerging and rapidly developing field of ultrafast lasers by their ability to generate high power femtosecond pulses. The proposed program will involve crystal growth in order to select the material with optimum operating performance and power handling capabilities. Issues to be addressed include the optimum concentration in the crystals, the uniformity of dopant incorporation during crystal growth, the preferred orientation of the crystal for laser rod fabrication, and methods to improve the quality and reliability of these crystals.

The first commercial ultrafast laser system based on this technology was recently introduced. In order to ensure the rapid development of this new technology and the myriad applications in material processing, medicine and basic science it will undoubtedly enable, considerable development effort is required. This research effort is directed toward bringing the material system on which the laser is based to a point of performance, reliability and producability necessary for the commercial success of this new device.

Title: SBIR Phase II: Novel Fluoropolymer Material

Award Number: 0422104
Program Manager: T. James Rudd

Start Date: December 1, 2004
Expires: November 30, 2006
Total Amount: $499,997

Investigator: Brian Strecker, bstrecker@nomadics.com
Company: Nomadics, Inc
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Phone: (405)372-9535

Abstract:

This Small Business Innovative Research (SBIR) Phase II project is to develop a novel material to enable improved performance of surface enhanced Raman spectroscopy (SERS). Availability of this material could result in the manufacture of pollution monitoring, industrial process monitoring, and defense-related products for the identification and quantification of analytes of importance to these markets. Currently available Raman spectroscopy systems provide detection of a broad range of analytes and have met with commercial success but are limited in sensitivity due to the inherent weakness of the Raman scattering phenomenon. They are also limited in their ability to differentiate analytes in complex matrices. SERS offers a means of overcoming these limitations but has been plagued by poor repeatability and limited availability of suitable substrates. Suspending noble metal particles in an inert matrix could allow their functionalization for analyte sensitivity.

The use of free floating and matrix-bound noble metal particles as SERS substrates has been demonstrated by other researchers but has not yet provided the reliability that is required for industrial and military applications. SERS has remained an "almost-commercial" technology for a number of years. It is believed that this material is a platform technology for the widespread investigation and commercialization. These enhancements and the increased understanding and control of the SERS effect provide should result in dramatic improvements in the sensitivity, selectivity, and cost of monitoring and detection systems for many Raman-active analytes of military and industrial importance.

Title: SBIR Phase II: High Conductivity Photoprintable Conducting Polymers for Polymeric Electronics

Award Number: 0420397
Program Manager: T. James Rudd

Start Date: November 1, 2004
Expires: October 31, 2006
Total Amount: $500,000

Investigator: Brian Elliott, belliott@tda.com
Company: TDA Research, Inc
12345 W 52nd Ave
Wheat Ridge CO, 80033
Phone: (303)940-2301

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop organic dispersible and photoprintable conducting polymers based on polyethylenedioxythiophene (PEDOT). PEDOT is the conducting polymer of choice for electronic displays and devices due to its high conductivity, stability and transparency as a thin film. However, it is only available as an aqueous dispersion, and no one else has been able to render PEDOT dispersible in organic solvents. It is important to make PEDOT dispersible in organics because water is incompatible with many semiconductor processing steps. This SBIR project will develop printable conducting polymers that are initially organic dispersible, can be cast a thin films, and conducting patterns can be made permanently fixed by selectively exposing the film to ultraviolet light. The material that is not exposed to the light can be easily removed. This project will develop printable PEDOT-based conducting polymers that contain no water, and that can be used in the production of electronics such as organic light emitting diode (OLED) displays.

This project hopes to increase knowledge of organic dispersible conducting polymers. Sample size quantities of organic dispersible conducting polymers developed in this project will be made available to researchers by sale through a major chemical distributor. This will promote a more rapid dissemination of the base technology and quicken the pace of additional discoveries and applications using our materials. The benefits of this research to society include a reduced environmental impact due to electronics manufacturing. The printing technology presented in this proposal results in fewer chemical waste streams than inorganic electronics production. Inorganic electronics fabrication facilities produce large amounts of toxic waste including arsenic and heavy metals. The lack of ground water pollution from toxins in the decomposition process is a plus for municipalities who struggle with this issue today. Furthermore, this printing technology will result in a reduction in the cost and a greater variety of electronic devices available to consumers. This technology should have a positive impact in areas where weight sensitivity represents a gating factor.

Title: SBIR Phase II: Geiger Mode Avalanche Photodiodes for Photon Counting from 0.9 Micrometers to 2.0 Micrometers

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| Award Number: | 0422110 |
| Program Manager: | Murali S. Nair |
| Start Date: | August 1, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $355,578 |

Investigator: John Dries, jcdries@sensorsinc.com
Company: Sensors Unlimited, Inc
3490 U.S. Route 1, Building 12
Princeton, NJ 08540
Phone: (609)520-0610

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to develop an InGaAs/InP avalanche photodiodes for use in Geiger mode photon counting with wavelength response extended from the conventional cutoff wavelength of 1.7 microns to 2.1 microns. Commercial InGaAs/InP avalanche photodiodes developed for linear operation in optical fiber communication systems have limited quantum detection efficiency and relatively high dark count rates when operated in Geiger mode, and are unable to detect radiation from important laser sources such as Tm/Ho near 2 microns. Using our experience as manufacturers of commercial linear-mode avalanche photodiodes and our epitaxial growth facility, we will design and fabricate avalanche photodiodes optimized specifically for Geiger-mode operation. The goal will be to obtain enhanced quantum detection efficiency, reduced dark count rate, and extended wavelength response to 2.1 microns. The two primary impacts of this work will be to enhance the understanding of the physics of Geiger-mode avalanche photodiodes, and to provide the broader research community with improved detectors that will significantly enhance the usefulness of photon-counting techniques in the near-infrared spectral region. Although the basic theory of Geiger-mode operation of avalanche photodiodes is several decades old, there continues to be a significant quantitative discrepancy between the quantum detection efficiency predicted by the theory and the quantum detection efficiency observed experimentally. Part of this study will pursue this discrepancy, not only to design improved devices but also to better understand the fundamental performance limits.

By developing improved near infrared photon-counting detectors this study will take a major step toward making such detectors commercially available to the larger research community, which will enable photon-counting techniques to be more widely applied in the near-infrared spectral region.

Title: SBIR Phase II: Ultra-Broadband Ferrite Circulators/Isolators

Award Number: 0349610
Program Manager: T. James Rudd

Start Date: March 1, 2004
Expires: February 28, 2006
Total Amount: $500,000

Investigator: Hoton How, hotonhow@hotech.com
Company: Hotech, Inc.
262 Clifton Street
Belmont, MA 02478
Phone: (617)484-8444

Abstract:

This Small Business Innovative Research (SBIR) Phase II project addresses the development of Innovative Ultra-Broadband Ferrite Circulators/Isolators. A conventional 3-port ferrite stripline junction circulator involves a low-Q ferrite stripline resonator so that at the circulation frequencies standing-wave resonant modes are excited dumping microwave energy from the input port to the output port but not the isolation port. Operation of a conventional ferrite circulator is nonreciprocal, and the transmission bandwidth is roughly proportional to the inverse of the Q-factor of the resonator, due to the standing-wave nature of the excited resonant modes. A new picture of ferrite-circulator operation utilizing traveling-wave coupling of microwave signals at the circulation frequencies haa been discovered. This is in contrast to the operation of the conventional circulators employing standing waves for coupling. As such, ultra-broadband operation of the circulators results, whose bandwidth has been measured in Phase I to cover from 1.6 to 16 GHz for a prototype device. It is not possible to acheive this bandwidth with a conventional circulator. This leads to a new generation of ferrite circulators or isolators.

Using the LTCC technology facilitates mass production in large quantities. As such, generic microwave circulators and isolators can be fabricated at low costs suitable for universal applications covering across many frequency bands. Ferrite-circulator operation does not require a ferrite resonator anymore. This requirement has been constantly enforced by the operation of a conventional circulator for more than 50 years. There is always a tremendous need for circulators or isolators which are able to provide signal-path separation or protection over many frequency bands, as demanded by the measurement of a broadband signal and by a narrow electromagnetic pulse.

Title: SBIR Phase II: Multimodal High-Conductivity Filler for Epoxy Molding Compounds

Award Number: 0349517
Program Manager: T. James Rudd

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $499,422

Investigator: Jared Sommer, jsommer@alum.mit.edu
Company: Sommer Materials Research
587 North Main Street
North Salt Lake, UT 84054
Phone: (801)397-2000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will focus on developing more efficient semiconductor packaging materials, which is one of the key challenges of the electronics industry where increasing power and reduced size of integrated circuits is creating heat dissipation challenges. Most epoxy molding compounds used to encapsulate semiconductors contain fused silica (55-70% by volume) to maintain a compatible thermal expansion coefficient and impart moisture resistance. However, the resulting thermal conductivities of the composite compounds are very low (<1 W/mK). The low thermal conductivity of the epoxy molding compound increases the operating temperatures, which in turn decreases the reliability and processing speed of microprocessors. As semiconductor clock speeds continue to increase and chip sizes decrease, the need for higher thermally conductive molding materials has become a stark necessity. In Phase I of this project multi-modal distributions of high-conductivity diamond powder where optimized to obtain high packing densities (over 72% by volume) in epoxy molding compounds. The resulting thermal conductivities of diamond/epoxy composites were almost 8 times higher than conventional silica-filled epoxies and almost 30 times higher than the epoxy matrix. The thermal expansions of silica and diamond filler are similarly low, thus allowing better matching to silicon. In this Phase II project significantly higher thermal conductivities are to be achieved by optimizing the epoxy/hardener system with the diamond filler to improve bonding and thereby improving the heat transfer mechanism. The diamond filler will be used as a direct substitute for commercially available silica filler, requiring little or no modification of existing equipment or processing. The diamond/epoxy molding compound will effectively act as a heat-spreader. The diamond filler will allow higher switching speeds, thinner oxide gates and increased reliability of electronics. The project team will work with an epoxy molding compound (EMC) manufacturer to introduce the diamond filler into the commercial market towards the end of Phase II.

Commercial markets for this EMC technology include high-performance aerospace, automobile and microelectronic packaging applications, where heat dissipation from the packaging material outweighs the increased material cost. The increased thermal conductivity offered by the diamond filler will benefit the business and scientific community by increasing computing speed and hardware reliability. Studies indicate that heat dissipation and associated thermal problems are the most critical factors in determining the efficiency and reliability of electronic devices. In terms of scientific and educational value, EMC's incorporating the optimized diamond filler will exhibit the maximum thermal conductivity obtainable and serve as the upper-limit benchmark in thermal conductivity for the composite material.

Title: SBIR Phase II: Crystalline Ferroelectrics Combined with Transistor Technology

Award Number: 0349729
Program Manager: T. James Rudd

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Zhiyong Zhao, zzhao@ngimat.com
Company: CCVD, Inc dba MicroCoating Technologies (MCT)
5315 Peachtree Industrial Blvd.
Atlanta, GA 30341
Phone: (678)287-2400

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will focus on developing tunable microwave devices that utilize ferroelectric thin films for their electronic properties. Specifically, barium strontium titanate (BST) thin films are being used to develop new classes of tunable microwave devices, including phase shifters, delay lines and frequency-agile filters. Currently, these ferroelectric devices suffer from two drawbacks: easily formed planar devices demand very large tuning voltages on the order of 100 Volts , while easily tuned parallel plate devices require sophisticated processing techniques. These problems have inhibited the development of commercially viable components. The current project proposes combining silicon based circuitry with ferroelectric devices on the same substrate. For example, a silicon charge pump circuit can be integrated on-chip to provide high tuning voltages for a ferroelectric phase shifter. The voltage will be isolated to the chip and less than 3 Volts would be needed to externally drive the device. Combining silicon semiconductor technology with ferroelectrics will enable development of devices which take advantage of ferroelectric's dielectric properties and overcome the current roadblocks in the way of commercializing these devices.

Commercially, a great deal of interest has emerged in the use of ferroelectric thin films in the wireless industry because of the material's ability to dramatically improve the functionality of existing devices. For example, a ferroelectric duplexer is possible which has one third the size of existing duplexers, while using 40% less power. Today's multiband handsets use up to four filters, so the potential for ferroelectrics is tremendous. A key wireless handset manufacturer identified at least six applications for tunable devices inside their telephones. Overall, the wireless telecommunications market has spawned the need for small, low power, high bandwidth microwave components. Over $50 billion of wireless handsets were sold in 2002, with $6 billion being spent on RF semiconductor components. With the trend towards highly functional wireless appliances like PDA's, the demand for wireless components will continue skyrocketing.

# Spintronics

Title: SBIR Phase II: High-Temperature Magnetic Rotary Encoder Based on a Spintronic Sensing Array

Award Number: 0522160
Program Manager: Muralidharan S. Nair

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $434,090

Investigator: Gurpreet Singh, singh@micromagnetics.com
Company: Micro Magnetics Inc
421 Currant Rd
Fall River MA, 02720
Phone: (508)672-4489

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will continue the development of an incremental magnetic rotary encoder based on magnetic tunnel junction (MTJ) sensor technology. This device uses sensitive MTJ devices to sense the magnetic field created by a patterned magnetized scale, and converts the resulting information into an accurate reading of angular position. The dual advantages of high-temperature operation (up to 200 degrees C) and contamination resistance will separate this device from the optical encoders that currently dominate the market for motor encoders. Current motor encoders are rarely capable of operation above 115 degrees C, a problem that requires motors in many market segments to operate in non-optimal configurations, costing end users in terms of time and efficiency. In addition, optical methods are sensitive to dust in the measurement path.

This development effort will create a new measurement technology with greatly enhanced capabilities for use in many critical segments of America's manufacturing sector. The creation of cost-effective encoders capable of operation at high temperatures will increase efficiency and enable further progress in a number of areas where hot environments are unavoidable, such as in the turbines of power-generating windmills. This research will advance the state of understanding of the emerging spintronic technology of magnetic tunnel junctions, a class of devices which forms the central component of a number of important commercial products in the high-tech semiconductor and data storage industries.

Title: SBIR Phase II: Reduction Of The Critical Current In Spin Transfer Switching Through Anisotropy Engineering

Award Number: 0646327
Program Manager: William Haines

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $497,550

Investigator: Alex Panchula, alex.panchula@grandisinc.com
Company: Grandis
1123 Cadillac Ct
Milpitas, CA 95035
Phone: (408)945-2165

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will address the critical steps needed to manufacture a fast, non-volatile, magnetic random access memory (MRAM) based on spin transfer torque (STT-RAM). STT-RAM which uses spin polarized current to switch individual bits is predicted to have better scaling properties than conventional MRAM which uses magnetic fields. This Phase II project will focus on sub-100nm device manufacturability, device performance testing, and circuit design to develop a set of results which will enable the creation of a 1 Mb demonstration chip. The STT-RAM test chip is needed to prove the technology for customers. The results obtained from this project will include the development of arrays of sub-100nm bits, with the appropriate thermal stability, read/write characteristics and distributions. Also addressed will be the reliability of reading and writing such small devices. The project will develop processes for manufacturing sub-100nm structures. Finally, a simulation of read and write circuitry based on STT-RAM will be produced allowing for tape-out of a 1 Mb test chip.

Commercially, as microelectronics scales to smaller sizes and higher speeds, more features are added to typical consumer electronic devices and the demands on memory continues to grow. These demands and the inherent limitations of existing technologies create opportunities for new memory technologies to fill. As a leading candidate for a future universal memory that incorporates all the desired characteristics; non-volatility, high speed, low power, unlimited rewriting capability, extendibility to future semiconductor nodes; STT-RAM is in a strong position to take advantage of these opportunities.

# Wafer & Sensor Production/Lithography

Title: SBIR Phase II: Single Crystal Silicon Flexible Display Backplane

Award Number: 0822770
Program Manager: Juan E. Figueroa

Start Date: August 1, 2008
Expires: July 31, 2010
Total Amount: $475,557

Investigator: Etienne Menard, etienne.menard@semprius.com
Company: Semprius, INC.
2530 Meridian Pkwy. 2nd Floor
Durham, NC 27713
Phone: (919) 806-4923

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on fabrication of flexible display backplanes using transfer printed electronics. The display industry has been successful at fabricating amorphous silicon (a-Si) thin film transistor (TFT) backplanes on rigid glass. However, a-Si TFT manufacturing does not easily translate to flexible substrates due to handling issues and the high temperature process of a-Si deposition. In transfer printing, a novel elastomeric stamp is used to pick-up specially designed circuits from the parent wafer and transfers the circuits to the desired target substrate. The parent wafer is fabricated using a standard silicon IC foundry and the single crystal silicon transistors have much better performance than the a-Si counterparts. The SBIR Phase I project demonstrated chip transfer printing process yields of 99.9% and chip placement accuracies better than +/- 5 ìm. Phase II objectives include design, fabrication and characterization of flexible backplane prototypes and further optimization of transfer printing by increasing throughput and demonstrating rework methods. The anticipated result is a manufacturing approach to flexible electronics that is cost competitive, low temperature and well suited to handle flexible substrates. The competitive advantage of the proposed approach is the fact that all the demanding fabrication process steps necessary to fabricate high performance electronic systems are performed on the ?mother? substrate and not on the final plastic substrate. If successful the inherent mechanical or chemical instabilities of the receiving plastic substrate do not limit the choice of semiconductor manufacturing processes for fabricating devices. The ability to manufacture flexible display backplanes to the demanding standards of the display industry will open up a broad market of opportunity in flexible electronics far beyond displays, including configurable X-ray sensors, RFID tags, and wearable electronics and biosensors. In displays, backplanes using the proposed technology will be utilized by all major display manufacturers and many specialty manufacturers.

Title: SBIR Phase II: High Performance Cooling Devices through Wafer Scale Manufacturing

Award Number: 0750189
Program Manager: William Haines

Start Date: February 1, 2008
Expires: January 31, 2010
Total Amount: $505,487

Investigator: Andrew Miner, miner@romny-scientific.com
Company: Romny Scientific
828 San Pablo Avenue
Albany, CA 94706
Phone: (510) 931-7511

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will create high performance coolers using waferscale semiconductor manufacturing by building on the material processing foundations demonstrated in Phase I. Phase I work has demonstrated that high quality materials can be formed in a method that can be extended to high volume production. This Phase II effort will implement this manufacturing technique at a wafer scale, integrating Phase I materials into initial devices for customer evaluation and sale. The broader impacts of widespread deployment of efficient thermoelectric coolers include reduction in energy consumption and more efficient use of available energy by widespread use of high performance thermoelectric power generation from waste heat; and broad improvements in general quality of life by high performance compact coolers that allow continued advancement of products in the microelectronics and optoelectronics industries.

Title: SBIR Phase II: Development of Efficient Short-Wavelength Radiation Sources For Next-Generation Lithography

Award Number: 0724183
Program Manager: Rathindra DasGupta

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Joseph MacFarlane, jjm@prism-cs.com
Company: Hyperion
455 Science Drive
Madison, WI 53711
Phone: (608)280-9179

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will pursue the development of novel plasma technologies for creating highly efficient, short-wavelength radiation sources for use in next-generation semiconductor chip manufacturing. The development of radiation sources that efficiently emit light at wavelengths near 13.5 nm is crucial to the expected emergence of EUV lithography as the primary technique used in manufacturing integrated circuits and DRAM near the end of this decade. Laser-produced plasma experiments will be conducted to validate and refine the novel high-efficiency, low-debris EUV light source designs developed in our previous work. Comparisons between experimental data and simulations performed using state-of-the-art simulation tools will facilitate the development of light sources with high 13.5 nm conversion efficiencies. This project will lead to lower cost, more efficient, and more robust EUV lithography light sources for use in the manufacturing of next-generation semiconductor chips.

Short-wavelength radiation sources are applicable to a wide variety of research areas, and have significant value in commercial applications, basic research, and defense research and technology. Such sources are valued not only for use in EUV lithography, but also in medical research, instrumentation, and technology. While this project will focus on the development of plasma-based technologies for creating highly efficient light sources for EUV lithography, it is likely that techniques and capabilities developed under this project will further the development of plasma light sources applicable to other major areas of research and technology.

Title: SBIR Phase II: Fabrication of Conformal Antennas for Airborne SatCom Using Kinetic Metallization

Award Number: 0724502
Program Manager: Muralidharan S. Nair

Start Date: September 1, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Ralph Tapphorn, rtapphorn@inovati.com
Company: Innovative Technology Inc
Cabrillo Business Park
Goleta, CA 93117
Phone: (805)571-8384

Abstract:

This Small Business Innovative Research (SBIR) Phase II research project will develop direct write copper conductors onto doubly curved dielectric substrates using the Kinetic Metallization (KM) process. There is a need for new processes and methodologies to enable low profile RF systems on current and planned airborne platforms. Low profiles antennas are achieved through integration with structural elements. The concept is referred to as aperstructures, and in this Phase II research the scientific and engineering foundation necessary for robust aperstructures will be laid. Principally, research to establish process-property relationships will be conducted, as well as an investigation of novel material systems. The envisioned result of this research is conformal antennas integrated into the load bearing structures of the application platform. Conformal antennas represent a significant stride forward in the ability to communicate in high bandwidth applications. They also offer lower profiles, lighter weight and greater mission flexibility.

Originally airborne platforms were identified as high benefit early adopters. Targeted markets in the Navy and Air Force have already been identified with customers awaiting the Phase II results to transition the KM process to the manufacture of antennas. Ship systems, land systems, and non-military opportunities such as automobiles and skyscrapers will also gain from the development of this research.

Title: STTR Phase II: Fully Embedded Optical Interconnects based on Optical Bus Architecture for Large Size Printed Circuit Boards

Award Number: 0724096
Program Manager: William Haines

Start Date: September 1, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Alan Wang, alan.wang@omegaoptics.com
Company: Omega Optics
10435 Burnet Rd Ste 108
Austin, TX 78758
(512)996-8833

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project is to develop a commercial board level optical interconnect using bus architecture. Conventional copper links on printed circuit boards fail to provide sufficient bandwidth for data transfer above 10 Gbit/sec. Optical interconnections are widely viewed as an alternative to higher throughput. However, existing photonics-related approaches suffer from issues of packaging, reliability and manufacturing cost. In this project, Omega Optics and the University of Texas at Austin seek to develop a fully embedded board level optical interconnect for enhanced bandwidth, while reducing the difficulties of optoelectronic packaging and device reliability. Phase I results demonstrated 150 GHz bandwidth with 51 cm interconnection distance.

Instead of utilizing surface mounted optical components this approach separates the fabrication of the optical layer with the electrical parts and laminates it inside printed circuit boards, between which the interconnection is setup through in-layer vias. This fully embedded technology seals all the optical components and provides a seamless interface with electrical layers, therefore it eliminates the concerns of external optoelectronic devices for end users.  The revolutionary breakthrough over copper links sought through this research would benefit the entire computer industry and enable the continued progression of bandwidth and interconnect distance.

Title: SBIR Phase II: R-CEL for DUV Lithography

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| Award Number: | 0724417 |
| Program Manager: | William Haines |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |

Investigator: Zhiyun Chen, zchen@pixelligent.com
Company: Pixelligent
387 Technology Drive Suite 3122
College Park, MD 20742
Phone: (301)405-9284

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to develop a product for a reversible contrast enhancement layer (R-CEL) using semiconductor nanocrystalline materials. The R-CEL technology, if successfully developed, will enable finer resolution optical lithography postponing the need for more expensive techniques such as electron beam or x-ray lithography. R-CEL technology will help to extend the diffraction limit facing optical lithography by enabling double exposure techniques to be used for pattern definition.

The use of R-CEL with double exposure will increase the capability of optical lithography thus enabling the extension of Moore's Law without the need to switch to more expensive alternatives. It will also help restore the technological competitiveness of domestic vendors in the lithography industry. The SBIR project will also advance the understanding of semiconductor nanocrystal characteristics including detailed absorption and recombination processes and the effect of nanocrystal surface conditions on dispersion with polymers. This information will be valuable in other semiconductor nanocrystal UV applications including optical storage, UV light sources and detectors.

Title: SBIR Phase II: Novel Hybrid Rapid Thermal Processing (HRTP) Systems for Annealing of Advanced Silicon Devices

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| Award Number: | 0725021 |
| Program Manager: | William Haines |
| Start Date: | August 1, 2007 |
| Expires: | July 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Syamal Lahiri, slahiri1@sinmat.com
Company: SINMAT
2153 SE Hawthorne Rd Ste 129
Gainesville, FL 32641
Phone: (352)334-7237



Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on development of a novel high-temperature system for processing of advanced silicon devices. Currently used rapid thermal processing (RTP) systems result in substantial dopant profile broadening because of their relatively large time constants. The development of a novel Hybrid Rapid Thermal Process (HRTP) system which combines the advantages of RTP and laser annealing will be accomplished through this project. The advantages of HRTP anneals was demonstrated in the Phase I of the project. In the Phase II project extensive thermal simulation studies will be performed to understand, optimize and scale up the process.

Rapid Thermal Processing (RTP) systems are a critical part of semiconductor manufacturing operations and are used to form gate oxides, silicides and annealed ion implanted dopants for formation of ultra-shallow junctions. The market-size for these applications exceeds $500 M/year. With the rapid miniaturization of the devices, there is a strong need to develop higher ramp rate and higher temperature annealing systems to achieve the formation of ultra-shallow junctions. The proposed HRTP system is expected to fill this niche. The HRTP system can also be usedin thermal annealing of wide band gap semiconductors such as GaN and SiC as they require extremely high temperature, which cannot be achieved by traditional systems.

Title: SBIR Phase II: Enhanced Plasma deposition Process for MgO-Based Magnetic Tunnel Junctions with 500% Magnetoresistance

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| Award Number: | 0724913 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | July 15, 2007 |
| Expires: | June 30, 2009 |
| Total Amount: | $499,883 |


Investigator: Benaiah Schrag, schrag@micromagnetics.com
Company: Micro Magnetics
421 Current Road
Fall River, MA 02720
Phone: (508)672-4489



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop the process to fabricate magnesium-oxide (MgO) based magnetic tunnel junction (MTJ) sensor devices, which are simultaneously ultra-sensitive at high frequencies, small in size, with high output, and extremely low power consumption. The dual advantages of high sensitivity and low power consumption will separate these sensor devices from traditional Hall-effect and magnetoresistive sensor products, which are power hungry and typically not suitable for many high-performance and battery-powered sensing applications. This innovative approach combines the high resistivity tunneling and enhanced signal strength derived from magnesium oxide tunnel barrier technology.

The broader impact anticipated if this project is realized is a new class of MgO-based sensors with high sensitivity and low power consumption, and the development of a reliable fabrication process suitable for mass production. This project will advance the state of understanding of the emerging spintronic technology of magnetic tunnel junctions, a class of devices which forms the central component of a number of important commercial products in the high-tech semiconductor and data storage industries. Finally, the collaboration of physicists, electrical engineers, materials scientists, and students will result in a broader multidisciplinary training and education for all the participants in the field of spintronics.

Title: SBIR Phase II: Microfluidics Device for Real-time Process Control of Copper Plating Baths

Award Number: 0646935
Program Manager: Muralidharan S. Nair

Start Date: April 1, 2007
Expires: March 31, 2009
Total Amount: $500,000

Investigator: Holly Garich, hollygarich@faradaytechnology.com
Company: Faraday Technology Inc
315 Huls
Clayton, OH 45315
Phone: (937)836-7749

Abstract:

This Small Business Innovation Research (SBIR) Phase II program will advance the monitoring of copper plating baths, responding to the stated need to design, develop and prototype innovative sensors and systems for testing and characterization in both industrial and laboratory settings, for specific use as a process control device. This technology couples the theories of microfluidics and alternating current voltammetry for a powerful monitoring tool. The anticipated result of this research project is a marketable, commercially viable sensor with the capability to accurately and precisely measure concentrations of all components of the copper plating bath. In addition, application of the proposed method is anticipated to significantly reduce the waste generated by semiconductor and printed circuit board industries.

This work addresses the needs of the printed circuit board and semiconductor industries, which are important aspects of the US commercial economy and will play an increasing role in the US as well as world society. In addition to providing tight process control and therefore a better quality product, the proposed sensor is anticipated to be more environmentally friendly than current technologies due to the decrease in sample size and analysis time requirements, resulting in lower chemical and power consumption, an objective of the 2005 International Technology Roadmap for Semiconductors.

Title: SBIR Phase II: A Quality Monitor for Enabling Water Recycling in Semiconductor Processing - The Particle Scout

Award Number: 0646557
Program Manager: Muralidharan S. Nair

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $500,000

Investigator: Bingrong He, bingrong@uncopiers.com
Company: Uncopiers, Inc.
6923 Redbud Drive
Manhattan, KS 66503
Phone: (785)293-4917

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project concerns Ultrapure Water (UPW), the life blood of the semiconductor industry. The proposed instrument seeks to satisfy the ITRS requirements on two counts: 1. full flow inspection, and 2. detection of sub-100nm liquid-borne particles. 1. A typical semiconductor fab uses about 3 million gallons of UPW every day, and the ITRS, in its attempt to conserve the precious resource, water, mandates that 90% of UPW be recycled/reused by 2010. The recycled UPW loop will need full flow monitoring, which the proposed Particle Scout will do. 2. The purity of UPW directly affects the chip yield, because the final operation on wafers is UPW rinse and any contaminants present in the UPW contaminate the wafers it rinses. As the industry moves to sub-100 nm nodes the ITRS particle detection requirements fall to sub-50 nm.

Particle Scout" for monitoring in real-time the particulate purity of recycled UPW for use in Semiconductor processing successfully overcomes a critical technological barrier facing the IC manufacturing industry today. Beyond IC manufacturing industry it will find applications in all enterprises where UPW is used: Power generation, Nuclear Reactors, Pharmaceutical industry, Biotechnology, Space exploration, and processing of Advanced high purity chemicals.

Title: SBIR Phase II: Trapping Particle Detector for On-Line Monitoring

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| Award Number: | 0646388 |
| Program Manager: | William Haines |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $500,000 |


Investigator: Chris Doughty, cdoughty@verionix.com
Company: Verionix
251 Granville Lane
North Andover, MA 01845
Phone: (617)905-0015



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop improved particle detectors for monitoring of semiconductor manufacturing tools. This detection technology will increase count rates for greater than 0.2 micron diameter particles by 100 to 1000 times improving correlations between the particle detector and wafer by greater than 10 times. For smaller particles this detector will enable detection, ultimately to the nanoparticle regime (less than 25 nanometers). The intellectual merit of this proposal is that it will advance the state of knowledge in the field of engineering and physics of microplasmas. It will broaden knowledge of plasma scaling and of the behavior of particles in plasmas. The project will involve the following tasks: Optical detector hardware development ; Trap development for capturing particles; Data analysis, Control system and Software interface development and ; Field testing of prototypes. This project will provide currently unavailable detection technology for monitoring particles.

Commercially, this project will improve the performance of semiconductor process tool manufacturer's products by enabling cost-effective, real-time monitoring. The broad economic benefit of this program will be to enhance the competitiveness of domestic semiconductor manufacturers where particle issues account for approximately 11% of manufacturing tool down time and are a major cause of scrap and yield losses. For the future nanotechnology industry as a whole this detector will enhance workplace and public safety by enabling monitoring of nanoparticle levels and production processes.

Title: SBIR Phase II: Extrusion Manufacturing Process for Ultrahigh Bandwidth, Low Attenuation Graded-Index Polymer Optical Fibers

Award Number: 0646397
Program Manager: Juan E. Figueroa

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Whitney White, white@chromisfiber.com
Company: Chromis Fiberoptics
6 Powder Horn Dr.
Warren, NJ 7059
Phone: (732)764-0907

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will advance the technology for reliably manufacturing low attenuation, ultrahigh bandwidth, graded-index, perfluorinated polymer optical fibers (GI-POF) by a low cost continuous extrusion process. Currently there is an unmet need for an easy-to-use, rugged medium that allows the migration of data communications to speeds of 10 Gigabits per second, and beyond, in rapidly growing applications such as data centers, supercomputing and consumer electronics. This project will result in a production quality process for manufacturing plastic fibers having bandwidth equal to the best multimode glass fibers, but with a simple "plug-and-clamp" installation process, and tolerance of bend radii fivefold tighter than that allowed by glass fibers. The project will address three areas to develop the technology into commercially viable products: 1) Advanced extrusion process development to greatly improve fiber bandwidth distribution and attenuation, while doubling production speed; 2) Investigation to prove-in new polymers that can increase the fiber operating temperature up to 85 deg C; 3) Investigation and development of a unique, readily manufactured multi-core fiber design that can offer customers almost unlimited bandwidth, as well as greatly improved attenuation in tight bends.

If successful the production technologies developed in this project will result in the possible recapturing of American leadership in POF manufacturing while stimulating American-based production of the manufacturing capital equipment used in this industry. Similarly, American companies using POF to develop next-generation short-distance communication systems will also benefit, as they will enjoy better access to information and custom products based on GI-POF. The results of this project will help improve the "ecosystem" for many areas of datacom manufacturing in the US. Also, by enabling a product that makes installation of high-bandwidth cabling much simpler and less expensive, the Phase II project will be of considerable benefit to schools, hospitals, and other institutions which have many needs for high-bandwidth communication, but often do not have large budgets to support such systems. The scientific benefits of the Phase II project are likely to be the simplified and lower-cost construction of massively parallel computing facilities, and increased commercial interest in chemical synthesis techniques for amorphous fluoropolymers and their precursor chemicals.

Title: SBIR Phase II: Gentle Atomic Level Chemical Mechanical Smoothening (CMS) of Gallium Nitride Substrates

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| Award Number: | 0646586 |
| Program Manager: | William Haines |
| Start Date: | February 15, 2007 |
| Expires: | January 31, 2009 |
| Total Amount: | $499,900 |


Investigator: Syamal Lahiri, slahiri1@sinmat.com
Company: SINMAT
2153 SE Hawthorne Rd Ste 129
Gainesville, FL 32641
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and scale-up an industrially robust and low cost chemical mechanical smoothening (CMS) process to produce atomically polished gallium nitride (GaN) on silicon substrates for high power and high frequency applications. As GaN is mechanically hard and chemically inert, traditional surface polishing processes have resulted in significant surface damage which negatively affects the electrical performance. In contrast, the CMS process forms a soft layer on GaN surface which can be removed by nanoparticles. In the Phase II of this project, the company plans to further optimize and scale-up the CMS process. In conjunction with the compound semiconductor chip manufacturers and academic partners, the company's plan is to further validate the polishing technology by fabricating and testing the performance of high electron mobility transistors. The research team members are internationally recognized experts and are in an excellent position to execute the research plan and attain the project goals.

The commercialization of the proposed polishing technology is expected to significantly impact GaN based semiconductor technology used for high frequency, high power microwave devices in wireless mobile communication and radar defense systems. This process will accelerate commercialization of GaN on silicon technology by increasing yield and reducing manufacturing costs.

Title: SBIR Phase II: Molecular Transfer Lithography with Real-Time Alignment

Award Number: 0646183
Program Manager: William Haines

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Charles Schaper, cschaper@transferdevices.com
Company: Transfer Devices, Inc.
500 Laurelwood Road, Suite 11
Santa Clara, CA 95054
Phone: (408) 980-9684

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a comprehensive automated nanolithography and alignment system for integrated electronics and photonics manufacturing. Transfer Devices, Inc. is the pioneer, and has significant intellectual property, in transfer lithography. The product driver for this application is the MxL (molecular transfer lithography) template. It is a consumable, one-time-per-use item that forms patterns by bonding patterned resist layers onto a substrate surface, with subsequent water dissolution of the template. MxL is a non-imprint, non-photolithography process that solves the defect propagation problem of contract printing, and is applied for large area, conformal printing at low costs and high throughput. The proposal seeks to optimize the replication of MxL templates, and coordination with an advanced adaptive alignment system, to achieve unprecedented overlay and high resolution patterning for high throughput next generation lithography of integrated circuits and photonic devices. The reason for the success of the proposed solution is a technologically superior solution of that of alternative approaches by combining low-cost, environmentally friendly processing with defect free conformal printing over large areas at high throughput rates. MxL (molecular transfer lithography) is a patent protected unique process using a water dissolvable sacrificial polymer template. This advanced process is coordinated with an adaptive alignment scheme to produce state-of-the-art registration with sub-50 nm features at sub-20 nm placement capability.

Commercially, the proposed process and technological solution will significantly advanced the capability to manufacture nano-technological devices for a wide range of applications including integrated circuits, solar wafers, displays, data storage, MEMS, as well as emerging areas in photonics, high brightness LED's, optoelectronics, life sciences, and nanotechnology. The project will be implemented commercially into the lithography marketplace, which by 2009 has a total market size of roughly $20B including equipment technology, masks, and consumables.

Title: SBIR Phase II: Large-Scale Manufacturing Process for Uniform Semiconductor Nanowires

Award Number: 0620589
Program Manager: James Rudd

Start Date: September 13, 2006
Expires: August 31, 2008
Total Amount: $297,784

Investigator: Francesco Lemmi, flemmi@nanosysinc.com
Company: Nanosys
2625 Hanover
Palo Alto, CA 94304
Phone: (650)331-2188

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an innovative manufacturing technology for inorganic semiconductor nanowires for use in high-performance thin-film electronics products. In Phase I, the company successfully demonstrated the feasibility of this innovative manufacturing method to yield large volumes of high quality, uniform nanowire nanostructures of the quality and quality required to enable the application of these materials in high performance thin-film electronics. Specifically, the company: (1) setup a prototype nanowire manufacturing reactor capable of large-volume production; (2) identified critical process parameters affecting materials quality and methods to optimize them; and (3) established control over the process parameters enabling the precise fabrication of nanowires. Phase II research will build on the knowledge gained in Phase I, and focus on further development and optimization of this system into a fully automated, manufacturing system capable of pilot scale production of nanowires for commercialization in high performance electronics applications including displays and phased array antennas.

Commercially, the project represents an innovative approach to a manufacturing process technology for large-scale production of high quality inorganic semiconductor nanowires, and will enable wide-spread production of low-cost high-performance electronics fabricated by roll-to-roll manufacturing. Applications of these materials exist in novel electronic devices and systems including specific uses in displays, RFIDs, phased array antennas and sensors.

Title: SBIR Phase II: High-Speed, Low-Cost Maskless Lithography

Award Number: 0620566
Program Manager: Juan Figueroa

Start Date: September 6, 2006
Expires: August 31, 2008
Total Amount: $429,287

Investigator: Richard Yeh, yeh@alcestech.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will research and develop a maskless lithography tool based on the results of the feasibility study. The company has a unique and proprietary approach to achieve higher throughput and lower cost than currently available maskless lithography tools. The approach will employ Line Light Modulator (LLM) to pattern wafers with a linear array of 2048 beams. The patent-pending LLM is a novel and efficient light engine that converts a single light source into a large linear array of beamlets. Using a large array of beamlets increases the power handling capability of the system which increases the exposure throughput. The result is a one to two order of magnitude improvement in throughput compared to existing maskless lithography tools. Our tool also takes advantage of the new 405nm diode laser. The 405nm diode laser offers a combination of power, cost, and speed not available in other UV laser sources. In the feasibility study, we have demonstrated the ability to pattern photoresist with <1um resolution using the LLM. In Phase II, we will develop and fully characterize a prototype tool that will achieve a 1um resolution, 50nm position accuracy, and a throughput of 65mm2/sec (two minutes per 4" wafer).

As high volume semiconductor production has mostly moved overseas, the US semiconductor industry relies more on prototyping and initial manufacturing of innovative, cutting-edge technology. Lowering the cost to pattern wafers at these volumes helps keep US companies competitive by enabling rapid and cost-effective innovations. Cost is especially important for the small- to medium-sized companies that neither have the capital for high cost mask sets, nor require the most advanced resolutions of modern conventional lithography tools. The proposed tool addresses this need for fast and cost-effective semiconductor lithography with good throughput, resolution, and seamless integration with current lithography processes. The proposed project will provide researchers with an affordable tool to quickly fabricate new and existing designs. These low cost lithography tools will also be useful in fabrication and MEMS laboratory courses. A maskless lithography tool will make it practical for students to design and fabricate devices instead of simply using masks made for the course.

Title: SBIR Phase II: Optical-Maskless-Lithography Equipment

Award Number: 0620456
Program Manager: Juan Figueroa

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $499,943

Investigator: Rajesh Menon, rmenon@nano.mit.edu
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project is a major step in the development of an optical-maskless lithography technology that is capable of high resolution, high throughput, flexibility, low cost, and extendibility. Current lithography technologies suffer from the problems of high tool costs, high mask costs, and inflexibility in the case of optical-projection lithography, and high tool costs, very low throughputs, and high complexity in the case of scanning electron- beam lithography. The company's Zone-Plate-Array-Lithography (ZPAL) technology will mitigate these issues, while providing unprecedented flexibility in nanopatterning. This project covers two major thrusts: one the manufacture of zone-plate arrays containing over 1000 zone plates, each with a numerical-aperture (NA) greater than 0.85, second the development of a high-accuracy alignment sub-system that can achieve overlay accuracy of 20nm with potential extendibility below 5nm. A successful completion of the first thrust of this project will result in large arrays of high-NA zone plates installed in the prototype lithography system, enabling high resolution and high throughput. A successful implementation of the alignment sub-system in the prototype tool will meet specifications of accuracy unmatched by alternate technologies.

It is widely recognized that nanostructures of complex geometries are indispensable to create functionality and enable a nanotechnology revolution. At present, the tools that are available for the creation of such nanostructures are highly limited in flexibility, resolution, cost and throughput. The tools based on ZPAL have the potential to create a new paradigm in the development and manufacture of nanostructures by sharply reducing the development-cycle time and manufacturing costs. Being maskless, this technology provides flexibility by enabling the designers of nanostructures to quickly realize their designs in hardware for prototyping and even low-volume manufacturing. The company's tools have the potential to enable industries in a wide spectrum of industries such as micro-electro-mechanical devices (MEMs), nano-electro-mechanical devices (NEMs), nano-electronics, nano-magnetics, integrated optics, photonics, biochips, microfluidics, to name a few. Initial target customers are manufacturers of application-specific-integrated circuits (ASICs), compound semiconductors and photomasks. In the ASIC industry alone, the tools have the potential to enable savings of over $3B per year. Furthermore, this technology can provide the cost-effective, flexible solution required to revive and grow this important segment of the semiconductor industry.

Title: SBIR Phase II: Micro-Coax Manufacturability Study

Award Number: 0620136
Program Manager: Juan Figueroa

Start Date: August 10, 2006
Expires: July 31, 2008
Total Amount: $500,000

Investigator: Sean Cahill, seanc@bridgewave.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II research project deals with the ever-increasing burden placed on the microelectronics industry as computational speeds increase. While the number-density-speed of transistors doubles every 18-24 months (a phenomenon known as Moore's Law), the ability to retrieve and store data from external sources is not increasing nearly as quickly. The performance improvement rate of key computing tasks such as simulation, signal processing and database searches is becoming limited by off-chip bandwidth. Approaches such as "flip-chip bumping" are not a panacea, because despite their small size, these structures leak signals to one another; a significant performance detriment. The company has developed a novel MicroCoax interconnect technology to address these problems, utilizing existing semiconductor manufacturing infrastructure. The research objectives are to gain insights into MicroCoax fundamentals and understand application specific issues within market segments that are most impacted by current technological limitations. Research will focus on continuing exploration of MicroCoax material set, process flow, integration, and reliability, along with specific application to three distinct market spaces namely, MMICs, High-speed Digital/Optoelectronics, and high-frequency test.

Electronics technology impacts nearly every person on earth in some way. Even folks living in remote places are subject to natural disasters, which may be predicted by atmospheric and geological simulation and warning systems, allowing timely evacuation. Goods distribution and logistics are increasingly dependent on computationally intensive database search and tracking. Medical diagnosis and treatment rely increasingly on signal processing for imaging and therapeutics. High-bandwidth wireless systems allow for recovery of communication infrastructure following floods and hurricanes. All of the aforementioned technologies have high-speed electronic systems at their core, and MicroCoax can affect them all. High-bandwidth systems are quite expensive today, in large part because of interconnects based on machined waveguides and significant labor content associated with such approaches. If successful the proposed technology, MicroCoax, can eliminate much of the cost, making such systems more commercially viable and ubiquitous. While a disruptive technology such as MicroCoax will be invisible to the average user, electronics designers and will be able to expand their application horizons due to elimination of prohibitive cost constraints. Electronics, semiconductor, communications and related industries will stall without continued innovation in packaging and interconnect strategies. The economic implications are significant, as worldwide electronics sales number somewhere around US$1.3 trillion at this time.

Title: SBIR Phase II: Single Step Chemical Mechanical Planarization of Copper/Ultra Low k Interconnects

Award Number: 0620428
Program Manager: Juan Figueroa

Start Date: July 26, 2006
Expires: July 31, 2008
Total Amount: $496,673

Investigator: Deepika Singh, singh@sinmat.com
Company: SINMAT
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Gainesville, FL 32641
Phone: (352)334-7237

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop and commercialize a single step chemical mechanical polishing (CMP) process for fabrication of next generation of copper based interconnects that join millions of transistors on a chip. The current state of the art copper CMP process is complicated and requires multiple steps to meet the defect quality and planarity requirements. Furthermore, existing processes create high stresses during polishing, which may not be compatible with the fragile low dielectric constant materials are now being introduced by the semiconductor industry. To address these challenges the research team proposes to develop the "soft polishing layer" concept for gentle removal of copper that does not damage the fragile dielectric layer. The use compatible chemistries and nanoparticles in the slurry allows successful development of a flexible, defect-free, single step process to fabricate copper based interconnects that will result in substantial cost savings to the semiconductor chip manufacturers. During Phase II, the company will partner with the leading edge CMP companies and chip manufacturers to address industrial scale integration issues related to development and commercialization of the single step slurry.

With the impending introduction of new fragile ultra low k materials, CMP processes are expected to become more complicated and expensive, to achieve the necessary levels of performance. The successful implementation of the single step CMP process is expected to meet or exceed the technical performance levels of the 45 nm manufacturing node while decreasing the CMP manufacturing costs by up to 80% which translates to over $ 4 billion savings for the chip industry (10 X savings for the chip industry for every "X" dollar of slurry revenue). The reduction in costs is largely due to the simplification of the manufacturing process, higher throughput, increased yield, less use of capital equipment and manpower, and reduction in consumable costs. The successful completion of this project will help maintain and grow the country's leadership in nanotechnology, a key area for future health and vitality of the nation. This project will help increase the number and quality of manufacturing jobs in the country.

Title: SBIR Phase II: Direct Measurement of Wafer Temperature in White/UV LED Manufacture

Award Number: 0450516
Program Manager: T. James Rudd

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $449,635

Investigator: Jeffrey Bodycomb, jeffreyb@technologist.com
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Columbia SC, 29204
Phone: (803)738-9965

Abstract:

This Small Business Innovation Research (SBIR) project will develop a highly accurate temperature measurement system that can be used in optimizing the growth of high brightness light emitting diodes for solid state lighting applications. This product does not currently exist due to technical difficulties in measuring the substrate or gallium nitride (GaN) epilayer in a region where they absorb energy. During Phase I of this program the company showed possible solutions to this problem that it can implement as the work progresses to Phase II. This SBIR Phase II program will address scientific and technical issues that has hindered the adoption of the Reflectivity Compensated Pyrometry (RCP) in the growth of GaN light emitting diodes (LEDs), the basis of solid state lighting sources. This program will result in a commercial instrument for directly measuring surface temperature during manufacture of visible and UV LEDs. Typical temperature variations during the growth of GaN-based LEDs results in a product which, even over a 2dimensional substrate, requires the LEDs to be separated into those with similar characteristics. Existing temperature measurements do not allow the accurate measurement of the substrate or the GaN epilayer because they are transparent at the measurement wavelength of ~1 micron.

Commercially, this project will increase manufacturing productivity in wide-bandgap materials and LED manufacture by providing better process control data. The improved manufacturing yields of LED's enabled by this work will lead to more widespread adoption of LEDs for solid state lighting with the accompanying economic and environmental benefits. For example, the use of LEDs has already saved the US economy nearly 10 TWh per year (equivalent to one large power plant) of energy in the niche applications implemented so far.

Title: SBIR Phase II: An Ultra-High-Speed Cleaning Process for Electronic Device Manufacturing

Award Number: 0522329
Program Manager: T. James Rudd

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,992

Investigator: David Boyers, dboyers@phifersmith.com
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2181 Park Blvd.
Palo Alto CA, 94306
Phone: (650)328-8200

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop process technology for removing photoresist from semiconductor wafers at high speed while not damaging underlying materials. This process technology can be readily integrated into existing single wafer wet processing tools. The development of higher performance semiconductor devices with smaller feature sizes has driven the adoption of copper and low-k dielectric materials that are susceptible to damage by traditional oxygen plasma based resist removal processes. While other low temperature plasma processes are being explored as low damage alternatives, appreciably lower resist removal rates (1,000 to 2,000 A /min) are a significant limitation. In response to this challenge the company successfully developed a new ozone-water based single wafer process chemistry which does not damage low k dielectric materials such as Black Diamond (TM), and does not corrode copper. In phase I this process achieved an etch rate greater than 8,000 A /min. The phase II research will concentrate on the early integration of the process hardware and process technology into a commercial single wafer spin processing system, the further development of process capabilities using 300 mm customer wafers, and the placement of three systems at customer sites for evaluation.

Commercially, the successful completion of this research program will culminate in the development of a new single wafer process technology for use in the manufacture of the high-density semiconductor devices with feature sizes below 90 nm. Nearly all of the new manufacturing capacity is built for 300 mm wafer fabrication at the leading edge technology node. In addition to direct sales of $60 to $120 million per year of new wafer processing equipment incorporating this technology, this project will enable the productivity benefits and reduction in unit manufacturing costs provided by the early migration to the next technology node. In addition, the innovative copper compatible cleaning chemistry developed here holds promise for corrosion free cleaning and surface treatment of copper in other electronic device manufacturing applications. Finally, this process uses an environmentally benign "green" chemistry.

Title: SBIR Phase II: Novel Wafer Fabrication Technology for Semiconductor Sensors

Award Number: 0522039
Program Manager: T. James Rudd

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $465,833

Investigator: Rabi Bhattacharya, rbhattacharya@ues.com
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Phone: (937)426-6900

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is directed toward the development of cadmium zinc telluride (CdZnTe) single crystal films by using an ion beam layer separation process from bulk single crystals. The separated layers will be transferred and bonded on to silicon (Si) wafers for applications as substrates for epitaxial growth of mercury cadmium telluride (HgCdTe) films. HgCdTe films are of interest in infrared detectors. The ion beam layer separation process will allow the fabrication of a large number of films from a single bulk crystal, thus providing an economical wafer production technology for infrared detector materials. High-energy (MeV) light ions will be used to produce a buried damaged layer in the bulk crystal. Thermal annealing at elevated temperatures may generate lateral crack enabling the layer separation. Phase I has shown the feasibility of this approach. Phase II research objectives are to optimize the process parameters for wafer-scale separation without breaking and develop the process to transfer the separated films on to Si wafers. The wafers thus fabricated will be used for epitaxial growth of HgCdTe and fabrication of IR detectors. CdTe and (Cd,Zn)Te alloy crystals have been grown by various techniques including zone refining, vertical gradient freeze (VGF), liquid encapsulated Czochralski (LEC) methods, horizontal and vertical Bridgman techniques. Due to variable yields, none of these methods have produced enough material with the quality needed for today's infrared (IR) detector applications.
The proposed method has been developed to overcome these limitations.

Commercially, the proposed technique has the advantage of producing many good quality substrates from a single bulk crystal by ion beam slicing, thus providing an economic way of producing reliable and reproducible quality material. Also, large area CdZnTe substrate for the growth of HgCdTe will be possible by stacking smaller slices in a floor tile pattern on cheaper Si substrates. Bonding with Si substrate will also allow the integration of IR detectors with electronics on a single chip. IR photodetectors and focal plane arrays are of interest in many industrial and scientific applications including environmental monitoring, chem-bio detection, medical and space sensors.

Title: SBIR Phase II: Hydrothermal Growth of Ultra-High Performance Nd:YVO4 Laser Crystals

Award Number: 0421946
Program Manager: T. James Rudd

Start Date: August 1, 2005
Expires: July 31, 2007
Total Amount: $409,807

Investigator: Henry Giesber, hgiesber@apcrystal.com
Company: Advanced Photonic Crystals, LLC
377 Carowinds Blvd
Fort Mill SC, 29708
Phone: (803)547-0881

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will focus on the development of a commercial process for the growth of Neodymium Yttrium Vanadate (Nd: $YVO_4$) single crystals for use in solid-state lasers. This research will generate the commercially viable conditions for growth of large boules of single crystals suitable for use in diode pumped solid-state lasers. The hydrothermal method is a low temperature growth technique that leads to crystals containing less thermal strain, much fewer defects and greater homogeneity than conventional methods. These defects combine to cause considerable optical loss and concomitant reduction in performance. The hydrothermal technique has slower growth kinetics and requires chemical development for economically viable growth. In the Phase I project, preliminary growth conditions that lead to suitable single crystals were identified. These conditions include approximate thermal ranges, a variety of starting materials, seed crystals and mineralizer concentrations. In the Phase II project growth conditions will be systematically optimized to provide suitable transport rates and crystal quality. Once an acceptable growth is developed, the resulting boules will be evaluated for performance efficiency and loss.

Commercially benefits will emerge as the company introduces new higher performance crystal materials to the market that cannot be grown by existing crystal growth methods. In addition, new laser materials will be donated to Clemson University for design of new laser devices and cavities supporting the University's participation in the emerging photonics Coalition of the Carolinas that includes Clemson, the OptoElectronics Center at UNC-Charlotte, COMSET at Clemson University, and the Carolina MicroOptics Consortium.

Title: SBIR Phase II: Development of High Performance, Environmentally Benign Lapping Fluids for Hard Disk Drive Manufacturing Applications

Award Number: 0450441
Program Manager: T. James Rudd

Start Date: May 1, 2005
Expires: April 30, 2007
Total Amount: $522,000

Investigator: John Lombardi, ventanaresearch@msn.com
Company: Ventana Research Company
831 North Camino Miramonte
Tucson AZ, 85716
Phone: (520)325-0440

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop novel, water soluble, environmentally benign, aspartate co-aspartamide copolymers for use as aluminum titanium carbide (AlTiC) Giant Magnetoresistive (GMR) Read Write Head lapping fluid additives. Efforts will be directed towards refining the composition of these copolymers such that they exhibit maximum adsorption & electrostatic charging effects upon AlTiC surfaces. This will enable rapid removal of AlTiC swarf formed during lapping producing GMR Heads of superior surface quality and uniformity compared to those manufactured currently. Furthermore, the adsorption properties of these copolymers upon AlTiC ceramic GMR Head surfaces as well as their metallic sensor layers will also be characterized in greater detail using Zeta Potential & Electrochemical Techniques. An optimized procedure for synthesizing these copolymers will be established enabling them to be economically produced in bulk quantities. Finally, the company will work closely with hard drive manufacturers and will integrate the aqueous lapping fluids formulated from these copolymers into its current GMR Head manufacturing operations.

Commercially and from an industrial standpoint, lapping fluids formulated from these copolymers will enable the last vertically integrated domestic hard drive manufacturer to produce GMR Read Write Heads more economically & efficiently thereby enhancing the company's competitiveness within the marketplace. Future data storage technologies may also benefit from these fluids since they will in all likelihood still require high precision lapping or a related super finishing technique to polish their drive components.

Title: SBIR Phase II: Advanced Detectors for X-Ray Diagnosis

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|---|---|
| Award Number: | 0450483 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | March 1, 2005 |
| Expires: | February 28, 2007 |
| Total Amount: | $500,000 |

Investigator: Michael Squillante, MSquillante@RMDInc.com
Company: Radiation Monitoring Devices Inc
44 Hunt Street
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Phone: (617)668-6801

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to produce a new, high-resolution x-ray detector for fluorescence measurements of lighter elements. For x-rays generally near 30 keV and below, there exist several tradeoffs between today's choices of lithium drifted silicon (Si/Li)) detectors and high purity germanium (HPGe) detectors. Si/Li) detectors offer simple spectral decomposition but have limited active volumes. Conversely, HPGe detectors can offer larger sizes, but pulse height analysis is complicated by short x-ray penetration and overlapping escape peaks. The technical goal is to develop a detector from high purity silicon, with a contact structure that allows for increasing detection volumes without high capacitance -antithetical to high-count rates. The work will entail device design and computational modeling, developing new electrical contact fabrications on high purity silicon, manufacturing numerous test detectors and evaluation under various conditions, including temperature.

The impact of this technology could be how the detectors will be utilized and the basic science learned through the fabrication process. These detectors are used in many applications for the identification of completely diverse samples. Just a few examples include materials science, surface science, environmental analysis, industrial process and quality control, forensic sciences and archaeology, and geological and extraterrestrial exploration. In virtually any of these applications, a new detector providing greater counting efficiency yields more productive and definitive results.

Title: SBIR Phase II: High-resolution, high-precision 193-nm photomask phase metrology system

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| Award Number: | 0450620 |
| Program Manager: | T. James Rudd |
| Start Date: | February 1, 2005 |
| Expires: | January 31, 2007 |
| Total Amount: | $500,000 |

Investigator: Andrew Merriam, merriam@actinix.com
Company: Actinix
2521 S. Rodeo Gulch Rd.
Soquel CA, 95073
Phone: (831)440-9388

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to design and construct an ultra-high-resolution, high-precision phase-shift integrated measurement system suitable for metrology of advanced phase-shifting photomasks. A number of semiconductor manufacturers now expect to progress from the 90 nm through the 45 nm nodes using an exposure wavelength of 193 nm. Advanced photolithographic techniques are necessary to print these sub-wavelength features. Phase-shifting photomasks, i.e. those in which the optical thickness, as well as the opacity is controlled, are a key reticle enhancement technology. Fast and accurate metrology of critical-layer phase-shift masks is becoming necessary both for process control and repair validation, but the enabling tools do not yet exist. The goal of this Phase II program is to integrate the actinic high-repetition rate laser built in Phase I into an interferometric laser microscope involving the design, construction, and integration of a stable phase-shifting interferometer and laser microscope, and the incorporation and optimization of phase-shifting interferometry signal processing algorithms. The integrated optical system will enable phase metrology on advanced photomasks, with the measurement precision and spatial resolution required by the International Technology Roadmap for Semiconductors (ITRS), mask makers and mask users.

Commercially, the primary beneficiary of the Phase II photomask phase metrology system is the semiconductor optical lithography industry. The ITRS 'roadmap' for the 90-nm node and beyond requires measurements of photomask optical path difference with sub-0.4 degree precision. This metrology must be performed at spatial resolution scales consistent with feature sizes of the respective technology nodes, and for both isolated and densely-packed structures. No commercial metrology tools yet exist which satisfy these demands. The Phase II high-precision metrology system will enable manufactures to characterize, predict, and control mask-loading effects and other repair and process control issues essential to the reliable fabrication of phaseshifting masks. It is also likely that the integrated phase metrology system will find utility in the area of nano-MEMS testing and other nano-scale interferometry.

Title: SBIR Phase II: Non-Contact/Zero-Stress Surface Polishing Process for Copper/Low Dielectric Constant Semiconductors

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| Award Number: | 0421638 |
| Program Manager: | T. James Rudd |
| Start Date: | November 1, 2004 |
| Expires: | October 31, 2006 |
| Total Amount: | $516,963 |


Investigator: E. Jennings Taylor, jenningstaylor@faradaytechnology.com
Company: Faraday Technology, Inc
315 Huls
Clayton OH, 45315
Phone: (937)836-7749


Abstract:


This Small Business Innovation Research (SBIR) Phase II project will advance the development of a non-contact electro-polish process, addressing the need for a non-contact/stress-free polishing method for planarization of Cu/low-k interconnects required for the fabrication of nanochip integrated circuits. This technology utilizes pulsed electrolysis and a moving electrolyte front to effect complete electrochemical removal of copper overplate from a semiconductor wafer. The Phase II objectives/research tasks include: 1) design and fabrication of a module for the non-contact electro-polish process, 2) demonstration and optimization of the process on full size wafers, 3) development of a theoretical model defining a process library for the non-contact electro-polish process, and 4) characterization of the polishing performance and relationship to the mechanical properties of the materials used.

Commercially, the anticipated results of the program are a marketable manufacturing process/manufacturing tool in the form of an electrochemical module incorporating the non-contact electro-polish process. This product/process technology is enabling to other emerging industries such as MEMS and/or NEMS. In general, the project addresses the needs of the semiconductor industry, which is an important aspect of the US commercial economy and will play an increasing role in the US as well as world society. Furthermore, the process minimizes chemical waste and environmental impact.

Title: SBIR Phase II: MatchBox Display Systems

Award Number: 0422099
Program Manager: Murali S. Nair

Start Date: October 1, 2004
Expires: September 30, 2006
Total Amount: $499,935

Investigator: Chongchang Mao, cmao@setechinv.com
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Phone: (919)624-1352

Abstract:

This Small Business Innovation Research (SBIR) Phase II project, matchbox projection systems, addresses a major opportunity in the multi-billion dollar projection display market. . The main goal for the phase II project is to develop a Matchbox projector based on one liquid crystal on silicon (LCOS) panel using the field sequential color (FSC) method. The development includes the fabrication of full custom and mixed signal integrated circuit (IC), LCOS panel, optical light engine, and mechanical assembly. The silicon backplane will contain 1280 x 768 frame buffer pixels that remove charge sharing and charge inducement noise, increase charge storage memory time, enhance display brightness, and increase image contrast ratio. The data loading will use frame-at-a-time approach, allowing an image to be displayed at full contrast while the next image is buffered onto the backplane. LCOS panel assembly process will be developed for implementing panels with high thickness uniformity, high contrast ratio, fast switching, and high reliability. The optical engine design will focus on compact FSC system. The display market is multi-billion dollar market with a wide range of products.

The commercial and military markets rely on highly specialized display products such as microscope and head mount displays. The LCOS system hopes to enable low power, high-resolution products in the market place.

Title: SBIR Phase II: A New Class of Ferroelectric Liquid Crystals for High Performance Optical Phase Modulation

Award Number: 0422196
Program Manager: T. James Rudd

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $499,994

Investigator: Michael Wand, wand@displaytech.com
Company: Displaytech Incorporated
2602 Clover Basin Drive
Longmont, CO 80503
Phone: (303)772-2191

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new class of ferroelectric liquid crystal (FLC) materials and novel operating mode to produce fast, analog, electro-optic phase modulation. This innovation exploits two recent developments in liquid crystal science: a new liquid crystal phase made from novel bent-core "banana" molecules, and electrostatically controlled analog modulation of high polarization FLCs. The new modulators will offer the fixed-optic-axis phase modulation capability of a nematic liquid crystal in combination with the much faster speed and lower drive voltage of a ferroelectric. Present day FLCs modulate light through electrically driven optic axis rotation. Phase modulation range is limited to less than 180 degrees unless complex multi-element device designs are used. What's so novel about the new FLC is that it modulates light through changes in its index of refraction; the direction of the optic axis remains fixed. Furthermore that modulation can be analog, unlike conventional FLCs, which are binary. This enables simpler device structures and phase ranges greater than 360 degrees. The new FLC should be compatible with liquid-crystal-on-silicon technology (LCOS), allowing the ability to construct inexpensive wavelength-tunable devices and wavefront modulators for diverse application including telecommunications, holographic and conventional optical data storage, and microdisplays.

This production on an electro-optic technology could be useful in an existing market (microdisplays), and could enable large new markets in the near future (active optics, optical data storage, telecommunications). Advantages over alternative technologies due to the nature of a lower cost manufacturing processes, and the ability to easily implement complex functionality because of the integration of this electro-optic technology with standard CMOS VLSI technology. Society could benefit through job creation, enhanced telecommunications, and improved data storage technologies.

Title: SBIR Phase II: Ge-Free Strained Silicon Via dTCE Bonding (Differential Thermal Coefficient of Expansion Bonding)

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|---|---|
| Award Number: | 0421948 |
| Program Manager: | T. James Rudd |
| Start Date: | July 15, 2004 |
| Expires: | June 30, 2006 |
| Total Amount: | $499,997 |


Investigator: Rona Belford, belford@hargray.com
Company: Belford Research, Inc.
386 Spanish Wells Road
Hilton Head Island, SC 29926
Phone: (843)681-7688



Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop a process that integrates wafer bonding technology with a novel straining process to create a new ultra fast silicon substrate: Strained-Silicon-On-Insulator (SSOI). This substrate can undergo normal IC fabrication and resulting circuits will be 30% faster at half the power required for comparative non-strained- SSOI architectures. The process is a direct approach and entirely surpasses the nearest competition as there is no germanium in any part of the processing. As a result the strained silicon is free from the high concentration of treading dislocations (>105 cm-2) always present when strained-silicon is grown on "strain-relaxed" silicon germanium virtual substrates. The silicon strained by the proposed method is maintained within its mechanically elastic region and thus is free from structural imperfections. The proposed method engages wafer bonding procedures already in place within the industry and modifies those processes to give a combined result of wafer bonding and SOI straining within a single step. The direct approach and single process makes the technique very inexpensive. The discipline evoked is fundamental surface science which involves investigation of both physical properties such as surface energies along with chemical aspects such as maintaining surface hydration and active surface species required for wafer bonding.

Commercially, the substrates available via this effort will make possible ultra fast silicon electronics. The proposed process also allows for non-intrusive radiation-hardening, giving initial commercial outlet in the military sector. Further markets include mainstream silicon-based electronics; effectively new host materials with speeds more characteristic of materials such as gallium arsenide and most salient, very low power electronics.

Title: SBIR Phase II: A Simple and Practical Solid-State 157nm and 193nm Coherent Light Source for Applications in Lithography Development

Award Number: 0349601
Program Manager: T. James Rudd

Start Date: March 1, 2004
Expires: February 28, 2006
Total Amount: $465,249

Investigator: Sterling Backus, sbackus@kmlabs.com
Company: Kapteyn-Murnane Laboratories LLC
4699 Nautilus Ct. Unit 204
Boulder, CO 80301
Phone: (303)544-9068

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new generation of fully-coherent, solid-state, vacuum-Ultraviolet (UV) light sources at 157nm and 193nm, to support the next generation of semiconductor fabrication and metrology, as well as for applications in basic research. Currently available UV excimer sources have limitations such as poor spatial coherence, making them unsuitable for metrology. Therefore, the most promising route to generate fully-spatially-coherent VUV sources is to up convert light from the visible-infrared region of the spectrum, where coherent laser sources already exist. However, a significant technical obstacle towards this goal is the lack of reliable solid-state nonlinear-optical crystals that work in the deep-UV. Unavoidable residual absorption at wavelengths <200nm can lead to long-term damage of nonlinear optical crystals, requiring constant replacement. Furthermore, for frequencies <193nm, no suitable nonlinear optical crystal currently exists. Therefore, gaseous nonlinear-optical media are an attractive alternative to crystals for generating light at wavelengths <200nm. This SBIR Phase II project will use four-wave mixing in gas filled hollow waveguides to develop a tabletop VUV laser capable of generating 10's of mW, and possibly 100's of mW of light at 157nm and at 193nm, in a fully coherent beam, at the very high (10kHz) repetition rates necessary for applications in metrology.

This project has the potential to have a very broad impact on the semiconductor and electronics industries, as well as in basic science. Progress in both the complexity and the speed of microprocessors, DRAM memory, and other integrated electronics has been driven by the ability to make increasingly dense IC's, with ever-smaller feature sizes. This has been enabled by the development of higher-resolution lithographic "steppers" and the use of ever-shorter wavelengths of light for lithography. Because no bright, tabletop, sources currently exist, most short-wavelength materials, nano- and chemical science must take place at synchrotron sources, where access is limited and the sources are not optimized. Therefore, significant gains in productivity could occur with the availability of such a source.

Title: SBIR Phase II: Nanoporous Silica Slurries for Enhanced Chemical Mechanical Planarization (CMP) of Low k Dielectrics

Award Number: 0349609
Program Manager: T. James Rudd

Start Date: March 1, 2004
Expires: February 28, 2006
Total Amount: $464,889

Investigator: Deepika Singh, singh@sinmat.com
Company: SINMAT INC
2153 Hawthorne Rd
Gainesville, FL 32641
Phone: (352)334-7237

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop unique chemical mechanical planarization (CMP) slurries based on nanoporous silica particles that will meet or exceed CMP needs of low k dielectrics for the 80 nm and beyond semiconductor manufacturing nodes. The integration of low k dielectrics (dielectric constant $2.2 < k < 3.3$) with copper metal lines is expected to considerably reduce RC (resistance x capacitance) delay for > 10 GHz CMOS expected devices in the next 3-5 years. One of the key issues plaguing the semiconductor industry is the chemical mechanical planarization (CMP) of copper/tantalum/low k dielectric materials. The low k dielectrics are fragile and are susceptible to both delamination and scratching (increased defectivity). Standard slurries employing hard abrasives may not meet the requirements for sub-80 nm CMOS devices which are expected to employ low k dielectric materials. The program proposes to develop & commercialize gentle CMP slurries based on nanoporous silica particles which exhibit reduced hardness and better stability. Combined with unique chemical formulations, these slurries are expected to achieve lower defectivity (surface scratching) and lower stress polishing than standard slurries. In this Phase II project extensive experiments will be conducted both in-house and with our partners (semiconductor chip manufacturers) to optimize performance and integration issues.

Commercially this research activity has significant impact not only in the semiconductor manufacturing areas, but also in may other areas such as biotechnology and nanotechnology, which are the key areas identified by the government for the future viability of US business. First and foremost it will ensure US can maintain its lead in CMP, even though semiconductor manufacturing jobs have been migrating overseas. As CMP slurries is the largest value added application of the nanoparticle technology (> 50%) excellence in this area will provide employment to nanotechnology graduates in the near future and could be a direct application of the skills they have acquired. This research will lead to the creation of faster electronic devices, which will in turn benefit the society to become more economically productive. The development of nanoporous particle technology can have applications in several other areas including controlled drug delivery systems.

Title: SBIR Phase II: Clock-on-Demand: High Performance, Ultra Low Power

Award Number: 0822542
Program Manager: Muralidharan S. Nair

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $500,000


Investigator: Farokh Eskafi, farokh@tagarray.com
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5150 El Camino Real
Los Altos, CA 94022
Phone: (650) 966-1640



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project is to develop a prototype and proof of concept for the tag and reader that uses an innovative low power Clock-on-Demand (CoD) and baseband/ media access controller (MAC) calibration algorithm to be used with ultra wideband communication systems. The new CoD and algorithm are motivated by application of ultra wideband to the RFID (Radio Frequency Identification) market. In this prototype, the CoD and the baseband/MAC layer algorithm are implemented in standard CMOS for tag and the UWB receiver and narrowband receiver with discrete components for reader. The low power requirement is achieved by the CoD and by dividing the time into epochs and epochs into slots. The CoD only runs until the tag transmits its impulse in the relevant slot, and the reader decodes the ID representations of all tags by the slot number. Therefore, if an epoch is divided into 210 slots, an impulse by tag represents 10 bits of the information. The robustness is achieved by having an UWB impulse transmitter in the tag and by repeating the impulse in different epochs. RFID is an exponentially growing market. However, the technology that supports its expansion is not able to provide robust communication and signaling between a tag and a reader. Furthermore, today?s technology only supports a low tag density (10s of tags/sec), while the applications that will fuel the exponential expansion of the RFID market, like point-of-sale, inventory management, shelf management, etc., require 100s and 1000s of tags/sec.

Title: STTR Phase II: Low-Cost Portable Telerehabilitation System for Intelligent Stretching and Remote Assessment of Hypertonic Arm Joints

Award Number: 0750515
Program Manager: Muralidharan S. Nair

Start Date: March 1, 2008
Expires: February 28, 2010
Total Amount: $485,564

Investigator: Yupeng Ren, yupeng.r@gmail.com
Company: Rehabtek LLC
2510 Wilmette Ave.
Wilmette, IL 60091
Phone: (847) 853-8380

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project seeks to develop technologies needed for rehabilitation of post-stroke patients with neurological impairment. For those patients, physical therapy followed by timely examination is the cornerstone of the rehabilitation. However, not all patients receive sufficient therapy due to limited access to expert healthcare services. There is a need for a tele-rehabilitation system that can stretch the spastic/contractured joints under accurate control at a remote location and provide remote access to expert healthcare services. This Phase II research will focus on improving the technology and making it suitable for the market by improving the design of the tele-rehabilitation system for multi-purpose applications to treat/evaluate multiple joints in the arm. It will make the portable device stand-alone with built-in capabilities of passive stretching, voluntary movement exercise, and tele-assessment of joint range of motion, stiffness, spasticity, and catch displayed in an intuitive way. Finally, a clinical test of the tele-rehabilitation system on stroke survivors will be conducted. This portable and low-cost stretching device is suitable for home use, making frequent and convenient treatment accessible to a large number of patients. It can potentially have broad impact on rehabilitation of stroke and other neurological impairments. The intelligent stretching concept was developed to insure safe and effective treatment and it will also be useful in other applications dealing with human-machine interface.

Title: SBIR Phase II: Location Aware Computing Using Near Field Electromagnetic Ranging

Award Number: 0646339
Program Manager: Muralidharan S. Nair

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $499,508

Investigator: Hans Schantz, h.schantz@q-track.com
Company: Q-Track
515 Sparkman Drive
Huntsville, AL 35816
Phone: (256)489-0075

Abstract:

This Small Business Innovative Research (SBIR) Phase II research project seeks to transform the Real-Time Location Systems (RTLS) industry by bringing to fruition a simple, inexpensive, yet highly accurate approach to location awareness: Near-Field Electromagnetic Ranging (NFER) technology. RTLS is an important and rapidly growing segment within the Radio Frequency Identification (RFID) industry. In today's world of just-in-time commerce, Supply Chain Management (SCM) requires inexpensive real-time location data to improve efficiency and maintain competitiveness. Established technologies like the Global Positioning System (GPS), UltraWideBand (UWB), and traditional time-of-flight ranging have proven unable to perform satisfactorily within complicated, real-world, indoor propagation environments.

The anticipated result of this research effort will be a pilot installation of a NFER tracking system in a warehouse. It is predicted that: "RTLS and wireless LAN technologies, combined with innovative applications, will fundamentally change the way businesses manage and track high-value assets." Accelerated development of a technology that can meet this market need will bolster the American economy and increase American competitiveness.

Title: SBIR Phase II: Adaptive/Cognitive Software Radio Architecture for Gbps+ Wireless Networking

Award Number: 0620588
Program Manager: Errol Arkilic

Start Date: August 4, 2006
Expires: July 31, 2008
Total Amount: $500,000

Investigator: David Fogelsong, david@silvuscom.com
Company: Silvus Communication Sys
1185 W Olympic Blvd
Los Angeles, CA 90064
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Abstract:

This Small Business Innovation Research(SBIR) Phase II project will develop interference-mitigating technology for wireless networks. The traditional 802.11 WLAN systems that have been used for data communications are becoming ubiquitous. The next generation of these systems will be relied upon for video distribution, metropolitan networking, as well as a host of other applications that are as yet undefined. They must achieve aggregate network throughput rates in excess of one Gbps while operating in the unlicensed ISM bands. This, however, must be done in the face of ever increasing interference in the bands that in turn pose a serious threat to continued market growth. The current effort will address the interference problem by successfully combining novel spectrum sensing and cognitive approaches (observe, learn, react) with a host of powerful PHY, MAC, and combined PHY-MAC protocols. This effort will look to heavily leverage a new tool in the arsenal, namely that of multiple antennae enabled nodes that are included in the major Wi-Fi and WiMax standards.

The FCC revolutionized the wireless industry by opening up the unlicensed ISM bands. These bands reduce the barrier to entry for companies to introduce wireless services to niche markets without the expense and delays associated with obtaining a proprietary licensed band. The price paid for utilization of the ISM bands is interference. Traditionally these bands have been sparsely occupied, however, with ever increasing adoption of WLANs, and the emergence of WiMax and metropolitan networking in this band, interference is going to increase in significance. If successful, the current effort will allow high utilization of the ISM bands for high throughput high fidelity applications, and will help ensure low price wireless access to the society at large.

Title: SBIR Phase II: Multi-Frequency Low-Multipath Small Antennas for High Accuracy GPS

Award Number: 0450524
Program Manager: Muralidharan S. Nair

Start Date: March 15, 2005
Expires: February 28, 2007
Total Amount: $500,000

Investigator: Francesca Scire-Scappuzzo, fscire@psicorp.com
Company: Physical Sciences Incorporated (PSI)
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Andover MA, 01810
Phone: (508)689-0003

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will consist of the design, development, and manufacturing of a novel low-multipath GPS antenna for high accuracy applications. This antenna prototype utilizes two key technologies: (1) a new design of GPS antennas using high-technology materials and manufacturing methodologies, that enables low-multipath, gain control, multi-frequency, tunability, and size reduction; and ( 2) a novel geometry of the metal ground plane to further rejects multipath interference. At the end of Phase II the anticipated results include, multipath error mitigation uniformly at L-Band, gain improvement at low elevation angles up to 10 dB with respect to choke ring antennas, multi-frequency operation at GPS and GALILEO frequencies, and at least 33% smaller size than other commercial low multipath antennas.

Because multipath interference reduction significantly improves GPS accuracy, the proposed multi-frequency GPS antenna will benefit the international scientific community that relies on high precision GPS for new advances in Earth and atmospheric sciences. In particular, the novel substrate antenna will allow accurate real-time GPS measurements, otherwise impossible, in support of the NSF funded EarthScope program, that is intended for the study of the structure and evolution of the North America continent using a network of GPS receivers.

Title: SBIR Phase II: Athermal Multiplexers Based on Reflective Arrayed Waveguide Grating Devices

Award Number: 0450072
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $500,000

Investigator: Luis Gravede-Peralta, luisgrave@hotmail.com
Company: Multipass Corporation
11 South Lake Shore Drive
Lubbock TX, 79366
Phone: (806)742-8060

Abstract:

This Small Business Innovation Research(SBIR) Phase II project will optimize Performance and demonstrate reliability of temperature insensitive silica-based arrayed waveguide grating (AWG) multiplexers developed under SBIR Phase I award. In Phase I we have successfully demonstrated that the temperature sensitivity of silica-based AWGs can be eliminated by a combination of a reflective device with a unique external mirror that rotates with temperature at a constant rate. The rotation of the external mirror compensates for the temperature induced index change of silica waveguides and the resulting peak wavelength shift of individual channels, making the device athermal. This has been accomplished without penalties in the device performance. The goal of Phase II is to develop compact 40-channel, 100 GHz, totally passive athermal AWGs with Gaussian or flattop passband profiles that is manufacturable in large volume. Special attention will be given to the reliability certification of athermal AWGs as specified by Telcordia standards. During Phase II we will distribute reliable prototypes to our partners and potential customers for field tests. The research and development program carried out under this Phase II project will result in robust manufacturing process of reliable athermal AWGs ready for commercialization.

This project is focused on producing a highly reliable, temperature insensitive, AWGs based on silica-on-silicon technology. AWGs are planar optical devices that are considered key components in dense wavelength division multiplexed (DWDM) optical Networks. The novel approach to the manufacture of silica based AWGs, relying on high-technology silicon IC foundries, results in high quality devices that are produced at low cost, in high volume, and without a large front-end investment. The innovative design results in complete suppression of the temperature sensitivity of silica based AWGs. This approach eliminates the need for electric power and external temperature control of AWGs, resulting in a more robust, and considerably less expensive device package.

Title: SBIR Phase II: Adaptive Phased Arrays for Broadband Wireless Access

Award Number: 0422037
Program Manager: Muralidharan S. Nair

Start Date: November 1, 2004
Expires: October 31, 2006
Total Amount: $496,968

Investigator: Joseph Carey, joe.carey@fidelity-comtech.com
Company: Fidelity Comtech Inc
2400 Trade Center Ave
Longmont CO, 80503
Phone: (303)786-8048

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will culminate in the demonstration of the smallest, most economical phased array system yet developed for addressing the problem of how to traverse the "last mile" between a broadband network and the home. During the course of the project, the state of the art in phased array antenna technology will be advanced and networking algorithms will be developed to take advantage of this innovative technology.

The broader impact of this research project is to fulfill the challenge to economically deliver wireless Internet access to rural communities. This steerable technology provides a greater than 50 percent increase in coverage and a cost savings of up to 55 percent. These cost and coverage improvements would help meet the needs and bring the benefits of broadband Internet into areas of the country that remain underserved.

# Computer Algorithms and Image Processing

Title: SBIR Phase II: Cilk++

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| Award Number: | 0822896 |
| Program Manager: | Ian M. Bennett |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $500,000 |

Investigator: Matteo Frigo, matteo@cilk.com
Company: Cilk Arts, Inc
12 Waltham Street
Lexington, MA 2421
Phone: (781) 325-0818

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to develop software technology to enable C++ programmers to easily program multicore chips produced by the leading processor hardware vendors. Physical limits are driving chipmakers to produce chips containing multiple processor cores, but existing methods for programming multicore chips are error-prone and difficult to use. The potential outcomes of this research project will enable C++ programmers to easily parallelize applications to run on multicore processors without restructuring their legacy applications. Cilk++ is a simple set of language extensions to C++, which, together with a powerful runtime platform, allows multicore processors to be programmed easily. Market research shows that global variables pose a major barrier to parallelizing legacy code. This research project seeks to understand the linguistics, implementation, and applicability of hypervariables, a new construct designed to solve data-race problems created by parallel accesses to global variables. The results of the project include software implementations of hyper-variables in the context of Cilk++, including modifications to the Cilk++ language, compiler, tools and runtime platform. Additionally, the project will produce engineering design documents, user documentation, and training and educational materials, and will evaluate this technology in customer applications. In 2008, the leading processor manufacturers will ship over 100 million processors, with forecasts for over 75 percent of such processors be multicore. On the software side, the C++ programming language has become the standard langauge for developing applications that run on uniprocessor-based platforms. Although C++ programmers number well over 3 million, most lack the specialized training to use create correct, high-performing parallel programs. This research project will allow ordinary developers to multicore-enable legacy code and bring new multicore applications to market, thereby fulfilling the potential of multicore technology to help users of computers and personal appliances be more productive and to take advantage of the increased performance of computers in as diverse areas as health care, shopping, scientific advancement, entertainment, financial planning, and more. This research will advance the understanding of how multicore computers can be programmed effectively. The lessons of Cilk++, and the innovation of hypervariables in particular, will generalize to other programming languages, such as Java, C#, and Fortran. The educational and training materials will educate software engineers in parallel programming and expose them generally to the subtle issues of concurrency.

Title: SBIR Phase II: Algorithms and Visualization Techniques for the Detection of Geographic Aberrations in Crime (GIS)

Award Number: 0750507
Program Manager: Ian M. Bennett

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $467,805

Investigator: M. Cecelia Buchanan, info@avencia.com
Company: Avencia Incorporated
340 N 12th St, Suite 402B
Philadelphia, PA 19107
Phone: (215) 925-2600

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will further develop HunchLab -- software tools that leverage spatial statistics to enable police personnel to test their theories of criminality against data collected in the day-to-day activities of policing. The preceding Phase I project proved the feasibility of developing HunchLab as a set of innovative software tools that scour the historic data of a police department, search for geographic aberrations expected by the theories or 'hunches' put forth by crime analysts, and apply spatial statistics to confirm or deny the supposition. Preventing crime is a more sophisticated task than simply mapping incidents or arrests and deploying resources accordingly. The ability to detect and analyze changes in the geographic patterns of crime and disorder is an innovation in policing which holds the potential to enhance the organizational capacity of police departments across the country. This Phase II project will refine the application and build additional functionality, including alternate workflows for different user types, expanding the alert infrastructure, and building text mining capabilities. The obvious sector that this product will impact is law enforcement at all levels of government. Additionally the successful outcome will impact federal law enforcement agencies and regional crime analysis consortia. There are roughly 250 municipalities with over 100,000 people in them, and these each have police departments that would find this system of use. The tools will be helping thousands of police officers do their jobs better every day. This efficiency will result in better policing, meaning that criminals will be caught more effectively. Criminals cause damage far in excess of the property and medical costs directly attributable to their activity. Perhaps more importantly, the research will form the basis for other products that operate in realms other than law enforcement. The algorithms and technologies developed in the Phase I prototype are transferable to other datasets that demonstrate similar point pattern processes - events with explicit spatial and temporal attributes. Our Phase I process demonstrated a substantial utility in domains other than law enforcement including fraud detection, real estate, sales and public health. The Phase II work plan includes testing with other data sets to refine that software should address these other markets.

Title: SBIR Phase II: FireScape: A Platform for On-Demand, Browser-Based Incident Command

Award Number: 0750514
Program Manager: Ian M. Bennett

Start Date: March 15, 2008
Expires: February 28, 2010
Total Amount: $491,180

Investigator: Robert Crabtree, crabtree@hyperspectives.net
Company: HyPerspectives, Inc.
2048 Analysis Drive
Bozeman, MT 59718
Phone: (406) 556-9880

Abstract:

This Small Business Innovation Research (SBIR) Phase II aims to prove the feasibility of creating a web-based mapping and visualization application for end-users in wildland fire management communities as an extension to the results of the Phase I work. By partnering with strategic vendors, the project will expand our current application to offer not only advanced remote-sensing data products and customized reports, but on-site, real-time weather data, GPS tracking, and full data transfer and communications networks (including audio and video). The project aims to ultimately provide end-users access to a complete team of expert analysts and engineers to gather, merge, and analyze fire-related data products through satellite communications networking. Our experts will then consolidate and simplify all the available data into custom, real-time data reports with geospatial context and delivery it to end-users to expedite high-level decision making, which can save valuable assets and lives. The platform will be amenable to the networking, visualization and analysis of a great number of issues in not only the natural resources realm, but also homeland security, disaster relief, global monitoring, and hazard mitigation. The ability to quickly and efficiently collect, analyze, and share geospatial data (in particular, time-sensitive environmental data) across the World Wide Web is the cornerstone value proposition for this product. These combined abilities provide a critical and as-yet-unavailable tool for the fire management community. The project has both economic and humanistic benefits in that confinement strategies decided-on and applied during the early stages of fires can significantly reduce the cost of fire suppression by several millions of dollars. This increased information will also allow decisions to be made that keep firefighters as safe as possible. Additionally the project will offer advanced data products in formats designed specifically to address the aspects that influence these decisions. The combination of the hub solution and web browser interface as a flexible architecture, is based on open standards and therefore is agile, dynamically configurable, and interoperable holding significant value for applications such as natural disasters, pandemics, or homeland security. The overlay and visualization of that data will provide analyses of critical importance for decision and policy makers, as well as regular citizens, all seeking the best geospatial information possible and in a form they can use.

Title: SBIR Phase II: User Oriented Character Animation Framework for Producing Believable Motions

Award Number: 0724452
Program Manager: Errol B. Arkilic

Start Date: November 15, 2007
Expires: October 31, 2009
Total Amount: $493,457

Investigator: Adam Divelbiss, awdivelbiss@optonline.net
Company: Creative Logic Entertainment
7 Barnes Drive
Wappingers Falls, NY 12590
Phone: (914) 649-2235

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project proposes a new approach to the problem of creating and editing premium quality computer-generated character animation that will dramatically reduce the heavy labor penalty associated with animation techniques and software tools currently available. The specific technical innovation consists of a generic animation framework that produces high-quality motion through a reduced set of input parameters (compared to keyframe techniques) while providing a high degree of "directability" for the user. Additionally the proposed innovation affords the ability to capture, store and reproduce stylistic motions with a high level of fidelity and repeatability. Style is encoded in both physically- and behaviorally-based time-variable parameters supporting smooth transitions between styles. The theoretical foundation is similar to spacetime approaches yet has major differences that improve usability, flexibility, and productivity. Successful completion of this project will lead to a product that increases the productivity of experienced animators by simplifying the animation process, and enables novice or non-animators to quickly and easily create animated content. The successful completion of this Small Business Innovative Research phase II project, in conjunction with an appropriately developed user interface, will positively impact the global content creation industry by increasing the ease-of-use for creation of animation compared to the difficult and labor intensive animation processes currently employed. Successful commercialization will expose a much broader consumer market to the art of computer animation. The broader exposure of the solution will allow un-trained and underrepresented groups the ability to express themselves through the art of 3D computer generated character animation that is currently the realm of highly skilled users only. In addition, the increased ease of creating compelling animations will afford the dissemination of animation based information over a broader audience. Finally, the solution will allow animation to be used for applications where it was not previously feasible due to ease-of-use and budgetary constraints opening up new commercial opportunities.

Title: SBIR Phase II: CLEAR-View - A Cost Effective Thermal Imaging Sensor

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| Award Number: | 0724500 |
| Program Manager: | Errol Arkilic |
| Start Date: | September 15, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,991 |


Investigator: Kamil Agi, kagi@ka-wireless.com
Company: K&A
2617 Juan Tabo Blbd NE Ste A
Albuquerque, NM 87112
Phone: (505)338-2380



Abstract:

This Small Business Innovative Research (SBIR) Phase II project aims to develop and produce a novel suite of algorithms to enhance the performance of thermal imagers, offering real-time solutions in the automotive, surveillance and other segments of the thermal imaging market. The proposed algorithm is integrated with noise-infested, uncooled microbolometer infrared cameras, elevating their performance and offering manufacturing-cost reductions while adding new features and capabilities. At the heart of the approach is a Scene-Based NonUniformity Correction (SBNUC) algorithm, which works to correct the fixed-pattern noise resulting from nonuniform detector-to-detector responses in the focal-pane array. The novel SBNUC approach relies on exploiting the presence of minute amounts of scene/camera motion in a video sequence, naturally present in almost all applications, to algebraically extract the nonuniformity-noise parameters in a dynamic fashion, without the need for a mechanical shutter, as done conventionally. This approach improves the camera's reliability.

If successfully commercialized, the largest market is in the automotive sector, where the lower cost and improved performance of the device can potentially lead to tens of millions of dollars from new installs of collision-avoidance systems in cars and trucks. The enhanced features and lower costs offered by this technology also offer the potential of expanding the use of thermal imaging in other applications. In the firefighting market segment, equipping every firefighter with a thermal imager will reduce the number of fatalities due to smoke inhalation, heat, and response efficiency. In security applications, more information will be delivered at a higher level of quality.

Title: SBIR Phase II: Algorithms and Hardware for Real-Time H.264 Encoder

Award Number: 0450514
Program Manager: Juan E. Figueroa

Start Date: February 1, 2007
Expires: January 31, 2007
Total Amount: $500,000

Investigator: Sassan Pejhan, sassanp@vbrick.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop novel algorithms and hardware accelerators, as well as a prototype, for a real-time, high-resolution, H.264-based network video appliance. H.264 is the latest video compression standard, jointly developed by the ITU-T and ISO/IEC (MPEG). It is also designed for transmission over packet-based networks and to achieve significantly superior compression efficiency compared to previous standards and proprietary solutions. This compression efficiency, however, is achieved at the cost of severely increasing the complexity of the encoder. Real-time, high-resolution H.264 encoders are not feasible with current personal computers or DSP-based approaches. The new algorithms and designs for hardware acceleration will be targeted at video compression techniques that were introduced by the H.264 standard for the first time. They are anticipated to improve encoder performance by at least one order of magnitude compared to current implementations

If successful a real-time, network appliance with the compression efficiency of H.264 will have broad applications, particularly in the areas of distance learning, remote training, security and surveillance. The innovations resulting from this should enable implementers to significantly improve the real-time performance of H.264. Limited bandwidth and the resulting poor quality video have so far been an impediment to realizing the full benefits of digital video. A real-time, high-resolution network appliance with the compression efficiency of H.264 will bring digital video in the mainstream by delivering high quality video to the endpoints of the network. This will drive both business and consumer uses. It will provide the visual communication crucial to making distance learning and remote training a superior experience and compelling from an economic viewpoint - and therefore mitigate geography as a barrier to participation in scientific and engineering activities. Students can partake in classes offered at remote campuses while rural K-12 schools can partner with museums in major cities to provide their students with a richer education.

Title: SBIR Phase II: Fast Remote X-ray Screening

Award Number: 0620369
Program Manager: Errol Arkilic

Start Date: September 7, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Edward Sommer, ejsommer@nrt-inc.com
Company: National Recovery Tech Inc
566 Mainstream Dr. Suite 300
Nashville, TN 37228
Phone: (615)734-6400

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will provide development of a new homeland security technology for improving security for crowded venues by integrating a new networked security screening technology and new electronics communications with materials handling automation and computerized process control. New approaches and technologies are needed to provide effective security screening for places having high passenger and high pedestrian traffic. A primary need is to be able to screen persons and their carried items at significantly higher processing rates from those achieved using conventional security checkpoints while maintaining a smooth flow of people through the system. The Phase I project demonstrated technical feasibility. Phase II will complete development of the new high flow security screening system and design, construct, and test a near commercial scale prototype system. It is planned that the prototype system will be tested and evaluated by a TSA-approved, independent third party. Upon successful testing the system will be ready for deployment.

The U.S. transportation industry needs fast effective improvements in its security systems. Improved security technologies for use in transit systems can be applied to many other segments of society as well. In today's world it is vital that our nation's citizenry, transportation systems, institutions, and economy have the best protection possible from those who seek to weaken and destroy our society. The proposed technology will provide smooth flow of people and items through a fast and effective security inspection station with greater than an order of magnitude increase in processing rates compared to current technologies. The new technology will provide a significantly higher level of protection to persons in busy and crowded areas against attacks by terrorists using weapons or explosives than is currently available. Similarly, security at federal buildings, government installations, maritime ports, shippers, mailrooms, and other sensitive locations can be improved by the proposed technology that will allow for a faster and less impeded flow of persons and packages through the security inspection process.

Title: SBIR Phase II:  T-Splines for Surface Intersection

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| Award Number: | 0620461 |
| Program Manager: | Errol Arkilic |
| Start Date: | August 4, 2006 |
| Expires: | July 31, 2008 |
| Total Amount: | $499,111 |

Investigator: David Cardon, tspline@byu.edu
Company: T-Spline Company
331 North 1100 East
Orem, UT 84097
Phone: (801)592-0263

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses what is considered to be a significant unsolved problem in the Computer-Aided Design (CAD) industry; the fact that many CAD models contain numerous small, unwanted holes or gaps. These gaps occur most often along the seams where two surfaces in a CAD model meet, such as where a wing meets the fuselage of an airplane, and result from fundamental mathematical limitations. Software for analyzing a CAD model for physical properties such as aerodynamics, deflection, or stress cannot work unless those holes are repaired; a time consuming process that causes a significant bottleneck in the CAD workflow. Under Phase I funding, a solution to this gap problem was devised that uses a new surface formulation called T-Splines. Tasks to be performed in Phase II include extending the algorithms to work in arbitrary cases, designing and implementing algorithms for converting trimmed-NURBS models into gap-free T-Splines, adding fillets to the surface intersection, and incorporating the core software into two existing CAD packages using the idea of a "plugin."

The gap problem has vexed the CAD industry for over 25 years.  The solution to the gap problem conceived in previous efforts involves a new technology called T-Splines, which some researchers in the CAD community believe represents a significant advance in the field of surface modeling theory.  This project will help the T-Splines technology to mature and will hasten its adoption into the CAD industry.

Title: SBIR Phase II: Video Mining for Customer Behavior in Retail Enterprises

Award Number: 0548734
Program Manager: Errol Arkilic

Start Date: May 26, 2006
Expires: May 31, 2008
Total Amount: $500,000

Investigator: Satish Mummareddy, smummareddy@videomining.com
Company: VideoMining Corporation
403 South Allen St Suite 101
State College, PA 16801
Phone: (814)867-8977

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims at developing video mining techniques for automatically generating statistics about in-store shopping behavior to help retail enterprises. These statistics can provide valuable insights for supporting critical decisions in store layout design, merchandising, marketing, and customer service. Further, since it is automated, video mining can become a tool for monitoring the impact of all customer-facing elements in a store. The Phase II research will continue in cooperation with the proposing company's partners and customers, while addressing the remaining challenges for video mining. The proposed tasks include robust person detection, tracking people across multiple cameras, modeling and recognizing complex shopping behavior involving shopping groups and sales associates. The approach will be to use a variety of computer vision and statistical learning techniques under the constraints of a typical retail environment.

Retail enterprises today operate in a hyper-competitive environment characterized by blurring categories, eroding market shares and fickle, but more demanding customers. These challenges have prompted retailers to adopt customer-centered strategies focused on uncovering and matching the needs of customers to gain (retain) market share. These strategies rely heavily on obtaining deeper insights into shopper behavior. Current methods (human observation and manual video indexing) for analyzing shopper behavior are limited in their scope while being expensive and time-consuming. On the contrary, the shopper insights gained from the proposed video mining platform will enable more informed decision-making leading to improvements in retail productivity and business process optimization. The proposing company has plans to immediately incorporate the outcome of the SBIR research into its retail product line.

Title: SBIR Phase II: THz Imaging Focal Plane Array

Award Number: 0548853
Program Manager: Errol Arkilic

Start Date: March 6, 2006
Expires: February 29, 2008
Total Amount: $464,344

Investigator: Oliver Edwards, oliver@zyberwear.com
Company: Zyberwear
2114 Victor Rd
Ocoee, FL 34761
Phone: (407)295 5955

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to develop a high-resolution focal plane array for terahertz imagery. THz radiation is a largely unexplored region of the spectrum, but holds great promise for its ability to pass through clothing, packaging and baggage walls (security applications) and for its ability to excite resonant molecular motions according to the composition and conformation of complex molecules such as explosives, illegal drugs and pharmaceuticals (imaging spectroscopy). Present uncooled detector technology is marginal in its ability to sense THz radiation and in video frame rate.

The anticipated results of this work are to demonstrate: (1) a 20 to 40 times improvement in noise-limited radiation detection at operation up to 250 Hz frame rate; (2) a new technique for very low cost manufacture of all-wavelength focal plane arrays; and (3) a high-performance THz focal plane array.

Title: SBIR Phase II: IBARS - An Image Barcode Acquisition and Recognition System for Mobile Commerce

Award Number: 0522144
Program Manager: Errol B. Arkilic

Start Date: September 15, 2005
Expires: August 31, 2007
Total Amount: $499,550

Investigator: Huiping Li, Huiping.Li@appliedmediaanalysis.com
Company: Applied Media Analysis, Inc.
7814 Rockburn Dr
Ellicott City MD, 21043
Phone: (410)493-9043

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops the concept of using hand-held, mobile devices to link the physical world to information networks using advanced pattern and symbol recognition technology that will be deployed on the mobile device. The proposed mobile symbol recognition technology will enable many opportunities for mobile e-commerce by recognizing bar codes, text on documents and user-customizable icons that are used to carry and convey information. To address these opportunities, technical challenges associated with limited processing power and memory resources, lower-quality optics in cameras, varying available network bandwidth, and the diversified development platforms they represent must be overcome. The advances proposed include the ability to unwarp images to account for distortions due to perspective imaging and lenses, removing imaging artifacts such as non-uniform lighting and highlights, deblurring images caused by fixed focus and motion, and improving the image contrast all within the resource constraints of the mobile devices. Recognition algorithms in the system must be able to automatically identify and decode various barcodes symbologies, handle multiple languages and fonts for Optical Character Recognition (OCR), and be trainable for user customizable icons. Special consideration must be given to cross platform development so algorithms can be efficiently and robustly embedded in different development platforms.

The ability to perform image processing and pattern recognition algorithms on diversified handheld devices will provide advances in fields such as computer vision, mobile computing, and software engineering. This concept is powerful in that it requires no new infrastructure, since it uses popular mobile devices, and existing symbols such as barcode tags, text, and user-customizable icons. The downloadable symbol recognition component will enable many applications. Other than service providers and OEMs, merchants, advertisers, information providers and other service providers are likely partners and customers for our technology. Finally, the technology can be used to help disadvantaged groups (handicapped or visually impaired, for example) get access to product information (prescription drug instructions, for example) or transact commerce activity conveniently, using a device they may already have, or that is easily acquired. These include applications in medical care delivery, military applications, sign recognition for the visually challenged, and others

Title: SBIR Phase II: A Foundation for Emergency Egress Simulation

| | |
|---|---|
| Award Number: | 0521897 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | September 1, 2005 |
| Expires: | August 31, 2007 |
| Total Amount: | $499,374 |

Investigator: Daniel Swenson, swenson@thunderheadeng.com
Company: Thunderhead Engineering Consultants, Inc
1006 Poyntz Ave
Manhattan KS, 66502
Phone: (785)770-8511

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop new capability to model emergency egress from buildings. The primary focus of the research is evacuation due to fires, but the software will be designed such that exposure and response to biological and chemical agents can also be simulated. The project will couple egress analysis to time-varying fire conditions (e.g. smoke density, heat, and CO) calculated using a Computational Fluid Dynamics fire simulator. This will enable simulation of emergency situations in which, for example, some exit paths become blocked. In addition to incorporating current human response models, the software will allow researchers to specify more complex individual behavior based on the results of recent studies of observed human behavior during emergencies. Thus, the project will not only result in a commercial product of immediate use to the fire safety industry, but will also provide a framework in which to incorporate future knowledge into a problem of fundamental importance to an urban society.

This research will lead to a product that will facilitate broad use of fire emergency egress analysis and will introduce a new technology (coupling egress analysis with CFD fire modeling) into the present fire safety design and regulation process. In 2003 fire claimed 3,925 American lives and caused direct losses of $12.3 billion, with a total economic cost of $165 billion. Any technology that reduces even a fraction of this cost will be significant. The integration of egress analysis with fire simulation provides new capability to more accurately simulate emergency building evacuation. The engineering time required for the analyses will be significantly reduced by a common user interface and geometry database that will enable the broader application of this technology throughout the fire safety industry. Societal impacts include increased public safety, advancement in fire research, and reduced building costs. Coupling egress analysis and fire simulation will lead to new discoveries and recommendations based on post accident analysis. The software will enable researchers to add their own models of human behavior to the analysis.

Title: SBIR Phase II: Grid Computing for Energy Exploration and Development

Award Number: 0522194
Program Manager: Errol B. Arkilic

Start Date: August 15, 2005
Expires: July 31, 2007
Total Amount: $500,000

Investigator: Dimitri Bevc, dimitri@3dgeo.com
Company: 3DGeo Development Inc
4633 Old Ironsides Dr # 401
Santa Clara CA, 95054
Phone: (408)450-7840

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a grid-enabled environment where large multidimensional seismic data sets can be rapidly accessed, visualized, and interpreted by geographically dispersed users with heterogeneous local resources. The proposed work will transform the Phase I prototype into production-ready commercial quality software, and demonstrate it on 3-D seismic data. The key technical innovations of the Phase II project are (1) a multi-resolution data visualizer, (2) a data-staging tool, and (3) a multi-channel collaboration tool to support collaborative visualization and data analysis on the grid. The proposed technology will allow multiple users to share and interact with multidimensional grid-dispersed data sets, while viewing independent multiple renderings with resolutions and bandwidths commensurate to their local display and network capabilities. The proposed technology will be enabled by implementing several grid services, and a virtual file system, that make grid deployed data sets appear local to the user. This implementation comprises the bulk of the technical tasks, and leverages the middleware. The immediate outcome of the Phase II project will be a version of Internet Seismic Processing production software (INSP) with specialized features for remote visualization, data staging, and collaborative analysis of seismic images on the grid.

The ultimate objective of the Phase II project is a commercial grid-enabled software product providing scientific data, services, computing power, and visualization on demand, not only to the oil and gas industry but to a much wider range of application areas, such as geographic information systems, education, medical imaging, and battlefield management. The product will push the limits of what can be done, and fully contribute to a new business paradigm, made possible by the advent of the grid, allowing businesses to concentrate on their core competencies and rely on other entities for grid-enabled context technologies, without deterring from their primary objectives. The outcome of Phase II will be a commercial implementation and utilization of the grid, and the toolkit, which up until now, has been used mostly in academic and research applications. This technology will first be commercialized in a strategically important economic sector; namely, for the exploration of new energy resources. Specific to U.S. energy needs, this unique application of high end information technology to an area of economic and national importance will ultimately open up new exploration venues in extremely complicated geological conditions, leading to new discoveries, and decreasing US dependence on imported oil.

Title: SBIR Phase II: Variable Azimuth Wave-Equation Imaging (VAWEM)

Award Number: 0450588
Program Manager: Juan E. Figueroa

Start Date: March 15, 2005
Expires: February 28, 2007
Total Amount: $512,000

Investigator: Dimitri Bevc, dimitri@3dgeo.com
Company: 3DGeo Development Inc
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Santa Clara CA, 95054
Phone: (408)450-7840

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will implement and demonstrate the feasibility of a new technology that enables enhance seismic resolution and imaging of deep water complex geologic structures by using variable azimuth wave-equation migration (VAWEM). VAWEM will provide much greater resolution and accuracy than what can be accomplished today for towed marine streamer data, and at significantly less computational cost. The software will be optimized for deployment on Linux clusters, and testing will be conducted to determine the optimal geophysical parameters for obtaining the best possible images. The project involves significant computer engineering to obtain the maximum efficiency required to image terabyte size data sets and significant geophysical work to demonstrate the validity of the approach. This advanced imaging methodology will improve success rate and cost effectiveness for new field discoveries and increase recovery efficiency for the development of existing fields. This technology is a fundamental revolutionary advance, and is a necessary building block in any seismic processing system that images 3-D prestack data using wave-equation methods for imaging deep water, under-salt complex geological structures which are the focus of modern oil and gas exploration.

Societal and economic benefits from the proposed VAWEM technology will accrue directly to the nation by lowering energy costs and reducing dependence on foreign energy sources. Energy is at the core of the U.S. and world economies; therefore, the political, societal, and economic benefits of the proposed technology go well beyond the substantial direct economic benefit that this technology will bring to the proposing company and its customers. Commercial potential of the proposed technology is directly applicable to the fastest growing and strategically most important area of U.S. exploration, namely the deepwater subsalt oil and gas province of the Gulf of Mexico federal waters. It is estimated that most of the Gulf's untapped resources (45 Billion barrels of oil and 207 trillion cubic feet of natural gas) are trapped in deepwater subsalt reservoirs, and in ultra deep (over 15,000 ft) gas deposits. Since exploratory wells in these areas typically cost more than $30 million, tapping these reserves will require advanced imaging technology such as VAWEM to reduce risk and make exploration feasible. Reduction USA's dependence on Persian Gulf sources and the strategic benefits of maintaining strong U.S.A. leadership in oil technology transcend purely financial considerations.

Title: SBIR Phase II: New Algorithms for Pan-Tilt-Zoom (PTZ) Camera Based Object Tracking

Award Number: 0450171
Program Manager: Juan E. Figueroa

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $500,000

Investigator: Laura Drake, ladrake@ieee.org
Company: JunTech, Inc.
2314 E. Stratford Ct.
Shorewood WI, 53211
Phone: (414)332-8349

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a new class of moving object tracking algorithms and software prototype for Pan-Tilt-Zoom (PTZ) cameras in video surveillance systems. In most of today's video surveillance systems, human operators using PTZ cameras perform real-time object tracking manually. This is often stressful and inefficient (an operator can only control one PTZ camera at a time) and causes inconsistent results. The proposed project will develop a new class of algorithms to direct PTZ cameras to track multiple moving objects of interest automatically. Using an optimal filter with new object state and observation models does this. The project outcome will be smart software modules that can be integrated into standard video surveillance systems to improve their capabilities.

Video surveillance systems are important tools in the fight against crime and terrorism. Most of the systems on the market today are relatively standard DVR's (digital video recorders) with few smart features. The proposed innovation (automatic object tracking) is a smart feature that can significantly improve a standard system's capabilities by allowing it to get better and more useful images. Since this feature is demanded by many end-users, it is highly attractive to equipment vendors and integrators. Furthermore, by introducing new models for object tracking , the proposed innovation also advances the state-of-the-art in image processing and computer vision research.

Title: SBIR Phase II: A Decision Support System for the Railroad Blocking Problem

Award Number: 0450504
Program Manager: Juan E. Figueroa

Start Date: December 1, 2004
Expires: November 30, 2006
Total Amount: $532,000

Investigator: Ravindra Ahuja, ravi@InnovativeScheduling.com
Company: Innovative Scheduling Systems, Inc.
4548 SW 97th Terrace
Gainesville FL, 32608
Phone: (352)336-1257

Abstract:

This Small Business Innovation Research Program (SBIR) Phase II project entails developing a decision support system for the railroad-blocking problem, one of freight railroad transportation's most significant optimization problems. The mathematical complexity of railroad transportation problems has precluded the development of optimization algorithms for solving them preventing railroads from benefiting from the advances taking place in the field of optimization; they still rely on manual decision-making processes for most of their planning and scheduling needs. During Phase I, the company developed prototype software for the railroad blocking problem and tested it on the data provided by three major US railroads: CSX Transportation, BNSF Railway, and Norfolk Southern Corporation. In this Phase II project the company will develop a prototype for a commercial decision support system for the railroad-blocking problem by combining state-of-the-art operations research techniques with latest information technology tools. This project will enhance core optimization engines and algorithms using cutting-edge ideas in network optimization, heuristic optimization, data structures, and software engineering. Database connectivity will also be provided. This Phase II project will extend algorithms for the railroad-blocking problem to similar problems arising in postal/package delivery service design and developing prototype software.

Currently, railroads takes months of team effort to determine a blocking plan and undertake this exercise once in several years with intermittent periods of minor adjustments to account for seasonal variations in the traffic pattern. The proposed decision support system would allow a railroad to determine a blocking plan in a matter of a few hours and produce solutions far superior than those obtained manually. The proposed solution will enable a large freight railroad to optimize its blocking plans frequently and reduce cost by at least $10 million annually and hundreds of millions of dollars for railroads companies in the USA and Canada over a few years. The research will establish the efficacy of network optimization and heuristic methodology in solving railroad planning and scheduling problems. The success of this product will lead to a greater acceptance of optimization models and optimization-based software in the railroad industry.

Title: SBIR Phase II: Next Generation Binary Decision Diagrams (BDD)-Based Logic Optimization System

Award Number: 0421993
Program Manager: Errol B. Arkilic

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $500,000

Investigator: Qian Ren, qren@logic-mill.com
Company: LogicMill Technology
41 The Hollow
Amherst, MA 01002
Phone: (413)587-2030

Abstract

This Small Business Innovation Research (SBIR) Phase II project targets the synthesis of very large-scale integrated circuits (ICs) and systems on chip (SoC) in very short CPU time. The expected short CPU time comes from relying on binary decision diagram (BDDs) that replaced the traditional algebraic representations used pervasively in present-day tools. This Phase II SBIR project is devoted to developing further the capabilities of swift and integrating it with a number of commercial tools. The development plan includes new capabilities, such as improving area by adding new logic transformations and improving the speed of processing by implementing novel decomposition algorithms.

This project will significantly advance the theory of modern logic optimization and promote its understanding in industry and academia. It would also promote the inclusion of faster logic synthesis tools in existing Electronic Design Automation (EDA) systems. It would benefit the national EDA industry, and help the US to maintain its competitive advantage against its foreign competitors in this strategically important market.

Title: SBIR Phase II: Computerized Tool for Baggage Screening

Award Number: 0422071
Program Manager: Juan E. Figueroa

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $498,882

Investigator: Edward Sommer, ejsommer@nrt-inc.com
Company: National Recovery Technologies, Inc. (NRT)
566 Mainstream Drive
Nashville, TN 37228
Phone: (615)734-6400

Abstract:

This Small Business Innovation Research Program (SBIR) Phase II research project will develop a technology for improving security checkpoint effectiveness and increasing throughput while reducing labor costs for airports and other sensitive installations by integrating information technology systems incorporating new x-ray image inspection technology, new electronics communications technology, materials handling automation, and database-centric computerization. Current processing rates through a typical security checkpoint are relatively slow and laborious and costs are high. Today's checkpoints take little advantage of computerization thereby limiting their effectiveness. It is planned that the prototype system will be integrated into a TSA approved test site and tested and evaluated by an independent third party Modernization of checkpoint security will improve protection of many other segments of society. In today's world it is vital that our nation's citizenry, transportation systems, institutions, sensitive installations, and economy have the best protection possible. Security has become much more restrictive and time consuming.

If successful this project will develop a product that will be able to increase the security at check bags handling facilities while reducing the time to conduct the checks. The streamlining and improving of security at federal buildings, government installations, maritime ports, shippers, mailrooms, and other sensitive locations can increase confidence in our day-to-day lives and help improve the nation's economic security.

Title: SBIR Phase II: Technology for Integrated Computation and Communication

Award Number: 0349414
Program Manager: Juan E. Figueroa

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $500,000

Investigator: Chitoor Srinivasan, srinivas@cs.rutgers.edu
Company: EDSS., Inc.
Port Saint Lucie, FL 34952
Phone: (772)335-3677

Abstract:

This Small Business Innovation Research Program (SBIR) Phase II research project proposes to develop a prototype product for an innovative parallel program development and execution technology, which can run parallel programs asynchronously in multiprocessors and supercomputers up to 100 times faster than what is currently possible, without using Message Passing Interfaces (MPI). For more than thirty years it had been assumed that the only way to efficiently compile and execute parallel programs was through MPI. Even though it had been recognized that parallel programs would run faster if executed asynchronously on the basis of data availability, technology needed to do that efficiently was not available, until Technology for Integrated Computation and Communication (TICC) came along. This tuning technology eliminates the need for dynamic checking of temporal coordination, and makes it possible to execute control signal exchange protocols in parallel with computations. More than 40 million messages may be exchanged per second. This eliminates communication bottleneck and allows asynchronous execution of parallel programs based on data availability without using MPI. TICC defines the semantics of causal statements and provides a very efficient implementation for them. TICC brings the following additional facilities: (1) Component based parallel program development environment, (2) Dynamic debugging of parallel programs (3) Dynamic monitoring and changing of messages and message traffic, (4) Dynamic repair and failure recovery, (5) Dynamic reconfiguration, and (5) Dynamic evolution parallel software systems. These have the consequent benefit of reducing parallel program development and maintenance costs, making them more easily and widely available.

This, together with decreasing costs of multiprocessors, has the potential to usher in a new era of desktop supercomputing by 2007, with profound impact on science, technology, industry, education, theories of computation and communication, and society in general.

Title: SBIR Phase II: Artificial Intelligence Software for Student Assessment in Chemistry Education

Award Number: 0349630
Program Manager: Sara B. Nerlove

Start Date: February 1, 2004
Expires: January 31, 2006
Total Amount: $500,000

Investigator: Benny Johnson, johnson@quantumsimulations.com
Company: Quantum Simulations Incorporated
5275 Sardis Road
Murrysville, PA 15668
Phone: (724)733-8603

Abstract:

This Small Business Innovation Research (SBIR) Phase II project builds Phase I work on development of meaningful interactive tutoring and assessment capabilities for chemistry education software. Despite clearly articulated teacher and student demand for improvement, this area has been repeatedly identified as that where existing offerings are weakest. Quantum Simulations proposes a new and different approach, adapting and incorporating new concepts from artificial intelligence (AI). More than just assigning a grade, meaningful opportunities will be created for students to learn directly from the assessment itself. The proposed technology will benefit all students; however, it is specifically targeted to help those who have the greatest need--such as students of average or marginal performance and students from historically underserved groups-- by lowering barriers to accessing high-quality science instructional software. Quantum Simulations has partnered with members of the Department of Education's STAR Schools program to further these goals.

Quantum Simulations' customers include textbook publishers, software providers, hardware vendors and distance learning companies. A prominent textbook publisher, Holt, Rinehart and Winston, has entered into a long-term contract and has partnered with Quantum Simulations to commercialize this Phase II technology, resulting in rapid dissemination to an established end user base.

Title: SBIR Phase II: Adaptive Personalization and Context Management for Location-Based Mobile Devices (AdaptTribe)

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| Award Number: | 0349778 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | January 15, 2004 |
| Expires: | December 31, 2005 |
| Total Amount: | $467,609 |


Investigator: Daniel Greening, greening@bigtribe.com
Company: BigTribe Corporation
330 Townsend St Ste 209
San Francisco, CA 94107
Phone: (415)995-7150



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops personalized user-interfaces for location-based services. This adaptive proximity-based personalization algorithm recommends nearby venues based on predicted user interest and distance. It will further develop a highly distributed algorithm that allows handsets to perform part of the calculation, dramatically reducing computation costs that central servers would otherwise bear. This context-based user-interface allows users to chain operations, concentrating activities by proximity, and avoiding retyping. This project will expand the user- interface advancements to include personalizing categories, and a user-interface approach that mixes categories with individual venues. In addition it will explore algorithms that mix different types of venues on the same screen. Identity federation will help retailers and portals more readily deal with intermediary services. Self-service retail interfaces can allow traditional "brick-and-mortar" retailers to cost-effectively provide "click-and-mortar" services to consumers. A SOAP-based web-service will allow portals to filter data and configure look-and-feel more precisely. However, the proposedtag mechanism will likely be good enough for most portals, as the output format can be configured easily through CSS, and filtering can be performed through the company's self-service portal interface

The end result of this project is a product that can be incorporated in enterprise logistics applications that help field personnel find, reserve, use and store resources while being able to improve the speed that consumers navigate user-interfaces, even when location is irrelevant. The in-handset personalization may ensure better privacy and security, even in non-location based applications. The product will use proximity to maximize value: building business-consumer relationships, enhancing social harmony and strengthening communities, as a result.

# Database Management

Title: SBIR Phase II: SaaS-Based Procurement and CRM Systems for Local Food Markets

Award Number: 0822889
Program Manager: Errol B. Arkilic

Start Date: August 15, 2008
Expires: July 31, 2010
Total Amount: $500,000

Investigator: Heather Hilleren, heather@greenleafmarket.com
Company: Hevva LLC
PO Box 5155
Madison, WI 53705
Phone: (608) 395-4990

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new methodology for data interchange in the agricultural industry. GreenLeaf Market is developing application program interfaces to enable the automated transfer of data to enterprise resource planning systems through a representational state transfer interface interchangeable with a webservice. This platform automatically identifies and aggregates agricultural market information while enabling this information to be integrated into the purchaser's business systems. If successfully commercialized, the application stands to significantly reduce post-harvest spoilage costs, now in the tens of billions of dollars for the United States. It will increase productivity for purchasers, assist the producer in identifying emerging markets, reduce the distance agricultural products must travel, boost the local economy, improve the food security of the US, and lower the overall cost of food by reducing the gap between supply and demand.

Title: STTR Phase II: Integrating Online Analytical Processing (OLAP) and Ontologies to Discover Inconsistencies in Expectations for Supply and Demand

Award Number: 0750543
Program Manager: Errol B. Arkilic

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $512,000

Investigator: Peter Moore, peter@clados.com
Company: Clados Management LLC
133 Saint Matthews Avenue
San Mateo, CA 94401
Phone: (650) 231-0494

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project aims to produce a software application that dramatically improves a manager's ability to allocate resources to productive uses. With advances in Online Analytical Processing (OLAP) and ontology technology, the tool has the potential to enable the discovery of future supply and demand imbalances for teams of business analysts. The objective is to produce at least one Investable Inconsistency per day by the end of the research period. The Phase I project produced unanticipated innovations that may have broad utility in both the OLAP field and the ontology field, and with these innovations, the software platform shows promise for transforming the essential practice of analysis in the field of market research in support of investment decisions. The Phase II project, if successful will result in technology that extends this promise to a broad audience, educating users in best practices for investment analysis and enabling them to materially improve their allocation of resources.

Title: STTR Phase II: Disciple Technologies for Development, Utilization, and Maintenance of Regulatory Knowledge Bases

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|---|---|
| Award Number: | 0750461 |
| Program Manager: | Ian M. Bennett |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $500,000 |


Investigator: Tomasz Dybala, tom.dybala@exprentis.com
Company: Exprentis, Inc.
4031 University Drive, Suite 200
Fairfax, VA 22030
Phone: (703) 272-7702



Abstract:

This Small Business Innovation Research (STTR) Phase II project as a continuation of the Phase I effort, will develop alpha versions of the Regulatory Knowledge Base (RKB) products. The Regulatory Knowledge Bases will be tailored to classes of compliance problems within the financial services space, such as broker or trading compliance, or anti-money laundering. Addtiionally, they will include a complex regulatory ontology specific to the financial services industry and rule bases that reflect the latest regulations and best practices that govern analysis of alerts and compliance cases. The Regulatory Knowledge Base products will be sold in various formats and standards so they can be directly deployed on various commercial off-the-shelf reasoning engines. Regulatory demands, as well as the increasing costs associated with financial crime, are placing increasing cost pressures on financial institutions. The burden of compliance is driving up operational costs. Financial services firms are seeking to improve the effectiveness, efficiency and return on investment of their compliance and risk management systems. The current knowledge management technologies and software tools cannot offer efficient customized procedures to deal with specific compliance cases. Therefore, there is a need for flexible knowledge-based systems, like Disciple-FS, and for Regulatory Knowledge Base products, that can offer help in solving specific cases while ensuring compliance with all the rules and regulations. These systems should also be capable of acquiring reasoning skills of their users to adapt their capabilities to deal with new cases. The prototype built during Phase I proved that the Disciple Technologies have the required functions and abilities to support development, utilization, and maintenance of regulatory knowledge bases. The prototype also helped to identify research and development goals for Phase II that we present in this proposal.

Title: SBIR Phase II: Universal Nanoparticle Taggants

Award Number: 0548756
Program Manager: Errol Arkilic

Start Date: February 16, 2006
Expires: February 29, 2008
Total Amount: $511,495

Investigator: Robert Haushalter, bob@parallel-synthesis.com
Company: PSTI
3054 Lawerence Expy
Santa Clara, CA 95051
Phone: (408)749-8308

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will provide a system that is capable of easily labeling documents, with millions of unique optical signatures that provide a means of distinguishing these documents from other similar objects. Since there are no suitable commercial alternatives, both a scanning spectrometer and hyperspectral imaging system will be constructed and evaluated. The compatibility of developed materials with current screening technology, and the large number of distinct resolvable optical codes available, provides a level of authentication that will be difficult to replicate or decrypt.

Since there is a strong and continuing need to authenticate and verify documents, objects or people, the benefits of this technology will be broad-based and will influence authentication, sorting and identification of many items such as documents, pharmaceuticals or biological samples. The commercially available multiplexing level (number of distinguishable optical signatures) for optical encoding technology is currently limited to 100, so there is immediate need for a technology to provide a means of optically distinguishing very large numbers of similar objects.

Title: SBIR Phase II: The Visual Database: Portable, Extensive Markup Language (XML)-Based Middleware For Media Representation, Interaction and Exchange

Award Number: 0450513
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $470,500

Investigator: William Schroeder, will.schroeder@kitware.com
Company: Kitware Inc
28 Corporate Dr # 204
Clifton Park NY, 12065
Phone: (518)371-3971

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will create a portable representational and interaction metaphor for digital media embedded in a 3D context. Popular document technologies remain text oriented-that is, content is organized into pages and viewed in reading order. The company is creating a novel information exchange paradigm that is generally applicable to information that is best understood in an interactive 3D environment. Applications of this technology include embedded routes on maps, electronic medical records, biological atlases, digital tours of 3D environments such as buildings, and mechanical assembly/disassembly diagrams. Analogous to a PDF file, but designed for a 3D interaction environment, the proposed solution defines an open, portable schema that can be efficiently represented using the portable Extensible Markup Language XML. In Phase II the company will specialize the editor for geospatial application, atlas creation, and assembly planning; addressing such technical challenges as large data and user interaction.

If successful the technology will enhance the ability of researchers, teachers, businesses, and consumers to record, describe and exchange complex 3D content. This innovation has the potential to improve the productivity of individuals and firms that create and communicate with such information; and to enhance the effectiveness of researchers and teachers to convey abstract concepts to others. This project defines a novel metaphor for working with information that goes beyond traditional organizational metaphors such as books and web pages. The proposed product supports complex 3D information; and takes advantage of recent developments in 3D graphics and visualization technology. The representational schema is simple enough to be supported by small portable devices such as PDA's, and sophisticated enough to support complex human/computer interaction in a 3D visualization environment.

Title: STTR Phase II: Location-Based PDA Bird Field Guide

Award Number: 0422158
Program Manager: Juan E. Figueroa

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $499,386

Investigator: Giles Timms, giles@pulluin.com
Company: South Dakota Health Technology Innovations, Inc.
109 Austin St.
Vermillion, SD 57069
Phone: (605)624-9792

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop and test an electronic field guide for North America that will facilitate bird identification in the field combining images, audio, geographic information, and descriptive data. The system will include 1000 birds of North America, uniquely presented audio content, expanded GIS features, support for Windows CE devices, and the wireless transfer of data. The highlights of this software are the mobility offered by the PDA, database searches to aid species identification, access to multimedia and GIS data in the field. The proposed software will provide significant benefits to the education and research communities by allowing multiple PDA users to upload their observations to CLOs (Cornell Lab of Ornithology) eBird server (www.ebird.org) via desktop software or wireless Internet connection.

The availability of PDA-based software for use by students will facilitate student learning and enable students to play a key role in data collection for national and international research projects. The availability of this software to birders and amateur naturalist will promote citizen participation in science and conservation. The data collection and GPS features of the system will help researchers to accurately record scientifically useful data. The portable data collection and data transfer features will facilitate the gathering of data and timely reporting of that data to researchers.

Title: SBIR Phase II: HIVbase, Data Integration Software to Support the Study of Chronic Viruses

Award Number: 0349669
Program Manager: Errol B. Arkilic

Start Date: March 1, 2004
Expires: February 28, 2006
Total Amount: $499,812

Investigator: Susanna Lamers, susanna@genejohnson.net
Company: Gene Johnson, Inc.
4 Milton St.
St. Augustine, FL 32084
Phone: (985)493-3487

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will provide HIV researchers with progressive approaches to manage and analyze genetic data. There is a crisis developing in biology, in that completely unstructured information does not enhance understanding. Today's HIV investigators possess massive amounts of research information in user-hostile formats, error- filled spreadsheets, outdated databases, and directories containing thousands of individual files. These researchers need advanced protocols for extracting value from their disorganized information. Phase I feasibility study proved that the proposed solution provides a quality link between collection and the analysis of data that has never before been available to HIV researchers. This link helps HIV researchers do their job and ultimately promotes understanding for the most deadly and costly epidemic of our time. This project aims to solving researchers problems through the development of software that combines the power of unique data storage and integration with novel applications for data mining, analysis, and data retrieval. The goal is to provide researchers with a combination of modern querying, database, and analysis approaches.

The initial target market for the proposed product is made of HIV researchers and their associated facilities. This market is large, growing in multiple directions, and in need of this product. HIV infects an estimated 40 million people and is being funded at record levels from both government and private organizations. The major significance of the proposed product is in its ability to assist accelerate the efforts of the many scientists, epidemiologists and pharmacologists to make important discoveries relating to this on-going and tragic epidemic.

Title: SBIR Phase II: Web-Based International Trade Knowledge Discovery System (TradingCube)

Award Number: 0349464
Program Manager: Juan E. Figueroa

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $499,895

Investigator: Carlos Sanchez, csanchez@tradingcube.com
Company: TradingCube Inc.
819 Florida Avenue
Pittsburgh, PA 15228
Phone: (412)624-2690

Abstract:

This Small Business Innovation Research Program (SBIR) Phase II project will focus on applied research for the development and implementation of a commercial Web-Based International Trade Knowledge Discovery System. It will address the significant need for organizations supporting international trade and for small and medium-sized business to have improved access to information and dynamic analyses of world markets in a single source. This product will provide subscribers with dynamic analyses of world markets for baskets of goods allowing them to extract actionable information to make strategic and tactical decisions while enabling the functionality of a novel combination of tools including knowledge discovery, data management technologies, web technologies, international trade economics and strategic analysis. This project will focus on: (1) Implementing a prototype based on the results of the Phase I feasibility study within a web portal framework, (2) Developing a library of international trade analyses, interactive maps and graphics, (3) Developing a meta-business directory and implement an international trade search engine, and (4) Developing personalization features and snapshot reports.

The proposed product will contribute to applications of knowledge discovery in the international trade domain, data warehousing, information hierarchies, and clustering-indexing techniques to support analytical queries. In addition it advances research in the application of Scalable Vector Graphics (SVG). SVG is a language for describing two-dimensional dynamic and interactive graphics in XML. The product addresses one of the fundamental areas on which trade promotion can have a significant impact --access to actionable information that will help businesses maximize export potential. In the process it will contribute to economic growth, education and participation of small businesses and underrepresented groups in international trade. The development process and product will involve researchers and students from several disciplines. The potential market includes any commercial, private or public organization with the need to find and evaluate international trade opportunities.

Title: SBIR Phase II: Discovery Analyst: A Data Mining System for Image Databases

Award Number: 0349736
Program Manager: Juan E. Figueroa

Start Date: February 1, 2004
Expires: January 31, 2006
Total Amount: $500,000

Investigator: Stuart Blundell, sblundell@vls-inc.com
Company: Visual Learning Systems, Inc.
1280 S. 3rd Street West
Missoula, MT 59801
Phone: (406)829-1384

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a highly innovative data mining software tool that is capable of mining imagery and spatial information stored in a database management system (DBMS). Billions of dollars have been spent in converting the world's vast supply of paper maps into digital, geographically referenced, data for geographic information systems (GIS) applications because location matters in almost every instance of decision-making for both government agencies and private sector businesses. The proliferation of relational, spatial, and now visual data from high-resolution satellites, all stored in a common DBMS architecture, offers organizations the opportunity for knowledge discovery in databases; however, the technical challenges of maintaining, navigating, and mining these data are formidable. Current workflow approaches are disjointed and exclusive of image data. The product resulting from this project will allow all of the data to be queried and mined in a holistic workflow approach yielding potential useful discoveries through its primary innovations not presently available in data mining software; 1) Seamless integration of data mining and feature extraction workflows, 2) Mining content of high-resolution earth imagery stored in spatial databases, 3) Cleanup of GIS databases, and 4) Advanced query generation and data mining technology. Market research confirms that companies are investing in data mining software and high- resolution commercial satellite imagery.

The proposed product will have commercial applications in both traditional GIS application areas (forestry, defense, civil government, agriculture) and emerging vertical markets for GIS applications (banking and financial, telecommunications, security, manufacturing, retail and healthcare. There is a powerful demand for the knowledge acquisition vital to all location-based government decision-making processes. This significantly impacts the quality of management in our national security, resource handling, and the quality of our environment.

Title: SBIR Phase II: Automatic Information Awareness

Award Number: 0349724
Program Manager: Sara B. Nerlove

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $499,560

Investigator: Yves Schabes, schabes@teragram.com
Company: Teragram Corporation
236 Huntington Ave
Boston, MA 02115
Phone: (617)369-0100

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to study and implement a large-scale information awareness system which will fuse, present and provide an alert as to the existence of newly available information from large bodies of documents based on each user's profile. The amount of information available electronically has been growing at such a rate that it is not only impossible for people to identify the nature of the information content as it is made available, but it is even more out of the question for people to absorb the actual information content. Thus, awareness of and synthesis of the content of information has now become the real challenge. This project will enable users to specify their interests and to detect new information trends matching each individual user's interests, based on the relevance and importance of newly available information. By extracting information from unstructured texts, categorizing it, and fusing it, each user will be presented with a unique view of the content.

Teragram profiler technology allows users to specify information needs for the future. It will provide an alert mechanism based on user specified interests contained in user profiles, measurement and formulation of information speed, volume, decay; and fusion of information found in multiple documents. Such techniques will enable the next generations of information retrieval systems in which information will be tailored to the users' interests thus enabling easy access to relevant information found in large repositories.

# Data Storage

Title:  STTR  Phase II:  Next Generation Digital Data Recovery System

Award Number: 0822980
Program Manager: Ian M. Bennett

Start Date: September 1, 2008
Expires: August 31, 2010
Total Amount: $489,525

Investigator: Anandabrata Pal, PashaPal@aol.com
Company: Digital Assembly LLC
Best
Brooklyn, NY  11201
Phone: (917) 482-0211

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project proposes to research and bring to market the next generation digital data recovery techniques. The problem of restoring lost data from a damaged digital device arises routinely in digital forensics and data recovery. In many advanced cases of digital storage failure currently available file recovery techniques based on disk storage information fail. During the Phase I of this project a software framework was developed for file carving. Using this framework a software library and a user interface to carve fragmented files from a disk image, called Adroit was implemented. Adroit currently supports carving of JPEG fles, structured documents (such as HTML, source code, plain-text fles, etc.), and Microsoft office documents. In tests conducted, Adroit recovers more files than tools currently available in the market. Furthermore, the validation and user interface component built into Adroit excels at allowing the user to guide the technology to recover more data with much less effort. The problem of recovery of information from bits and pieces of digital data, in the absence of storage meta-information to tie the pieces together, is equivalent to the problem of having hundreds/thousands of jigsaw puzzles mixed into together. The challenge of identifying if a piece of data belongs to a specific file or file type is daunting. The preliminary research conducted in Phase I has demonstrated the viability of developing domain specific techniques to identify the type of data fragments and the use of file type specific algorithms to reconstruct files.  The broad impact of this technology and its commercialization are: 1) it will change the nature of the data recovery market and make possible unprecedented recovery of data in a variety of situations; 2) it will save countless users the agony of losing valuable data. Be it important data that is needed for a company's survival or an emotionally valuable photograph of a proud parent or child; 3) it will provide law enforcement officials with an increased ability to gather evidence and prosecute their cases more effectively; 4) it will provide counter-terrorism experts the ability to glean crucial evidence that they may have otherwise missed.

Title: SBIR Phase II: Scalable Location Data Management

Award Number: 0822777
Program Manager: Errol B. Arkilic

Start Date: August 1, 2008
Expires: July 31, 2010
Total Amount: $500,000

Investigator: Karthikeyan Ramasamy, karthik@cs.wisc.edu
Company: Locomatix, LLC
48 Washington St., #8
Santa Clara, CA 95050
Phone: (408) 249-8845

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to design, implement, and test scalable methods for providing location-based services, with a special emphasis on mobile cell phone applications. Examples of such applications include continuous monitoring of static and dynamic geo-fences, building dynamic mobile social networks, and mobile e-commerce. The Phase II effort will develop methods to push the efficiency of the location-based computation techniques, and develop methods for more sophisticated features such as privacy management and mobile power management, which will be crucial for the wider adoption of location-based applications. Location data is currently generated by continually moving physical objects equipped with location-based sensors, such as GPS and Wi-Fi based tags. Data management methods for these datasets require dealing with high update rates, large volumes of historical location data, and location-based triggers that raise an alert when the location of a moving object meets certain criteria (for example, if an object is beyond a well-defined boundary). Existing methods for supporting applications that have these requirements are not scalable. The broader merits of this project include the development of a technology that has a potentially large commercial value and addresses an emerging market need. For example, for the cell phone market, these location-based services are projected to grow from $464M in 2007 to over $11B by 2011. If successful, the potential impact in both consumer and enterprise markets for location-based services could be substantial.

Title: STTR Phase II: Splintered Topologically Close-Packed (TCP) Offload Engine for Grid Computing and Bandwith-Delay Product (BWDP)

| | |
|---|---|
| Award Number: | 0822744 |
| Program Manager: | Ian M. Bennett |
| Start Date: | August 1, 2008 |
| Expires: | July 31, 2010 |
| Total Amount: | $488,128 |


Investigator: James Awrach, jma@seafire.com<br>
Company: SeaFire Micros, Inc.<br>
39 Dodge St #319<br>
Beverly, MA 1915<br>
Phone: (978) 317-1831


Abstract:


This Small Business Technology Transfer Research (STTR) Phase II research project addresses the challenges of networks with extreme bandwidth delay products. Bulk data transfer over such networks used by national research laboratories and aerospace companies need to be provided with the endpoint resources required to ensure high performance in a cost effective manner. The outcomes of this project attempts to provide compatibility with present and future versions of GridFTP. The project addresses these challenges through the use of a novel offload engine. During the Phase I project, the feasibility of deriving and simulating the offload engine architecture, firmware, and creation of intellectual property (IP) for low-cost, high-performance field programmable gate array (FPGA) subsystems was completed. Successful results from this research will significantly advance the state of the art for off-load engines used in grid computing. Immediate applications include accommodating the e-Science community's need for scalable 10-100 Gbps off-load engines, while supporting present and future versions of GridFTP. Other applications include the use of our ultra high-speed offload engines for grid and cluster computing, utilizing our open source firmware. The FPGA code resulting from this project has the potential to be used as intellectual property that could then be marketed to off-load engine manufacturers. These IP cores would accrue cost-effective savings for existing engine firms and would accelerate products to the market.

Title: SBIR Phase II: Zero-Remanence Tamper-Responsive Cryptokey Memory

| | |
|---|---|
| Award Number: | 0724306 |
| Program Manager: | William Haines |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,809 |

Investigator: James Deak, jdeak@nve.com
Company: NVE Corporation
11409 Valley View Rd
Eden Prairie, MN 55344
Phone: (952)996-1636

Abstract:

This Small Business Innovative Research (SBIR) Phase II research project is to develop a more secure encryption key for non-volatile memory. Secure ICs often utilize encryption to protect non-volatile memory contents. A clever engineer can recover the key after decapsulating and probing the semiconductor die. NVE intends to produce an innovative non-volatile spintronic cryptographic key memory that will self-erase without data remanence in the event of tampering and without applied power. The main research objectives of this work involve development of a fully integrated 256-bit embedded tamper resistant magnetic random access memory.

The technology proposed in this Phase II SBIR program is intended to provide a defense against theft of intellectual property and to protect sensitive data stored in an integrated circuit. Identity theft has become a very large issue for society in general and particularly in the more computerized societies. This is more than a problem of economics, as US military systems have also been reversed engineered by both friendly and unfriendly nations to gain access to US weapons capability. The technology proposed under the Phase II program addresses the need to provide a tighter level of security for data stored on integrated circuit (IC) and IC assemblies. Commercially, this provides an extra layer of protection on IC-based assemblies such as smart cards, cash machines etc. In addition, the proposed program would render a system inoperable in the event of physical tamper. This may be a very useful tool in stemming the tide of fraudulent usage, compromises, and reverse engineering of IC-based instruments as well as certain types of identify theft.

Title: SBIR Phase II: Novel Coded High Density Optical Disk Data Storage

Award Number: 0450531
Program Manager: Juan E. Figueroa

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $485,058

Investigator: Jianwen Yang, jjyang@nsotech.com
Company: New Span Optotechnology Inc
9380 SW 72nd St Ste B180
Miami FL, 33173
Phone: (305)275-6998

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project aims to develop a high-density optical disk storage prototype based on a new coding concept that will result in the prototype development of a compact packaged high-density optical disk storage system that is back compatible with current optical disk. Using such coding concept can significantly increase the disk data storage density and data access rate based on a modification of existing optical disk recording/readout hardware architecture. The new high density disk drive allows back compatibility with the current DVD disk and has advantage of easier market acceptance for product roll out than other developing storage technologies such as holographic and near field storages. The near term objective is to achieve 50 GB/disk capacity and more than 100 GB/disk is the next foreseeable product goal.

If successful, the outcome of this project will enhance the availability of high-density low cost storage for many social applications, increasing US based data storage technologies, and increasing US jobs. It will have extensive commercial and military applications such as computer data storage, on-line storage, library archival applications, image storage, and processing for medical applications, and military target identification and fast access to large intelligent databases. Educational impacts include advancing library archive storage for educational uses and benefiting university research in astronomy, meteorology and others that require huge data storage

# Engineering Analysis & Modeling

Title: STTR Phase II: Condensing Ejector for Second-Step Compression in Reversed Rankine Cycle

Award Number: 0822525
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $499,873

Investigator: Mark Bergander, mjb1000@aol.com
Company: Magnetic Development, Inc.
68 Winterhill Rd.
Madison, CT 6443
Phone: (203) 421-3562

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project seeks to continue the research and analysis of condensing ejectors for second stage compression in a refrigeration cycle. A condensing ejector is a two-phase jet device that produces outlet pressure higher than either of inlet pressures. The project combines theoretical and experimental models in order to design the condensing ejector for use in more efficient refrigeration systems. The results thus far show that the new design is capable of improving the efficiency of vapor compression refrigeration cycle by approximately one-third with R22 refrigerant. The goal is to draw closer to this ideal value with environmentally friendly refrigerants like R410A. The application of critical two-phase flow devices will lead to development of more efficient thermodynamic cycles for refrigeration and A/C and in the future possibly for propulsion and power generation. The broader impact/commercial potential from this project will bring considerable economic and societal benefits by reducing our nation's dependence on foreign oil, improving safety of nuclear reactors and natural gas pipelines, and better understanding of phenomena of two-phase flow. Applications of the condensing ejector theory in heat pumps might promote use of renewable geothermal energy sources in the remote communities with limited energy choices. This project leads to enabling technologies by providing the technology platform for a new approach to evaluating two-phase flows. The capability to handle rapid phase change simulations has generated interest from the automotive industry to simulate flash boiling in automotive fuel injection. This project also provides the basis for establishing fundamentally new engineering and designing methods for equipment operating on two-phase flow.

Title: SBIR Phase II: Virtual Prototyping Tool for Complex Flows of Polymers and Suspensions

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|---|---|
| Award Number: | 0750465 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $497,699 |


Investigator: Ilya Staroselsky, ilya@exa.com
Company: Exa Corporation
3 Burlington Woods Drive
Burlington, MA 1803
Phone: (781) 676-8587



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an engineering design level simulation tool for non-Newtonian fluid systems used in advanced materials engineering/process design. The project will implement innovative physics modeling of rheological properties and will leverage the full computational strength of the company's PowerFLOW simulator, including automatic grid generation for arbitrarily complex geometry and perfect parallel scalability on cluster computers using hundreds of million computational cells. This project will convert the hydrokinetic software resulting from Phase I project into a stable and robust technology platform that can be fully commercialized. The broader impact/commercial potential from the technology will be virtual design tools to overcome physical and/or engineering limits in flow simulations of chemicals, food products, pharmaceuticals, and nutritional processing, disk drive manufacturing, environmentally benign processes, semiconductor equipment, anti-icing aircraft sprays, etc. The tool for non-Newtonian flow prediction will open new commercial markets for the PowerFLOW technology. Key advantages include grid generation and set up times, thus enabling shortened product/process development cycles, optimization to improve yield and energy efficiency, and environmental improvements.

Title: SBIR Phase II: Engine Combustion Simulator

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| Award Number: | 0750406 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $488,721 |

Investigator: Glen Ko, ghk@resgroupinc.com
Company: RES Group, Inc.
11 Cambridge Center
Cambridge, MA 2142
Phone: (617) 834-2416

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop the Engine Combustion Simulator (ECS), an innovative software product that will enable researchers to develop and apply accurate chemical reactions for the design, control and optimization of the automotive engine and exhaust gas after-treatment devices. The ECS will reduce the costly and time-consuming experimental testing, as well as enable the researcher to probe concepts that are difficult or infeasible to test experimentally. These developments will accelerate the development of more fuel efficient and environmentally cleaner automobiles. At the core of the ECS is a suite of advanced database technologies and computational algorithms that enable the user to easily build accurate reaction mechanisms, and quickly perform simulation studies using these mechanisms. The broader impact/commercial potential from this technology will result in cleaner and more fuel-efficient vehicles. Even a small gain in fuel efficiency can translate to billions of savings in fuels as well as reduced dependence on foreign oil. Less fuel consumption directly scales to reduction in emissions thus lowering of greenhouse gases while improving the human health. The ECS will be made available at no-charge for use in education and research in academia and some of the key components will be made available as an open-source to the research community to foster collaboration between researchers.

Title: SBIR Phase II: Strategic Model for Manufacturing Organizations (DSMMO)

Award Number: 0646275
Program Manager: Ian Bennett

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Lia DiBello, lia@wtri.com
Company: WTRI
1425 Russ Blvd.
San Diego, CA 92101
Phone: (619)232-8054

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project proposes a dynamic modeling technology that helps decision makers visualize and calculate the top and bottom line financial impact of changes made at the strategic, tactical, and operational levels of a business. The proposed research will make intellectual contributions regarding how technologies extend complex cognitive capabilities in high-performance business settings. The resulting tool promises to address two well-known problems faced by business executives: decision-making rigidity and the inability to think simultaneously on strategic and tactical levels.

The broader impacts of the proposed technology have already been indicated by the increased use and measurable success of these models in client engagements. However, the models in their current form, are not widely or easily accessed although demand for them is high. This tool will have important pedagogic value to university programs because it will enable students to think through the multi-level issues in organizations. The models themselves may also add to the understanding of how the different levels and functions in an organization interact.

Title: STTR Phase II: Parallel Lattice Kinetic Software for High Mach Number Fluid Dynamics

Award Number: 0620490
Program Manager: Ian Bennett

Start Date: August 25, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Hudong Chen, hudong@exa.com
Company: Exa Corp.
3 Burlington Woods Drive
Burlington, MA 01803
Phone: (781)676-8587

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will produce a novel parallel dynamic rule-based software tool for simulating high Mach number flows of interest for the ground transportation, aerospace and power generation markets. This work couples a multi-disciplinary interplay between algorithm design, modern cluster/grid computer architecture, parallel processing, and software engineering, and employs Lattice-Boltzmann Methods (LBM) with automatically generated grids with up to 100 million computational cells.

This new technology will enable virtual design within the ground transportation industry. Secondly, the ability of the parallel lattice kinetic software to address high Mach/Knudsen number problems should open important markets in aerospace, power generation, automotive, and other industries. Additionally, this new technology should establish markets for computer aided engineering (CAE), by numerical simulation of vehicles and powertrain components whose complexity have forced design/optimization using either physical experimentation or semi-empirical rules. The research will help to demonstrate the linkage between fundamental research and industrial applications, and emphasize the importance of non-equilibrium statistical physics methods as a core component in the commercial simulators.

Title: STTR Phase II: Modular Feedforward Adaptive Noise Control

Award Number: 0620496
Program Manager: Errol Arkilic

Start Date: August 23, 2006
Expires: August 31, 2008
Total Amount: $499,827

Investigator: Robert Collier, robert.d.collier@dartmouth.edu
Company: Sound Innovations
55 Railroad Row
White River Junction, VT 05001
Phone: (802)280-3020

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project seeks to develop an inexpensive, multi-purpose active noise reduction (ANR) module and associated software evaluation tools with broad commercial application to many occupational environments. This project will develop signal processing algorithms that improve the computational efficiency for ANR. The current Phase II objectives include: (1) developing a multi-purpose ANR module and associated ANR software modules capable of single- and multi-channel ANR for two markets: "quiet zone" ANR in commercial vehicle cabins and active noise abatement products for the noise consulting industry; (2) developing a corresponding suite of software tools to be used by noise consultants for turnkey retrofits of noisy environments with active noise abatement products, and (3) conducting full-scale in-situ evaluation of the ANR module, software, and tool suite in demonstration projects with the support of commercialization partners. The expected technical outcomes of Phase II include: (1) a manufacture-ready ANR hardware module with associated modular ANR software, (2) a suite of ANR evaluation tools for the noise consulting industry, validated through in-situ testing and (3) experimental results of the modular ANR concept from several full-scale demonstration projects.

The strong pull for new noise control technologies is the result of increasingly strict government and community regulations, industry standards, the growing body of scientific evidence of on noise-induced hearing loss (NIHL), and the multimillion dollar cost of occupational hearing disability compensation. The current business model is based on partnerships in which the proprietary 'Plug-and-Play' ANR module represents a branded embedded component for products manufactured and marketed by other industrial organizations and for installations by acoustical consultants.

Title: SBIR Phase II: Development of ModelGlove - A Virtual Clay Modeling System Using Force/Position Sensor

Award Number: 0620509
Program Manager: Errol Arkilic

Start Date: August 23, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Kevin Chugh, chugh@tactustech.com
Company: Tactus
4250 Ridge LEA Suite 39
Amherst, NY 14226
Phone: (716)898-5923

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a Virtual Clay system comprised of a patent-pending sensor-enabled glove (called the ModelGlove), and a physics-based simulation engine which presents the user with a virtual 3D representation of modeling clay. The glove enables a designer to mold and shape the virtual clay with his or her fingers and hand, just as he or she would with physical clay. Clay modeling was pioneered by General Motors in 1914, and remains a popular technique. Since the early 80's, the computer aided design (CAD) market has grown dramatically, and 3D CAD has become the most technically-advanced tool for designing complex shapes. However, very little work has been done to merge the physical clay and CAD environments. Virtual Clay aims to fuse these environments, blurring the line between art and engineering and giving designers a unified modeling tool at all stages of development.

By advancing the state of the art in design and opening new worlds of design to mechanical engineers designing and modeling products, broad impacts are anticipated. The Virtual Clay system represents a significant advancement in wearable computing, where the user directly manipulates a virtual object with his or her hand. Further, a physics-based simulation of clay in a design environment promises to open new areas of exploration in the CAD world. By giving control to the user of not only the design, but the simulation environment itself (the user can control how soft or hard the clay is, for example), a whole new way of thinking about how simulation and CAD can evolve. Further, artists and engineers will benefit from being able to watch and decipher every manipulation that an expert modeler has completed on the virtual clay. Bringing a physical medium to a digital environment will thus open up numerous possibilities in design, assessment and analysis, testing, and collaboration.

Title: SBIR Phase II: Multi-Environment Probability Density Function (PDF) Method for Modeling Turbulent Combustion Using Detailed Chemistry

Award Number: 0548752
Program Manager: Rosemarie Wesson

Start Date: February 10, 2006
Expires: January 31, 2008
Total Amount: $500,000

Investigator: Qing Tang, tang@reaction-eng.com
Company: Reaction Engineering Intl
77 W 200 S STE 210
Salt Lake, UT 84101
Phone: (801)364-6925

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will extend the applicability of the multi-environment probability density function (MEPDF) method to model turbulent combustion problems with realistic chemical kinetics within comprehensive Computational Fluid Dynamic (CFD) simulations of practical combustion equipment. The project aims to further advance the MEPDF method by extending it to simulate industrially relevant single-phase and two-phase combustion systems, such as chemical process furnaces fired with lean pre-mixed gas burners; oil fired utility boilers and industrial furnaces; and coal gasification equipment.

The proposed activities for extending the MEPDF method to simulate practical combustion systems using complex chemical kinetics would result in a tool that will enhance the scientific and engineering knowledge base for these processes. The advanced simulation tools produced from this project would provide a means for companies in the power generation, chemical process, mineral process, and incineration industries to improve product designs and services, which in-turn would benefit the environment, global competitiveness and national/homeland security.

Title: SBIR Phase II: Web-Based Manufacturing Performance Management with Multi-Objective, Multi-model Optimization using Meta-Modeling

Award Number: 0548731
Program Manager: Ian Bennett

Start Date: January 13, 2006
Expires: December 31, 2007
Total Amount: $512,000

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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop a new Flow Path Management System (FPMS) representing an innovation in manufacturing software that: (1) Extends existing Enterprise Resource Planning (ERP), Supply Chain Management (SCM), and Manufacturing Execution Systems (MES) software by incorporating 'Lean Manufacturing' principles into a set of innovative simulation-based optimization algorithms; (2) Provides millions of dollars in inventory savings to existing and targeted manufacturing customers; and, (3) Is more available to virtual enterprises and smaller manufacturing companies than existing systems in that it can be delivered via the World Wide Web. The focus of this research project is the development of a meta-model-based simulation software for the analysis, prediction and optimization of manufacturing and supply chain processes. This software applies Kriging spatial optimization models - a proven interpolation-based response technique employed successfully in geo-statistics to solve complex and computationally intense manufacturing and supply chain problems.

The technology will be commercialized as a new module within the company's existing software suite, called the Flow Path Management System, and sold through three distribution channels: (1) on-site intranet installations at large companies; (2) delivery as a web service via the Internet to smaller companies; and, (3) licensing the algorithms to larger ERP/SCM/MES customers for incorporation in their software suites.

Title: SBIR Phase II: A Decision Support System for the Train Schedule Design Problem

Award Number: 0548666
Program Manager: Sally Nerlove

Start Date: December 29, 2005
Expires: December 31, 2007
Total Amount: $512,000

Investigator: Ravindra Ahuja, ravi@InnovativeScheduling.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project entails developing a decision support system for the train schedule design problem, one of the freight railroad transportation's most significant optimization problems. Train scheduling is an important part of a railroad's operating plan that enables efficient movement of railcars. Designing such an operating plan is a very large-scale and very complex multi-objective optimization problem that, to date, has defied solution. Consequently, operating plan development at railroads is a lengthy, manual, and cumbersome process that may involve five to ten persons for a period of three to six months. Using cutting-edge operations research techniques, Innovative Scheduling, is developing a software product that can obtain a new operating plan within two weeks using two-three employees and can save a typical Class I US railroad over $50M annually. The train schedule design problem determines: how many trains to run; the origin, destination, and route of each train; the train arrival and departure times for each station at which it stops; the weekly operating schedule for each train; and the assignment of blocks of cars to trains. The train schedule must satisfy numerous practical constraints and business rules and achieve the minimum cost of transportation. This problem is a very large-scale multi-objective integer-programming problem containing trillions of decision variables. The proposed research will develop decomposition-based customized algorithms using state-of-the-art network optimization and heuristic techniques so that this problem can be solved within two hours of computer time on a workstation. These algorithms will be packaged into a web-based decision support system with attractive and friendly graphical and geographical interfaces, which will allow sufficient user control. The proposed research and development requires significant advances in modeling, algorithmic, and implementation technologies and will provide much needed software to schedule freight trains worldwide. This research will further be extended to develop a decision support system for passenger train scheduling. BNSF Railway, a Class I US Railroad, which is a Development Partner in this project and is providing supplementary funds, data and manpower.

The train scheduling decision support system is likely to be used by all freight railroads in their operating plan development process. A computerized method for train scheduling will make a railroad more responsive to traffic changes and enable it to change its schedule frequently. Optimal and timely train schedule will introduce greater efficiency in the system and significantly lower costs. Further, optimal train schedules require significantly less train miles, crew hours, locomotive hours, and railcar hours to transport the same set of shipments, thereby increasing our nation's energy efficiency and reducing pollution. The success of this product will lead to a greater acceptance of models and operations research techniques in railroad planning and scheduling. Railroads are then anticipated to embrace operations research models and introduce decision support systems in a variety of business processes including tactical operations and commercial strategy. The railroad industry will then be in a position to achieve a new level of productivity, resulting in lower freight charges for end users, and making America's products more competitive on the world market.

Title: SBIR Phase II: Applications of Morse Theory in Reverse Engineering

Award Number: 0521838
Program Manager: Errol B. Arkilic

Start Date: July 15, 2005
Expires: June 30, 2007
Total Amount: $500,000

Investigator: Michael Facello, facello@geomagic.com
Company: Raindrop Geomagic Inc
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Phone: (919)474-0133

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will investigate applications of Combinatorial Morse Theory in Reverse Engineering, a field that focuses on converting physical objects into a digital representation suitable for CAD, CAM, and CAE. The biggest challenge in this field is to automate the conversion process while producing a model that meets all the requirements of downstream applications. These requirements include both an accurate representation of features and a high degree of smoothness. Combinatorial Morse Theory relies on a single mathematical approach: the definition of a continuous function on a polygonal model and the decomposition of the surface based on the gradient flow of that function. One advantage of this over earlier approaches to the conversion problem is its flexibility obtained by adapting to and combining different analysis criteria. Morse theory is the key to computing patch layouts that naturally adapt to and follow the shape of the surface, a property that is difficult to achieve but necessary to automatically construct high-quality NURBS surfaces of scanned or triangulated CAD models.

The proposed algorithms will allow users to easily create accurate representations of scanned physical parts, thereby providing an efficient closed-loop between physical and digital at any phase of a product life cycle. This project will make strong research contributions in computer science and mechanical engineering by dealing with the practical applications of Morse Theory, automatic feature detection and patch layout. It will also make strong advances in the amount of information that can be extracted from a polygonal model. Commercial applications include design and analysis of complex shapes such as turbine blades, transmission housings, and engine blocks, creating digital inventory of legacy parts, historical preservation, mass customization and biometric shape reconstruction. These applications will allow manufacturing companies to be more competitive globally because it enables product differentiations and existing processes to be carried out efficiently, cost-effectively, and automatically. The societal impact of this technology includes the improvement of work environments due to reduction of dust, noise, and work-related injuries associated with traditional processes, prevention of loss of lives and equipment by enabling sampling based inspections as well as improvement of the quality life through customized medical devices, and apparel that conform perfectly to the wearer.

Title: SBIR Phase II: An Integrated Software Tool for Modeling and Model-Based Control of Semiconductor Manufacturing Equipment

Award Number: 0450482
Program Manager: Juan E. Figueroa

Start Date: June 1, 2005
Expires: May 31, 2007
Total Amount: $500,000

Investigator: Jon Ebert, jle@scsolutions.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a commercial prototype of a novel software tool for integrated model-based control design for Rapid Thermal Processing (RTP) systems. Semiconductor process engineers and RTP equipment design engineers will use the tool. Currently, the design and development of advanced process controllers is a relatively slow and complicated process. There is no high-level tool that allows the process engineer to design, tune and deploy advanced controllers and develop low-order, fast physical models to be used for control. Based on customer feedback and its own experience the company has found a strong need for an integrated modeling and control tool that can be customized for a specific process. Phase I results proved the feasibility of such a tool by closed-loop simulations of a generic RTP chamber using a proof-of-concept version of the proposed tool. This Phase II will further develop and implement relevant model-order reduction algorithms, implement the algorithm for speeding up the Monte Carlo ray tracing calculations, develop the user interface, and integrate the tool components. The company will work closely with its industrial partner in testing the prototype tool in the design of next-generation RTP equipment.

If successful the proposed software package will result in a tool that will substantially reduce the development time of RTP equipment and processes. The tool also provides components for development of advanced techniques in virtual sensing and fault detection. RTP is the company's initial focus, but will leverage the modular nature of the product to extend its capabilities to other semiconductor equipment (e.g., CMP, CVD, etch, etc.) and even equipment used in other industries. Moreover, devices for MEMS and new nanoscale electronics technologies (e.g. spintronic and molecular computing) are expected to be commercialized using CMOS-like manufacturing processes. Hence, by creating a new way of designing and developing equipment and processes efficiently, this tool will have an impact far beyond RTP. The software will serve as a teaching and training tool that can be used in universities and government laboratories of NIST, DoD, DoE, etc.

Title: SBIR Phase II: Creating Functionally Decomposed Surface Models from Measured Data

Award Number: 0450230
Program Manager: Ian M. Bennett

Start Date: February 15, 2005
Expires: January 31, 2007
Total Amount: $489,179
Investigator: Tamas Varady, varady@geomagic.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project deals with the problems of reconstructing complex free-form shapes from measured data. Raindrop Magic's primary interest is to produce well-structured, high-quality CAD models. Several techniques exist to reach this goal; unfortunately, automatic surfacing systems provide only rough approximations and do not capture the original design intent, while manual segmentation methods are not very stable and require tedious work. Using functional decomposition, objects are built up as a collection of large, independent primary surfaces being connected by smaller, dependent feature surfaces, such as fillets or swept surfaces. In Phase I, semi-automatic methods were elaborated to create good segmenting curve nets. Exploiting the specific properties of different feature types, the research team proposed algorithms to compute optimal surface representations for each. In Phase II, the team envisions transforming and extending their theoretical results into robust and efficient computational algorithms. Five subsystems are proposed: Surface-Indicators, Constrained-Fitting, Curve-Tracing, Fairing, and Feature-Fitting. New core technologies are developed for creating different geometric entities, which are eventually integrated to obtain high-quality surface models. This technology should significantly shorten lead-time in related industrial design and manufacturing processes and produce aesthetic objects, having a positive impact on the whole society.

The proffered technology has broader impacts in two key market sectors: reverse engineering and advanced surfacing. At the research front, the proposed project deepens the understanding of computer-aided geometric modeling working with scan data, a field that has not received much attention from the large CAD companies, but is an active area of research. It combines the knowledge of both discrete and continuous mathematics and takes advantage of the strength of both approaches. On the technology front, it introduces a new paradigm that will significantly improve the current commercial systems of reverse engineering with better engineering features and advanced surfacing through simpler operations. The main applications will be product design, including automotive, aerospace, consumer products, and medical devices. The improved product will help the US manufacturing industry to be more competitive in the world market, providing a way to introduce design on demand and engineering on demand services. The proposed project will help US companies to increase customer-focused production and reduce the time between product iterations.

Title: SBIR Phase II: Rapid Application Development Architecture for Product, Process, and Cost Configuration Across Manufacturing Verticals

Award Number: 0450308
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $499,999

Investigator: Nainesh Rathod, nainesh.rathod@imaginestics.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop prototype architecture of an engineering advisory system and validate its application. Although the cost of product design could be only about 5% of the total product cost, decisions made during the design stage can contribute as much as 70-80% to the final product cost. Inappropriate design decisions made without sufficient manufacturing knowledge, or information, increases iterations in the product development lifecycle, causing significant costs to both the original equipment manufactures (OEMs) and the lower tier manufacturers. A survey by Purdue University indicated that 90% of the engineers/designers had very little process knowledge, thus indicating that there is a serious design-manufacturing knowledge gap. The aims and responsibilities of the Phase II project are to bridge the design-manufacturing knowledge gap through the development of an engineering advisory system to be used in early design. The system would be analogous to a spell-checking tool, advising engineers/designers on manufacturability and cost. The system will perform Dynamic Design for Manufacturability (DFM) analysis, evaluate part geometry in order to provide advice on the manufacturing aspects of the part, especially tooling and process related parameters in part design, help in estimating relative manufacturing costs for a part by mapping the geometric and non-geometric parameters of the part to a cost-based manufacturing process model, integrate 3D Shape Search Engine (licensed from Purdue University) with Part/Tooling/Cost Advisor & Knowledge Reuse Agent, seamlessly integrate with commercial Computer-Aided-Design (CAD) system using sophisticated geometric reasoning algorithms and a hybrid B-rep-voxel approach, and extract manufacturing feature-based geometric information.

If successful this product will enable engineers/designers make informed decisions early in product design about processes and part/tooling for manufacturability while serving as an on-demand manufacturing "what-if" educational tool for engineers/designers. It will reduce non-value added design features so optimal and economical processes can be considered, thus lowering tooling costs while minimizing the risk in the quotation process for both OEMs and tooling firms. The outcome of this research also have an educational impact in engineering schools by introducing students to manufacturing processes and design for manufacturability concepts. The company will provide the engineering advisory system to universities to use in their engineering curriculum. The outcome of the proposed research can improve product design, lower cost and positively impact the local economy by linking local suppliers in early design directly through an engineering advisory system.

Title: STTR Phase II: Integrated Software and Systems for Large-Scale Nonlinear Optimization

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| Award Number: | 0422132 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | July 15, 2004 |
| Expires: | June 30, 2006 |
| Total Amount: | $499,929 |

Investigator: Richard Waltz, waltz@ziena.com
Company: Ziena Optimization Inc.
2615 Hartzell Street
Evanston, IL 60201
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Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will address the design and creation of integrated nonlinear optimization software that combines complementary approaches to nonlinear optimization to achieve robust performance over a wide range of application requirements. The work will concentrate on the area of smooth nonlinearly constrained optimization, which arises directly in numerous applications and as a sub-problem in mixed-integer nonlinear programming and global optimization. The work will employ both mathematical convergence analyses and extensive testing on problems of practical interest. Results of the research will take nonlinear optimization software to a new level, based on an adaptive and versatile collection of algorithms in contrast to the single-algorithm approaches employed by current optimization packages. Nonlinear optimization models arise in diverse areas of science such as medical imaging, oceanography, crystallography, and climate modeling, and in almost all areas of engineering, chip feature placement for semiconductor manufacturers to energy management for electric and gas utilities.

Nonlinear optimization is also rapidly becoming a key tool in decision analysis in such areas as finance and revenue management. By enabling optimization packages to be more fexible and more reliable, this research will lead to stronger support for current nonlinear optimization applications while making new, more ambitious applications possible.

Title: SBIR Phase II: Meshless Petrov-Galerkin Geo-Environ Technology For Wide Scale Field Uses

Award Number: 0321651
Program Manager: Juan E. Figueroa

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $379,038

Investigator: Sumant Gupta, cfest@cfest.com
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Abstract:

This Small Business Innovative Research (SBIR) Phase II proposes to develop a Meshless Petrov-Galerkin Geo-Environ Technology For Wide Scale Field Uses. Groundwater supplies are increasingly threatened by organic, inorganic, and radioactive contaminants that are introduced to the environment by improper disposal or accidental releases. Estimates of remediation costs at U.S. government sites alone totals into the billions of dollars. Computational mechanics and aerospace advances in meshless Petrov-Galerkin provide easy means for stable accurate simulations of large groundwater reservoirs without grid generation. The proposed software package Meshless Groundwater Model-Petrov Galerkin (MGM-PG) will be designed for advanced hydrologists as well as for groundwater basin managers, purveyors, and field hydrologists. Current software advancements will be interfaced for easy conceptual model development for various applications. MGM-PG potential market includes: (i) groundwater reservoir quantity and quality management; (ii) cleanup of contaminated sites; (iii) storage of wet year surplus surface water underground and its uses for extended draught periods (ASR projects); (iv) safe disposal of treated effluents by rapid infiltration and extraction projects (RIX projects); (v) conjunctive uses of surface and subsurface water; (vi) landfill sites; and (vii) cleanup of large contaminated Federal Facilities.

This technology has applicability to thousands of EPA National Priority List for expedited clean up of contaminated sites and also for groundwater management projects that are implemented at a cost of billions of dollars by federal agencies, State, counties, petroleum facilities, and chemical industries. Worldwide only 4-5 geo-environ codes have been developed for wide variety of societal needs. MGM-PG will be a new technological advancement and will promote training of new graduate students in meshless advances rather than old methods.

Title: SBIR Phase II: Integrated Fire Modeling Software

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| Award Number: | 0349759 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | February 15, 2004 |
| Expires: | January 31, 2006 |
| Total Amount: | $498,900 |


Investigator: Brian Hardeman, hardeman@thunderheadeng.com
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Abstract:

This Small Business Innovation Research (SBIR) project will develop an integrated fire modeling software package for use in building design and accident analysis. This will increase public safety by providing widespread access to state-of-the-art fire simulation. Modeling fires using a rigorous scientific approach makes it possible to predict the course of an evolving fire and its impact on the building occupants, contents, and structure. The software will help designers implement new fire safety codes and standards that allow the use of Performance-Based design as an alternative to Rule-Based design. Performance-based design and post-accident analysis offer the potential to reduce injury, loss of life, property damage, and the overall cost of constructing and maintaining buildings through advanced technology. This project will accelerate the introduction of new fire simulation technology into the fire safety industry. In the United States, the total cost of fires is over $100 billion annually, with a loss of more than 4,000 lives. Driven by the availability of the Fire Dynamics Simulator (FDS) from NIST and new performance-based fire safety standards, the fire safety industry is responding to these costs by adopting greater use of fire simulation. As a result, there is an emerging market for fire simulation software that is powerful, yet easy to use.

The potential market includes fire safety engineers (design), companies involved in accident review and litigation, Authorities Having Jurisdiction (regulation), and fire service personnel (suppression and investigation).

Title: SBIR Phase II: Relational Bayesian Modeling for Electronic Commerce

Award Number: 0349497
Program Manager: Juan E. Figueroa

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $450,056

Investigator: Bruce D'Ambrosio, dambrosi@cleverset.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will focus on scale-up and validation of the company's relational model discovery technology, with specific application focus on web-visitor behavior modeling. In Phase I research the company developed a modeling paradigm based a synthetic variable language for relational Bayesian modeling. Its synthetic variable language is the first comprehensive effort to develop a principled way to represent, discover, and perform probabilistic inference with mixed intra-table, cross-table, and multi-table relational features. This capability provides the basis for construction of comprehensive, integrated models of relational data. Models constructed capture the rich detail of web visitor behavior and can be used to make inferences about web visitor intent (e.g., whether or not a purchase in planned) in real- time. These results are not obtainable by any other modeling technology. The technical objectives for the Phase II project are to: (1) develop a complete language to establish solutions to outstanding issues in our synthetic variable capability, (2) engineer the infrastructure needed for commercial deployment, (3) construct deployable models of web visitor behavior to identify opportunities for intervention, and (4) conduct field-trials of model-based interventions to establish the business value of our approach. A paradox of modern society is that we possess so little knowledge relative to the amount of data we collect and store. E-commerce provides a paradigmatic example of this paradox. E-Commerce platforms collect unprecedented amounts of information about customer interactions, yet today's E-commerce applications do not provide the service expected by customers or the performance demanded by online retailers. Online retailers are demanding increasingly sophisticated marketing and merchandising technologies.

The proposed product will empower online merchants and service providers by enabling efficient and integrated understanding of online consumer behavior and will bring in a new class of customer centric (instead of page-centric) web-based interactions that will contribute to the evolution of the World Wide Web as a communication medium. The company's technology also applies to offline scientific analysis as a method for hypothesis generation in complex relational data as in the E-commerce domain. This technology enables scientists to make better use of the data at their disposal.

# Enterprise Systems

Title: SBIR Phase II: Software Platform for Quality-by-Design Implementation

Award Number: 0750063
Program Manager: Ian M. Bennett

Start Date: March 15, 2008
Expires: February 28, 2010
Total Amount: $511,771

Investigator: Paul vanEikeren, paul.van.eikeren@bluereference.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a novel Quality-by-Design (QbD) software platform directed at the needs of FDA's QbD initiative, a framework for innovative pharmaceutical development, manufacturing and quality assurance. QbD is implemented at four levels: process understanding; quality by design; monitor, predict and control; and continuous improvement. QbD implementation is hampered by the lack of a reusable and extensible QbD Software Platform for assembling QbD tools that execute, document and integrate QbD workflow. In the Phase I program, we successfully demonstrated 'proof-ofconcept' for the QbD Software Platform for application to the first QbD level workflow. This project will extend research to the other levels and enhance the QbD Software Platform in three principal ways: 1) increase capabilities for managing QbD data-set objects; 2) enlarge the pool of QbD workflow objects; and 3) add collaboration capability in conjunction with a centralized repository. We will test, evaluate and validate the QbD Software Platform through use scenarios developed in conjunction with pharmaceutical-company research collaborators. The ultimate goal of the program is to develop a commercial QbD software toolkit that enables scientists and engineers to implement QbD for increased manufacturing efficiency with regulatory flexibility. The health of our nation's citizens depends on the availability of safe, effective and affordable medicines. Pharmaceutical companies need to employ innovation, cutting-edge scientific and engineering knowledge, and the best principles of quality management to respond to the challenges of new discoveries (e.g., complex drug delivery systems and nanotechnology) and individualized therapies or genetically tailored treatments. The FDA and global pharmaceutical community are laying the foundation for a regulatory policy revolution, Quality-by-Design (QbD), that provides a framework for allowing regulatory processes to more readily-adopt state-of-the-art technological advances in drug development, production and quality assurance. QbD shifts focus from 'quality by testing' to 'quality by design', i.e. build quality into the process rather than rely on resource-intensive quality control systems to prevent defective products from leaving the factory. The Quality-by-Design (QbD) Software Platform of the present proposal enables scientists and engineers to implement state-of-the-art multi-variate analysis and machine learning to manufacturing quality. Additionally, given that manufacturing represents 25% of drug cost, equipment utilization is below 40%, and batch quality failures range from 5 to 15%, the effective implementation of QbD will enable improved efficiency providing lower drug costs and increased competitiveness for the US pharmaceutical industry.

Title: SBIR Phase II: Parts Forecasting for Configurable Products

Award Number: 0723832
Program Manager: Errol Arkilic

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $499,905

Investigator: Roy Marsten, rmarsten@emcien.com
Company: Emcien
75 Fifth Street, NW
Atlanta, GA 30308
Phone: (770)621-5877

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop a new methodology for parts forecasting for discrete manufacturing. Emcien is developing a software suite to enable a product manager to better manage a configurable manufactured product. This suite includes a method for forecasting the demand for a configurable product at the full configuration level of detail. This means forecasting unique configurations, each with an expected volume. The method depends on extracting customer buying patterns from the sales history for the product. The mathematical algorithms for extracting and representing these patterns, and forecasting using these patterns are the main contributions of the research. The set of parts needed to build a configurable product generally depends on combinations of options, so it is not possible to plan parts requirements from an aggregate forecast. By using a configuration level forecast, it is possible to expand each unique configuration into component parts, and then use the associated volumes to produce a complete parts forecast.

American manufacturers are specializing in complex, configurable, high-end products, as mass produced commodity products move offshore. Allowing customers to customize a product results in significant numbers of alternative product configurations. This variety increases costs in many ways. One important way is the increased difficulty of planning parts requirements. The current practice of basing parts planning on a few popular variants leads to excess inventory of some parts and shortages of others. Excess inventory incurs both holding and obsolescence costs. Shortages can interrupt production and cause both lost sales and quality problems. Emcien has developed a methodology that, among many other benefits, can improve the accuracy of parts planning.

Title: SBIR Phase II: Supply Chain Optimization and Product Explorer

Award Number: 0620233
Program Manager: Errol Arkilic

Start Date: August 1, 2006
Expires: July 31, 2008
Total Amount: $499,995

Investigator: Nainesh Rathod, nainesh.rathod@imaginestics.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will achieve higher retrieval accuracy for shape-based search for both the web and the enterprise. The proposed work in Phase II is to achieve higher retrieval accuracy supported by three key components: 1) pose determination for 3D models: bridging the space gap between 2D and 3D shapes by finding three intuitive and robust orthogonal orientations for 3D models; 2) 2D orthogonal view generation: representing a three orthogonal views along the pose orientations; 3) similarity measurement between 2D shapes: finding 2D and 3D shapes based on the user's query. A framework will be developed by focusing on three important modules: 1) 2D constraint detection and use of implied constraints with initial application in 2D and 3D views; (2) Enhanced multiple level-of-details in 3D representations, and (3) Human assisted system classification of large datasets.

Traditional options of finding part suppliers using catalogs, trade shows and prior business relationship limit the choice of suppliers. Current text-based search to find suppliers face challenges, such as context and language sensitivity, and is inadequate in overcoming the technological challenges posed by variations in how product or part information is specified across a global supply chain. The current effort proposes to use shape, which is the lowest common denominator, to link the OEMs and suppliers. This technology can also aid the current trend among companies in aerospace, automotive, medical equipments and other industries towards 3Ddata standards for fast retrieval, as it can provide a significant leap in terms of accuracy, speed and relevance in the search and retrieval of information. If successful, this technology can contribute significantly to research in areas where shape is important, such as bio-technology and pharmaceutical sectors, where rapid identification of molecules and their docking features help reduce time and cost involved in drug development. For the medical industry due to increased usage of CT scans and 3D imaging technologies, 3D shape search can be used for local feature identification in colonoscopy or other exploratory procedures, brain angiography, reconstruction, projection of malformation or location of polyps and ensure better and rapid diagnosis of disease. Development of methods for automatically parsing human sketches and determining constraints will enable many other research activities and broadly help in a more natural human machine interaction.

Title: SBIR Phase II: Reducing Lead Time and Inventory by Using Optimized Product Configurations

Award Number: 0620269
Program Manager: Errol Arkilic

Start Date: July 25, 2006
Expires: July 31, 2008
Total Amount: $499,818

Investigator: Roy Marsten, rmarsten@emcien.com
Company: Emcien
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the impact of product variety on the customer order fulfillment process. It aims to help the manufacturers of highly configurable products with many possible "variants" or "configurations" to maximize product availability and order fill rates. Prior research by Emcien has created a methodology for representing product variants, modeling customer demand, and computing an optimal set of product configurations to maximize margins. These stockers are optimal in the sense of satisfying the most demand while maximizing profitability, but they assume unlimited product inventory. In previous research, Emcien built a prototype simulation model to determine how well these optimal stockers would perform in practice. The prototype simulation model was used successfully by two of Emcien's clients. The Phase II project will turn this prototype into production quality software that will become a part of Emcien's suite of products that address product variety.

More manufacturers are moving in the direction of "mass customization", which means allowing each customer to choose the features and options they want. Mass production of a uniform product, or one with a small number of variants, is evolving into flexible production as more and more choices are offered to the customer. But customers not only want to customize their product, they also want to get it quickly. Pure build-to-order systems can result in unacceptably long customer lead times, especially when demand has seasonal ups and downs. This forces manufacturers to build partially finished or fully finished units for inventory, in order to smooth production and reduce customer lead time. This requires a delicate balance between the extra revenue and the extra costs of offering more variety. Emcien's mission is to help manufacturers profit from product variety as a competitive advantage, rather than being overwhelmed by the extra costs of supporting too much variety.

Title: SBIR Phase II: Advanced Planning and Scheduling Tools for Extended Enterprise Systems

Award Number: 0450552
Program Manager: Juan E. Figueroa

Start Date: April 1, 2005
Expires: March 31, 2007
Total Amount: $394,965

Investigator: Guining Li, guining@yahoo.com
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Madison WI, 53719
Phone: (608)833-1189

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will build upon the successful development of the Phase I project that developed models and algorithms for planning and job scheduling systems. The software tool described in this proposal will allow organizations to schedule their operations in real-time to generate the optimal plan to maximizing their operational targets. During Phase I, the team created new planning and scheduling algorithms and successful empirical studies using recent innovative research in the areas of large-scale optimization and the newly developed methodology of Nested Partitions. In Phase II the team plan to further develop the concept to create successful implementations in several manufacturing firms. The technology to be developed in Phase II will greatly enhance the capability of the current planning and scheduling software tools. This innovation brings the state-of-the-art decision and optimization methodology to the Advanced Planning and Scheduling software market. In addition, planning systems developed with the proposed methodology will add new levels of flexibility for companies to more quickly adapt to changing material, operational, and market conditions.

This SBIR project will make new planning and scheduling tools broadly accessible to virtually any manufacturing firm. The proposed scheduling and planning tools will enable them to communicate, collaborate, and integrate their planning and scheduling functionalities to obtain optimal results throughout their enterprise and their entire supply chain. It is expected that coordinated use of these tools will eventually create an integrated cyber-infrastructure for American manufacturing firms and create more efficient supply chains that will enable these firms to be more competitive in the global marketplace. Moreover, if successful, the development of this proposed tool will lead to fruitful attempts to develop and commercialize an advanced planning and scheduling software tools that can be used for many other sectors of the economy.

Title: SBIR Phase II: Uncertainty Analysis of Manufacturing Process Models

Award Number: 0348771
Program Manager: Juan E. Figueroa

Start Date: May 1, 2004
Expires: April 30, 2006
Total Amount: $499,235

Investigator: Ellen Meeks, emeeks@reactiondesign.com
Company: Reaction Design, Inc
6440 Lusk Boulevard
San Diego, CA 92121
Phone: (858)550-1920

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to create a robust software system for performing uncertainty analysis of process simulations for manufacturing. For simulations that are large or that contain many parameters, even the best Monte Carlo, or importance-based sampling methods for uncertainty analysis can be prohibitively expensive. Consequently, systematic uncertainty analyses are rarely implemented for complex systems. This proposal presents a plan to produce a commercially viable package of a new method for quantifying simulation uncertainty, based on polynomial chaos expansions. The method can determine the probability density functions of black-box model responses and can identify quantitatively which of the parameters contribute most to uncertainties in responses for multivariate inputs and outputs. The unique sampling approach enabled by the use of polynomial chaos expansions allows more accurate resolution of probability distribution functions at a very small fraction of the cost to achieve similar results with more traditional uncertainty-analysis methods.

While illustrative examples from the chemical manufacturing industries will be used to demonstrate the software functionality, the methodology has broad application to such fields as circuit design, risk management, allocation of experimental resources, chemical plant design and operation of production systems. Due to the ability to handle arbitrary or black-box simulations, the methods can be applied as easily to economic market analysis, or global climate modeling, as to chemical process design.

Title:  SBIR Phase II: Evolving Object Neural Networks

Award Number: 0349604
Program Manager: Errol B. Arkilic

Start Date: February 1, 2004
Expires: January 31, 2006
Total Amount: $499,642

Investigator: David Fogel, dfogel@natural-selection.com
Company: Natural Selection, Inc.
3333 N. Torrey Pines Ct.
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Phone: (858)455-6449

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will investigate the problem of generating evolutionary object neural networks for controlling characters in classes of entertainment software, with consideration given to genres of massively multiplayer online games. The objective of the research is to identify and develop general self-adaptive routines and software tools that can be incorporated in a software developer's kit (SDK) that is suitable for licensing to third-party developers. A series of experiments conducted within a statistical framework will identify first- and second-order effects of parameter choices for the evolutionary control of game characters, which will be incorporated into the SDK. R&D will be aimed at generating the most rapid evolutionary learning for game characters while having the smallest code "footprint." Additional research will facilitate automatic play testing and optimization of artificial intelligence in games. The scientific and technical understanding of hybridizing evolutionary computation and neural networks will be enhanced by the careful study of the nonlinear effects of parameter choices in the studied settings.

If successful this product will ease the transition of video games from development to products. The development of an SDK that will help reduce the time and cost of segments of video game production by 50-80%. The software developed may serve as educational classroom aids in university courses. Furthermore, the strong correlation between video games and military simulations suggests important contributions to dynamic planning in combat simulations, as well as extensions to optimizing courses of action in business operations, such as supply-chain management.

Title: SBIR Phase II: Lean Physics: Streamlining the Supply Chain Using Factory Physics

Award Number: 0349659
Program Manager: Juan E. Figueroa

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Keith DiAngelis, diangelis@factoryphysics.com
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5107 Laurel Valley Court
College Station, TX 77845
Phone: (979)690-7105

Abstract:

This Small Business Innovation Research (SBIR) Phase II project involves the creation of an innovative Methodology and software Toolkit that can substantially improve the supply chain of virtually any manufacturing firm. The proposed Support Tools offers a comprehensive system that combines the best of the "software only" and the "best-practices" approaches with a framework to create a new paradigm for production system improvement. Algorithms based on this framework will provide important diagnostic and analysis tools that show how and where major improvements to the supply chain should be made. Execution algorithms that "bolt onto" existing supply chain management systems will provide the means to improve productivity, reduce inventory, and increase customer responsiveness without having to replace existing implementations. The toolkit can also be delivered over the Internet, providing a cost effective alternative to smaller companies.

Commercial versions of this innovation could enable widespread adoption of a new and more effective paradigm of manufacturing logistics. With the loss of 2.3 million jobs in the last three years, the issue of manufacturing productivity is critical as is the need for supply chain tools which integrate production software systems with operational initiatives to improve productivity and cost competitiveness. Widespread adoption of this methodology and tools could have a profound influence on the competitiveness of U.S. industry.

Title: SBIR Phase II: Implementation, Testing and Refinement of a Hybrid Distributed / Traditional System for Broadcasting Live and Pre-Recorded Content to Large Online Audiences

Award Number: 0750136
Program Manager: Errol B. Arkilic

Start Date: February 15, 2008
Expires: January 31, 2010
Total Amount: $512,000

Investigator: Mike O'Neal, mike@nft-tv.com
Company: Network Foundation Technologies
818 Nelson Avenue
Ruston, LA 71272
Phone: (318) 257-5432

Abstract:

This Small Business Innovation Research (SBIR) Phase II project has two technical goals. In Year 1 the focus is on increasing the video quality (bit rate) of NFT delivered broadcasts, while keeping bandwidth costs low. In Year 2 the focus shifts to expanding product support to Mac and other non-Windows systems. Network Foundation Technologies (NFT) has developed a patented distributed broadcast technology that overcomes many of the current bottlenecks. The key difference between the NFT approach and the traditional approach is that with NFT the computers and Internet connections of the viewers watching a broadcast help deliver that broadcast on to other viewers. Network Foundation Technologies' products and technology have the potential to significantly impact the way television-style broadcasting is conducted over the Internet, greatly increasing the number of voices that can be heard. While NFT's near term goal is "to bring television to the Internet", the long term goal is to give ordinary citizens their own "online television stations."

Title: SBIR Phase II: TRX Sentinal First Responder Tracking System

Award Number: 0750498
Program Manager: Ian M. Bennett

Start Date: February 1, 2008
Expires: January 31, 2010
Total Amount: $512,000

Investigator: Carole Teolis, carole@technosci.com
Company: Trx Systems Inc
387 Technology Drive
College Park, MD 20742
Phone: (240) 790-0620

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the critical problems of tracking and monitoring firefighters or other first responders inside structures. Whereas many available systems such as GPS fail indoors or require an overwhelming number of access points to obtain accurate information, our system requires only a base station that can be quickly set up at a command post outside (or inside) a building and small devices worn by the responders. Our system sets up a mesh network to communicate data amongst responders, as well as between the responders and the command post base station(s). The mesh network extends the range of the base station by allowing data to be relayed through another team member if a responder goes out of range. Our prototype system has been demonstrated to provide accurate tracking and location of personnel performing simple motions in complex structures from a base station outside of the structure. This project will focus on improving tracking algorithms such that complex motions can be recognized and accurately tracked. The expected outcome of the project is a much improved interface between the typical command center and the first responders. The initial market impacted by this project development is firefighter location and monitoring. Firefighting is one of the most dangerous jobs in the US. An average of 95 firefighters have been lost every year over the past decade. Some of these deaths could have been prevented if only the firefighter's distressed condition and exact position were known. No commercial technology currently exists that pinpoints the location of a downed firefighter. Critical time can be wasted before a downed firefighter is even first detected. Subsequently, critical resources are often diverted in frantic searches in hazardous conditions and extremely poor visibility. The seconds saved by knowledge of firefighter alarms and their positions could mean the difference between minor and severe injuries or death.

Title: SBIR Phase II: Hardware Support for 10 Gbps Intrusion Detection

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| Award Number: | 0521902 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | July 1, 2005 |
| Expires: | June 30, 2007 |
| Total Amount: | $498,205 |

Investigator: Livio Ricciulli, livio@metanetworks.org
Company: Metanetworks, inc, CA
647 N Santa Cruz Ave E
Los Gatos CA, 95030
Phone: (408)879-9133

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will dramatically advance performance breakthroughs achieved by utilizing a Multiple Instruction Single Data (MISD) processing model applied to high-speed Intrusion Detection and Prevention System (IDPS) hardware. A multiple-chip implementation of the MISD processing model will further demonstrate the scalability and cost-effectiveness of the technology by increasing IDPS processing capacity to levels while reducing costs for the existing system. Current line speed stateful computations are limited by the cost and scalability of currently available content addressable memories. Ideas derived from memory caching architectures will be adapted to build a novel memory subsystem specifically designed to cost-effectively support critical, stateful, 10 Gbps security applications such as TCP stream reassembly and protocol normalization. Finally, the development of open-source interfaces will extend the use of these innovations to a large community of users who will certainly contribute to the advancement of IDPS technology through inter-organizational collaborative efforts.

Next-generation applications require high-speed network connectivity. For example, supercomputer clustering, medical image delivery, data storage networking, video conferencing, and tele-presence applications all need 10 Gigabit and higher speeds. Unfortunately, public and private communication infrastructures are today being destabilized by security compromises. Network viruses, worms and other attacks can propagate very quickly over the Internet and private networks, disabling commerce and resulting in significant productivity loss. The ability to detect and prevent these attacks from traveling through high speed links is a crucial requirement for fostering their adoption across organizational boundaries. Without proper intrusion detection and prevention, high speed links will introduce severe attacks in information systems and limit the commercial viability and far-reaching benefits of high bandwidth, next-generation applications. This Phase II project will dramatically improve the cost-effectiveness, openness and scalability of high-speed IDPS technology. This will facilitate a broader use of inter-organizational, high-speed connectivity and impact social, economic and educational progress.

Title: SBIR Phase II: Scalable and Reliable Storage Infrastructure for Network Storage Environments

Award Number: 0450528
Program Manager: Juan E. Figueroa

Start Date: February 1, 2005
Expires: January 31, 2007
Total Amount: $500,000

Investigator: M.Firas Malouhi, firas@datareliability.com
Company: Data Reliability Inc.
3895 Metro Drive
Jackson MS, 39209
Phone: (601)944-0048

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will build a scalable and reliable storage system for network storage environments. This outcome of this project is a revolutionary system that employs a combination of unique ideas to address the main challenges encountered in today's demanding storage environments namely scalability, availability, performance, and manageability. The ideas of this proposed solution are applied as a disk-based solution for the time-consuming network backup/restore problem. With the rapid growth of data-driven network services, traditional storage solutions are not able to keep pace with the rapidly expanding storage requirements. Unlike traditional solutions the proposed solution employs a new architecture that allows for independent and practically unlimited scalability of capacity, file access performance, and namespace access performance. The proposed product utilizes a unique, very fast coding technique called PND to ensure fast, reliable, and highly available access to data. It offers the opportunity of applying a more effective block-level edge caching technique, which enhances the performance and achieves better utilization of the valuable cache memory. It takes advantage of Data Reliability, Inc.'s innovative RAISTM storage engine to cost-effectively aggregate distributed islands of independent storage resources into a single virtual shared pool of storage. Project Phase I has clearly demonstrated the above advantages.

Many applications will exploit the competitive advantages of the proposed product including Web server farms; multimedia network services, content management, document storage and delivery, digital imaging, and file transfer services. In addition, the expected solution's ideas can be expanded to build general-purpose file servers that are not subject to performance bottlenecks and capacity limitations. Therefore, these ideas will have an important impact on building next generation NAS devices. The PND technique, pioneered by this project, provides a new class of codes that are expected to result in scientific advances in coding theory. In addition, the PND technique will contribute to enhanced performance and architectures of disk arrays. Applications of PND coding in areas other than data storage include mobile communications, reliable multicasting, audio/video streaming, and digital fountain systems. The company is partnering with Jackson State University (JSU) and will offer JSU students a tremendous educational experience. Since Jackson State University is an HBCU (Historically Black College and University) in the underrepresented state of Mississippi, the project will foster continuous collaboration and will increase the participation of underrepresented and minority groups in science and technology.

Title: SBIR Phase II: Commoca Internet Protocol Phone - Making Communications Personal

Award Number: 0450436
Program Manager: Juan E. Figueroa

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $500,000

Investigator: Carlos Velez-Rivera, carlosvelez@comoca.com
Company: Commoca, Inc.
Calle Mendez Vigo 68E
Mayaguez PR, 680
Phone: (787)640-0439

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a suite of server based infrastructure software and applications to empower service providers with the ability to deploy, monitor, customize content, debug, and upgrade their VoIP (Voice over Internet Protocol) terminals remotely. The proposed Transactional Applications Delivery System (TADS) will allow service providers to define new revenue generating applications and corporate IT departments and third-party IT solution providers to develop vertically integrated, productivity enhancing data-voice applications. The proposed system will also provide a cost-effective means for service providers to move high-end VoIP terminals into the home consumer market, through, for example, multi-year service contracts in exchange for subsidized phones (the new revenue generating opportunities will allow service providers to do this). By addressing these needs, TADS will allow tighter integration between telephony features and IT based systems, taking better advantage of unified messaging (voice mail, e-mail, video mail, instant messaging, etc), collaboration, conferencing, presence, etc. It will also allow end-users access to ubiquitous features across different networks and different locations.

This project will define, develop, and deploy a complex software platform that will significantly accelerate the time to market of revenue generating and productivity enhancing advanced VoIP applications and services. In addition, the development of the proposed TADS technology will lead to new knowledge in the areas of human computer interaction, data mining, IP information appliances, and networking. The results to be obtained from this project will have a significant impact on the structure of the VoIP consumer market and the way converged voice-data applications are developed and deployed in the enterprise market.

Title: SBIR Phase II: Automated Personalized Rich Media Broadcast Generation

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| Award Number: | 0349740 |
| Program Manager: | Juan E. Figueroa |
| Start Date: | March 1, 2004 |
| Expires: | February 28, 2006 |
| Total Amount: | $494,723 |

Investigator: Robert Rubinoff, robert.rubinoff@streamsage.com
Company: StreamSage, Inc.
1202 Delafield Pl., NW
Washington, DC 20011
Phone: (202)722-2440

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will create a prototype system that will cut through the overload of audio/video (rich media) content by generating personalized broadcasts from a library of rich media documents. Building upon existing expertise in dealing with rich media, the proposed research will apply and refine the techniques discovered in phase I to organize relevant material using both the context of the documents and the topics of the selected material. The prototype will also apply the phase I results to identify and fill in the critical gaps between segments of material extracted from the source documents with bridging text that will provide necessary context and structure, allowing the system to present the relevant material as a single coherent broadcast. This research will result in new techniques that allow separately obtained passages of audio/video (or even text) to be joined together coherently. It will also provide techniques for organizing information based on both contextual and topical cues. These techniques will be applicable in any context in which information in natural language form is being extracted from a source collection. Furthermore, the research results will provide cost efficiencies for a number of specific important vertical markets (e.g. finance, broadcast news monitoring, etc.).

The resulting software products will dramatically reduce the costs of the currently manually intensive information extraction process employed by firms in these markets. More generally, the software products that are derived from the company's current technology platform will also increase individuals' ability to find and absorb relevant information from diverse information sources, many of which are entirely intractable today. This ability is important in a wide range of communities such as academic institutions, intelligence agencies, homeland security agencies, financial institutions, and news broadcasters.

Title:  SBIR Phase II: Advanced Proxies for Shared Wireless Internet Access

Award Number: 0348440
Program Manager: Juan E. Figueroa

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Norman Abramson, nabramson@hokupaa.com
Company: Hokupaa Technologies, Inc.
521 Lake Street
San Francisco, CA 94118
Phone: (415)666-3223

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop advanced forms of transparent network proxies for both satellite and terrestrial broadband wireless communications to the Internet. Shared wireless access links to the Internet often exhibit what has been called a traffic / cost anomaly. While almost 90% of the traffic in the network can flow from the Internet to the user, almost 90% of the cost of the access links can be attributed to the channel transmitting packets from the user to the Internet. Wireless Internet access from the user to the Internet is often implemented by means of some variation of a random access ALOHA channel. The interaction of ALOHA channels with TCP and other high level protocols used in the Internet can limit the effectiveness of both TCP and ALOHA for such access. The goal of this NSF SBIR research program is to understand this awkward interaction of standards in the high cost random access channel and to develop a strategy of migration to a more sensible access architecture based upon transparent proxies.

The societal and commercial impact of this project will be to increase the capacity of broadband wireless Internet multiple access channels thereby decreasing the cost per user of the channel. This decrease in the cost per user when shared with customers can increase the market for broadband wireless access to the Internet while increasing the profitability for wireless Internet Service Providers. These fast proxies will make wireless Internet access affordable for under-served and un-served end users in rural areas in the United States and in much of the rest of the world. Additionally the technical innovations of this research will serve to advance the current level of understanding of how TCP/IP protocols interact with other protocols in wireless data networks.

# Human/Computer Interface

Title: SBIR Phase II: Multi-Party Peer-to-Peer V3oIP

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| Award Number: | 0750558 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | January 15, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $495,154 |

Investigator: Milton Chen, milton.chen@vsee.com
Company: VSee Lab
3188 Kimlee Drive
San Jose, CA 95132
Phone: (510) 823-3564

Abstract:

This Small Business Innovation Research (SBIR) Phase II project extends the PI's Phase I to create a theoretical bandwidth and latency efficient multimedia streaming framework for communication. The ultimate goal is a software system that achieves less than 150 msec one-way end-to-end delay (the typical delay of telephone) for a 10-30 site meeting supporting wideband audio, full motion video, and application/desktop sharing over broadband networks. The industry norm to achieve multiparty video/web conferencing is the client-server architecture. Client-server architecture is expensive to deploy due to the number of servers required and the bandwidth required at the server nodes. Peer-to-peer approaches have been successfully used for large scale file sharing. However, peer-to-peer approaches have been relatively unexplored to scale the number of participants in a single meeting. This research combines real-time network sensing and the domain knowledge of video and web conferencing to create a scalable and cost effective peer-to-peer streaming algorithm. The maximum number of sites in a multiparty videoconferencing is typically 4-6. Given the limited screen resolution of a laptop/desktop, methods for showing 10-30 full motion video and a shared application are relatively unexplored. Poor user experience from inadequate user interface is a major barrier to the adoption of previous video/web conferencing tools. This research combines recent human factor discoveries to create a novel user interface that intuitively supports multiparty communication. Since AT&T invented videoconferencing in 1927, videoconferencing has been one commercial failure after another. The PI's previous research suggests that such failures are rooted in inadequate knowledge of the human factor requirements of videoconferencing. Based on previous research, they are developing a commercial software system which will make substantial impact on telework, remote education, and humanitarian operations. This project aims to create a low-cost peer-to-peer alternative to client-server architectures for large scale meetings. If successful, the architecture proposed in this effort could have significant commercial impact.

Title: SBIR Phase II:  Development of a Tunable Filter for Mini Hyperspectral Imager

Award Number: 0724494
Program Manager: Juan E. Figueroa

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $499,421

Investigator: Dennis Zander, dennis.zander@infotonics.org
Company: SpectralSight
5450 Campus Drive
Canandaigua, NY 14424
Phone: (585)919-3029

Abstract:

This Small Business Innovative Research (SBIR) Phase II research project will address the need to see beyond ordinary human vision, which is critical to improvements in health care delivery, development of precision agriculture methods, guarantee of front-line responder safety and protection, and processing a safe food supply. Hyperspectral imaging, with its ability to capture hundreds of continuous spectra, delivers a valuable tool that provides enhanced visualization and analysis. Current systems tend to be space- or air-borne, large bulky modules that do not lend themselves to portable or hand-held solutions. This mini hyperspectral imager has at its core a novel MEMS monolithic, Fabry-Perot tunable filter and optical system and will be portable and handy, similar in size to a zoom camera in a cell phone.

This research and development effort will develop a family of innovative miniature hyperspectral imaging systems that potentially can have a significant impact. These systems can alert our modern war fighter and emergency first responders by seeing beyond our vision and identifying terrorist threats. It can safeguard our nation's water and food supplies by utilizing affordable hyperspectral systems to identify e-coli and other bacterial contaminations before they are consumed.

Title: SBIR Phase II: Robust Speech-to-Text Messaging

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| Award Number: | 0724271 |
| Program Manager: | Ian Bennett |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Ashwin Rao, ashwin@travellingwave.com
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1200 Mercer St Suite 412
Seattle, WA 98109
Phone: (425)273-6933



Abstract:

This Small Business Innovation Research (SBIR) Phase II research project proposes to develop techniques for the hands-free input of text to mobile devices. Specifically, this project extends the results of the Phase I effort to produce a speech-recognition system for mobile devices and personal appliances that is robust in the presence of background noise. To increase the speech recognition accuracy, four techniques are employed: 1) Spellation where the users have to speak and partially spell the words as they dictate, 2) VoiceTap which requires that, for each character, the user says that character and the following character in the alphabet, 3) Voice Predict where the user has to say the word and input the first character of the word using the keyboard or VoiceTap, and 4) multi-modal speech to text, where the user speaks and uses the keyboard simultaneously. The research effort will focus on developing modules that allow speech to be dictated using a combination of whole words and spelled words.

The outcome of the proposed research has significant commercial potential. Because the front end or client-side can be ported to a variety of operating systems and processors, the flexibility of this technology should enable wide licensing of the technology to telecommunication device manufacturers. The mobile wireless industry is very large and growing industry, and multi-modal input technology is important to mobile customers who demand more efficient and accurate methods for communication. Improvements in accuracy could be very significant and would potentially have widespread applicability.

Title: SBIR Phase II: Artificial Intelligence and Character Animation

Award Number: 0548723
Program Manager: Errol Arkilic

Start Date: February 7, 2006
Expires: January 31, 2008
Total Amount: $499,996

Investigator: Michal Hlavac, michal@ingeeni.com
Company: Ingeeni Studios
271 Windsor Street
Cambridge, MA 02139
Phone: (617)818-7547

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to build and launch simple and intuitive software tools that allow for the creation of interactive 3D graphics within Macromedia Flash (a 2D vector graphics package). Combined with the existing technology, this collection of technologies will provide the first version of the revolutionary Artificial Intelligence Platform for the creation and delivering of interactive animated characters with emotional intelligence. The systems provide the characters with autonomous behavior selection (what should I do?), emotion (how do I feel?) and learning (have I seen this before?). Such a unique blend of technologies opens opportunities for the study of the theories of the human mind and creates an entirely new class of interactive media.

The broader impacts of this work are scientific, educational, and economic. The technologies advance discovery and understanding of the workings of the human mind by giving a rapid prototyping environment for computational theories of the mind. Scientists and non-scientists alike can create AI networks and see the resulting characters "twitch" on screen in real time. This work promotes teaching, training and learning as Ingeeni will work with UC Irvine and MIT Media Lab to develop curriculums for Synthetic Characters classes that use the platform. Massive adoption of Ingeeni's technologies is the company's main goal, and it is developing libraries of detailed step-by-step tutorials freely available online.

Title: SBIR Phase II: The Delivery of Content-Rich Traffic Information to Improve Driver Decision Making

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| Award Number: | 0522320 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | October 1, 2005 |
| Expires: | September 30, 2007 |
| Total Amount: | $500,000 |


Investigator: Randall Cayford, rcayford@intellione.com

Company: IntelliOne Technologies Corporation
1776 Peachtree Rd NW
Atlanta GA, 30309

Phone: (404)969-3755


Abstract:


This Small Business Innovation Research (SBIR) Phase II project will develop user interfaces, routing algorithms, and driver notification systems necessary to deliver content-rich traffic information to travelers en route. Large volumes of traffic data, of varying types over large areas, is being gathered by public and private agencies. To be useful to a driver while traveling, this data must be reduced to small amounts of information and delivered in a way that allows easy comprehension with minimal distraction. Key driver behaviors benefiting from traffic information are pre-trip departure time changes, pre-trip and en-route route changes, and en-route anxiety reduction through drivers knowing the estimated arrival time. These behaviors depend on collecting and analyzing the planned route under changing traffic conditions and comparing that route with possible better alternatives. This research will develop user interfaces to collect origin, destination, and route information from drivers, pre-trip via the web and en-route via cell phone. Algorithms to determine alternate routes will be developed through analysis of field collected route data. Notification methods that present the salient information with minimal distraction will be developed and tested. The research will result in the development of better traffic information services that truly support the decisions drivers make as they travel.

The results of this research have potentially broad impacts on society. Traffic congestion is a growing problem in U.S. cities. In some areas, it has become a limiting factor on economic growth. Emphasis has shifted in recent years from providing additional capacity to better utilization of the existing infrastructure. Broad dissemination of traffic information in a form suitable for making optimal routing and trip decisions allows efficiency improvements based on the decentralized decisions of many drivers. Trip modifications based on traffic information can save drivers an estimated $3.9 billion in lost productivity, 225 million hours of travel time, and 340 million gallons of fuel, per year. It is believed that such savings could support a viable commercial marketplace for personalized traffic information. Similar savings are possible for commercial travel through improvements in delivery routing, on-time delivery, and more efficient dispatching. Congestion management by public agencies strives for efficient use of the public infrastructure by shifting motorists onto less congested roads and would benefit from better interfaces between the traffic data collected and the individual drivers on the roads. The examination of route choice will advance the scientific understanding of how drivers choose their routes and how they alter those routes under changing external conditions.

Title: SBIR Phase II: Automatic Classification of Magnetocardiograms

Award Number: 0349580
Program Manager: Errol B. Arkilic

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $486,749

Investigator: Karsten Sternickel, karsten@cardiomag.com
Company: CardioMag Imaging, Inc
450 Duane Ave
Schenectady, NY 12304
Phone: (518)381-1000

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will incorporate machine-learning techniques into agneto-cardiography (MCG) that measures minute magnetic fields emitted by the heart's electrophysiological activity, based on SQUID technology and operable in typical (magnetically unshielded) hospital rooms, for early non-invasive diagnosis of heart disease. The overall objective of this project is to identify and localize, using MCG, cardiac ischemia, the leading cause of death in the US. The focus will be on excellent predictability, ease of tuning, and user transparency of machine learning tools. Upon successful completion of this project MCG has the potential to become the new gold standard for the detection of cardiac ischemia in patients presenting with suspicion of acute coronary syndrome. Worldwide, the lack of inexpensive and non-invasive cardiac diagnostic techniques causes unnecessary delays in the recognition of acute coronary heart disease and its treatment. The feasibility of MCG to diagnose heart disease has been demonstrated. Machine learning tools provide quantitative methods for the automated diagnosis of heart disease.

After successful completion of this project, physicians and nurses in leading U.S. hospitals can be trained in automated MCG diagnosis. It will also usher the use of machine learning tools for medical diagnosis in general.

# Information Management and Retrieval

Title: SBIR Phase II: Mobile Visual Search Engine

Award Number: 0822713
Program Manager: Errol B. Arkilic

Start Date: August 1, 2008
Expires: July 31, 2010
Total Amount: $500,000

Investigator: Gerald Pesavento, gerry.pesavento@iqengines.com
Company: IQ Engines, Inc.
821 Pine Lane
davis, CA 95616
Phone: (530) 219-2192

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a biologically-inspired image search and recognition technology to provide rapid object information retrieval from a mobile phone camera. The end result is that potentially any object in the real world is now "clickable": a picture of an object provides a hyperlink to the Internet. The proposed system utilizes a new method for sparse, multi-scale image representation based on the monogenic signal, a 2D generalization of the analytic signal that is robust to image transformations. By 2010, it is estimated that there will be over 1 billion mobile phones with cameras.The mobile phone is becoming an important connection between people and the digital world. The applications for mobile search technology are enormous and include national homeland security, product information retrieval (such as environmental ratings, pricing, or specifications), vision support for the blind, accessing object information for the disabled, and general purpose information retrieval including remote visual data analysis and inspection. Search technology has brought about many profound societal, educational and scientific benefits in the past decade. The proposed mobile image search technology will extend those benefits to a broader base of users and applications.

Title: SBIR Phase II: OpenBio Workbench for Sharing of Mathematical Models in Drug Discovery

Award Number: 0822975
Program Manager: Errol B. Arkilic

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $496,357

Investigator: Taeshin Park, tspark@alum.mit.edu
Company: RES Group, Inc.
11 Cambridge Center
Cambridge, MA 2142
Phone: (617) 834-2416

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an innovative software platform called OpenBio Workbench that will enable researchers in drug discovery to easily access and share mathematical models and model results. Modeling is becoming increasing important, motivated by the FDA's drive to modernize the drug discovery process and the advent of emerging fields such as Systems Biology. A broad adoption of modeling has been limited, however, because the current practice requires programming and computational skills not typically possessed by experimental researchers in biological sciences. In the Phase II project, the tool's capabilities will be augmented by allowing users to calibrate models by including experimental data, adding innovative advanced modeling tools such as model building. The potential commercial value of this workbench is high as the pharmaceutical industry is investing significantly in mathematical modeling and Systems Biology aiming to overcome both the high costs of drug development and the stagnation in the discovery of new drugs since the 1990's. Further, aging populations in developed countries are going to cause sharp increases in health care costs, while at the same time there are serious budgetary pressures (both from government and private insurers) to keep health care costs under control. Thus, methods that speed up the research cycle and reduce development costs for new drugs and treatments are going to become increasingly important.

Title: STTR Phase II: Integrating Online Analytical Processing (OLAP) and Ontologies to Discover Inconsistencies in Expectations for Supply and Demand

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| Award Number: | 0750543 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $512,000 |

Investigator: Peter Moore, peter@clados.com
Company: Clados Management LLC
133 Saint Matthews Avenue
San Mateo, CA 94401
Phone: (650) 231-0494

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project aims to produce a software application that dramatically improves a manager's ability to allocate resources to productive uses. With advances in Online Analytical Processing (OLAP) and ontology technology, the tool has the potential to enable the discovery of future supply and demand imbalances for teams of business analysts. The objective is to produce at least one Investable Inconsistency per day by the end of the research period. The Phase I project produced unanticipated innovations that may have broad utility in both the OLAP field and the ontology field, and with these innovations, the software platform shows promise for transforming the essential practice of analysis in the field of market research in support of investment decisions. The Phase II project, if successful will result in technology that extends this promise to a broad audience, educating users in best practices for investment analysis and enabling them to materially improve their allocation of resources.

Title: SBIR Phase II: Collaborative Patent Drafting Software

Award Number: 0750550
Program Manager: Errol B. Arkilic

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $500,000

Investigator: Rocky Kahn, rocky@teampatent.com
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5832 Birch Court
Oakland, CA 94618
Phone: (510) 601-7625

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a patent-drafting software tool which addresses two critical problems currently preventing inventors from closely collaborating with patent attorneys: 1. Attorneys need tools to hold their comprehension of and manipulate the relations in the document while ensuring they're used correctly and 2. Inventors need an ability to share the attorney's comprehension of the relations, review the application at any time, and author parts of the specification without requiring extensive oversight or rework by the attorney. The project will entail prototyping a set of collaborative knowledge representation methodologies, which are not currently available on any platform and which require cutting-edge, broadband-enabled infrastructure. The U.S. economy relies heavily and increasingly upon intellectual property, and patents are the primary currency of this economy. 500,000 utility patent applications will be filed in 2008 with the U.S. Patent and Trademark Office (USPTO), a quantity that has been growing annually at 7.5% for a decade. As patents become more significant in the operations and outcome of U.S. businesses, it becomes increasingly important to assure that the system can be efficiently traversed by high-technology startups, which will provide the next-generation of innovations. A U.S. patent application typically costs $10,000 and requires either specialized knowledge or the time to learn how to navigate the process. The large expense and difficulty of patents leads companies to triage protection for their innovations, leading to curtailment of promising activities due to the lack of a budget for patent protection. They must decide whether to divert precious capital and engineering resources from product development to patenting. The proposed patent-drafting software tool will encourage greater participation in the intellectual property economy by reducing costs, increasing relevance, and allowing inventors to actively participate in drafting the application.

Title: SBIR Phase II: Automated Community and Sentiment Mining for Global Media Preference Understanding

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| Award Number: | 0750544 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | April 1, 2008 |
| Expires: | March 31, 2010 |
| Total Amount: | $500,000 |

Investigator: Tristan Jehan, tristan@echonest.com
Company: The Echo Nest Corporation
48 Grove Street
Somerville, MA 2144
Phone: (617) 628-0233

Abstract:

This Small Business Innovation Research (SBIR) Phase II project applies data mining and machine learning techniques to both natural language description and Internet link graphs to model communities in order to predict preference, taste and sentiment for different kinds of media (music, TV, online media, video games, books). Current contextual information mining approaches that scan the text on a page for advertisement or recommendation ignore valuable community connections inherent in most self-published Internet discussion. Sentiment and opinion extraction systems operating on full text create challenging language parsing problems are fraught with issues of scale and adaptability. The identification systems can automatically categorize anonymous Internet writers or website visitors into specific demographic communities based on their tastes in many kinds of media. The Phase II research project approaches opinion extraction with a bias-free learning model based on training from known online corpuses that can be adapted to different languages and learns in real time as more data becomes available for high accuracy. Current personalization and marketing approaches either look at the "clickstream" of an anonymous user, leading to equally anonymous recommendations for popular movies and music -- or by scanning a surface-level overview of the text, leading to keyword advertisements with limited contextual understanding of entertainment content and community sentiment. The project plans to fully integrate people-focused community and sentiment analysis technologies into an autonomous, learning and scale-free "media knowledge service" for digital entertainment providers and marketers that can change the way digital content is marketed and sold.

Title: SBIR Phase II: The Media Fusion Project: A Distributed Architecture for Mega-Pixel Displays

Award Number: 0750202
Program Manager: Errol B. Arkilic

Start Date: March 1, 2008
Expires: October 31, 2009
Total Amount: $499,999

Investigator: Christopher Jaynes, cjaynes@mersive.com
Company: Mersive Technologies, LLC
137 West Vine
Lexington, KY 40507
Phone: (859) 806-0398

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and deliver a software media architecture that removes a critical barrier to the widespread use of multi-projector, high-resolution, ultra definition displays. The approach defines a set of layered abstractions from the low-level display driver to higher-level protocols including multi-user display use and security. This model is the bedrock of a new display architecture that will not constrain future display innovations, allow content developers and producers to communicate to current and future display systems, and acts to isolate the underlying complexities of new display technologies from users. Building on this new architecture, the Phase II project will implement a software-based Display Operating System. The project is motivated by the perception that we will soon live in a world where displays cease to be individual discreet devices but rather become an extension of our environment; a limitless fabric of pixels. The potential impact of this innovation is significant, by removing the usability and cost barriers normally associated with ultrahigh-resolution displays, applications once available to only a select few can become commonplace. This has the potential to change the advanced visualization, media interaction models, as well as the way in which we interact with our computational environments.

Title: SBIR Phase II: SAFE: Behavior-based Malware Detection and Prevention

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| Award Number: | 0750299 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | March 1, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $500,000 |


Investigator: Hao Wang, hwang@novashield.com

Company: Novashield, Inc.
1200 John Q Hammons Dr
Madison, WI 53717

Phone: (608) 833-2610



Abstract:

This Small Business Innovation Research (SBIR) Phase II project has the objective of implementing a commercially-competitive, host-based, malware detection and prevention system. During Phase I, a host-based malware detection system that demonstrated the practicality of detecting a malicious process by dynamically monitoring its system events was developed. The prototype called SAFE (Secure Activity Filtering Engine) filters system events using a stateful policy engine whose policies specify malicious behavior and the appropriate response. Because the technology does not rely upon the detection of "signatures" (i.e. patterns of bytes), it can detect previously unseen malware. During Phase II a number of significant enhancements to the policy engine including a checkpoint/rollback capability will be developed. The proposed functionality removes file system and registry changes associated with a process when a policy violation is detected. The ability to delay detection of malicious behavior until detailed system events are observed provides a just-in-time detection capability that increases the accuracy of the detection process while reducing false positives. The SAFE technology has the potential to demonstrate an effective approach to combating at least two of the dominant trends in the threat landscape. One such trend is the crafting of blended threats which use multiple infections vectors like email readers, web browsers, and messaging software to infect a host computer. Another trend is the popularity of "malware toolkits" which can be used by malware writers to quickly generate multiple variants of the same virus. The rapid proliferation of obfuscated variants is a potent threat to traditional signature-based solutions on two fronts: the rate of malware infection may overwhelm efforts to produce signatures to detect these variants and the logarithmic increase in the size of signatures databases reduces the performance of signature scanning. The SAFE technology addresses both of these trends. The stateful policy engine can correlate non simultaneous events across multiple sub systems and processes and thus detect and block blended threats. If successful, the architecture of the proposed system will have the potential to address a myriad of security threats and make a commercially-significant impact.

Title: SBIR Phase II: Visualization Toolkit for 3D Photography

Award Number: 0724338
Program Manager: Errol Arkilic

Start Date: September 15, 2007
Expires: August 31, 2009
Total Amount: $500,000
Investigator: Siavash Zokai, zokai@brainstormllc.com
Company: Brainstorm Technology LLC
514 West 24th Street, 3rd Floor
New York, NY 10011
Phone: (516)668-1393

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to develop a comprehensive 3D photography toolkit for importing the geometry of existing large-scale urban structures into the computer. The goal of the project is to minimize the effort of building models of high geometric and photometric accuracy that are suitable for efficient rendering, manipulation, and analysis. The proposed Phase II work will build upon the feasibility study conducted in Phase I. The Phase I effort introduced a novel algorithm that successfully integrated multiview geometry with automated 3D registration to produce realistic visualizations of complex, reconstructed, real-world 3D models with minimal human interaction. The goal is to build approximate lightweight 3D models directly from a collection of photographs of the scene. The proposed workflow treats a photograph as tracing paper upon which 2D shapes are defined prior to extruding them into 3D models.

The commercial application of this Phase II project is the introduction of a comprehensive software toolkit for 3D photography. The ultimate goal is the reconstruction and visualization of detailed models of urban sites, i.e. digital cities. The creation of digital cities drives other areas of research as well: visualization of very large data sets, creation of model databases for GIS (Geographical Information Systems) and combination of reconstructed areas with existing digital maps. Other applications include video game development, entertainment, architecture, virtual tourism, fire/police/urban planning, urban design, disaster prevention, archaeology, and historical preservation.

Title: STTR Phase II: Nonintrusive Electrical Monitor (NEMO)

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| Award Number: | 0646585 |
| Program Manager: | Errol Arkilic |
| Start Date: | April 1, 2007 |
| Expires: | March 31, 2009 |
| Total Amount: | $500,000 |

Investigator: John Rodriguez, NEMOmetrics@aol.com
Company: NEMOmetrics
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Charlestown, MA 02129
Phone: (617)242-0050

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop and qualify a Non-Intrusive Electrical Monitor product (NEMO) to provide inexpensive, accurate, in depth monitoring of electrical usage, permit expanded energy savings and provide additional information, like potential equipment faults and failures. NEMO increases the amounts and kinds of diagnostic information that can be gleaned from a single set of electrical measurements, thus lowering the cost of monitoring building energy management systems. By analyzing the transient signatures produced when different electrical equipment draws power, NEMO can identify which of multiple loads turn on and off and assess their condition. The objectives of the research are to determine: the reliability of NEMO algorithms in the presence of multiple loads, prioritize several possible diagnostic analyses for the commercial product, and maximize the automation of NEMO data analysis while minimizing the need for human scrutiny and intervention. Phase I demonstrated the value of NEMO systems in monitoring and diagnostics with air conditioning units. The Phase II research plan calls for continuing the development work and installation of a qualified prototype in commercial buildings.

Data analysis will reveal inefficiencies in building operation and effectiveness of the algorithms themselves. This project will develop a system for non-intrusive detection and identification of multiple electrical loads with major energy conservation and other benefits. Time of use data can be used to create new automated algorithms that minimize energy use and optimize heating, ventilation, and air conditioning system operation without affecting occupant comfort, while electrical health diagnostics can signal when a motor is nearing failure or a valve has jammed. A reduction in the cost of in-depth monitoring allows more commercial facilities to reap energy and maintenance savings from these algorithms and the NEMO product that contains them. Actual measurement rather than estimation of initial and ongoing electrical power consumption of electrical equipment within a commercial building enables verification of upgrade performance. It also facilitates design and operation of intelligent, energy efficient buildings and assists in attaining Leadership in Energy Efficient Design (LEEDTM) certification. By promoting energy efficiency in buildings, NEMO will enable customers to reduce their energy costs, reduce or eliminated unscheduled maintenance and increase profitability.

Title: SBIR Phase II: Surface Enhanced Raman Scattering (SERS)-Based Nanoparticles as Covert Taggants for Anti-Counterfeiting Applications

Award Number: 0548687
Program Manager: Errol Arkilic

Start Date: February 7, 2006
Expires: January 31, 2008
Total Amount: $499,624

Investigator: Sharron Penn, sharron.penn@oxonica.com
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665 Clyde Ave, Suite A
Mountain View, CA 94043
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project will continue the development of an anti-counterfeiting solution for the brand security market, built around a series of covert, nanoscale taggants, called SERS nanotags. Three technical hurdles remain for the innovative tags to be accepted by customers: (1) ability for to develop cost-effective, commercial scale manufacture; (2) the demonstration of a handheld reader; and, (3) seamless integration into printed products.

Because of its mushrooming growth and profound economic impact, the FBI has called counterfeiting "the crime of the 21st century". Part of the problem is that current anticounterfeiting technologies offer extremely limited performance and are themselves easy to counterfeit. SERS nanotags embody all of the features of the, much needed, next generation of anti-counterfeiting technologies. Therefore, if successful, this technology will have an impact across many commercial and government sectors.

Title: SBIR Phase II: Unsupervised Extraction of Relational Data from the Web

Award Number: 0548699
Program Manager: Errol Arkilic

Start Date: January 23, 2006
Expires: January 31, 2008
Total Amount: $499,936

Investigator: Steven Minton, minton@fetch.com
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Phone: (310)414-9849

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will enable software systems to make use of data on the Web that is embedded in HTML pages. The semantic web is intended to allow data to be shared and used by software applications. Unfortunately, in the present world, data on the Web is generally inaccessible to most applications because it is presented in a format intended to be usable by humans, as opposed to computers. The goal of this project is to create a relational view of data on the Web, so that applications can access Web data based on entities and their relations. The approach uses unsupervised machine learning to extract data from web sites for conversion into relational form. This project will result in a new generation of Web harvesting technology that has clear commercial value.

Web harvesting is an area of growing commercial interest for a variety of vertical markets, including Sales Intelligence, Market Intelligence, News Aggregation, and Background Search. However, web harvesting technology is limited today, since the collection of rich, detailed data must be done on a site-by-site basis. The approach described here, if successful, will enable a new generation of intelligent web harvesting technology that can scale to the entire Web. Ultimately, our approach will enable applications to query the entire Web as if it were a relational database. This has tremendous commercial value, and will enable many new types of web applications to be developed. In addition to the commercial value, the technical approach is novel and has significant merits on its own. If it is successful, the proposed method should generalize to other complex domains (such as scene understanding and natural language processing) where multiple heterogeneous types of structure must be analyzed to discover underlying meaning.

Title: SBIR Phase II: Improving Infection Control Through Radio Frequency Identifier (RFID)-Based Patient Tracking

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| Award Number: | 0548737 |
| Program Manager: | Errol Arkilic |
| Start Date: | January 23, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $495,856 |


Investigator: Daniel Kokotov, dkokotov@vecna.com
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College Park, MD 20740
Phone: (301)864-7253



Abstract:

This Small Business Innovation Research (SBIR) Phase II Project will provide hospitals with a way to analyze and prevent hospital-associated infection outbreaks based on integrating a location tracking system with live hospital microbiology data, building on research done in Phase I. The goal is the design, implementation, deployment and clinical validation of two tools: (1) a visualization and analysis tool for investigating propagation dynamics of past and current infection outbreaks; and, (2) a simulation tool for evaluating response measures to potential outbreaks. The research will center on clinical acceptance and usability. The involvement of medical and infection control experts will ensure that the models of infection spread are accurate, the visualization and analysis tools are intuitive, and the simulation tools cover the important infections and scenarios.

Every year tens of thousands of lives, and billions of dollars, are lost to infections acquired in health care facilities. The envisioned product will give hospitals powerful tools for reducing these numbers, allowing them to better understand why infections happen and what counter-measures are effective. Hospital-associated infections' impact goes beyond the immediate sickness they cause, forcing treatment of the infection in addition to the underlying illness, and dissuading many from seeking necessary care because of the fear of acquiring infections.

Title: SBIR Phase II: Building a Large-Scale, Effective, Self-Maintainable and Customizable News Metasearch System

Award Number: 0522271
Program Manager: Errol B. Arkilic

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $500,000

Investigator: King-Lup Liu, kliu2002@yahoo.com
Company: WebScalers L.L.C.
121 Conque Drive
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Phone: (337)984-3968

Abstract:

The Small Business Innovation Research (SBIR) Phase II project develops a metasearch capability engineered for news searching. Searching is the second most popular activity on the Internet behind emailing and it already has a multibillion dollar advertising market. News searching accounts for a major percentage of all searches. News items are available from a large number of online sources but the current technologies for news search are not scalable to effectively cover all of these sources in a timely manner. This project is to develop a new technology to tackle this problem via constructing a large-scale, highly effective, self-maintainable and customizable news metasearch engine. High effectiveness is achieved by automatically selecting the most appropriate search engines to access for each user query and by effectively identifying the correct meanings of the terms in each query. By employing highly automated techniques to incorporate search engines, this system can automatically adapt to changes that are made to the connected search engines and users can customize by adding their favorite news search engines.

Highly automated solutions employed herein reduce labor costs for development and maintenance, which translate to lower advertising costs and make online advertising more affordable for "small players", including small, local media Websites, individuals and small companies. This project advances large-scale information integration, large-scale distributed information retrieval, information extraction, automatic system self-maintenance, and customization on demand. The proposed technology empowers ordinary users in their search for more relevant and more up-to-date news items from a large number of news sources. It also empowers them to customize the search system to suit their information needs

Title: SBIR Phase II: Assessing Status and Trends of Threatened Species from Uncertain Monitoring Data: Methodology and Software

Award Number: 0514541
Program Manager: Errol B. Arkilic

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $499,785

Investigator: H Akcakaya, resit@ramas.com
Company: Applied Biomathematics Inc
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Setauket NY, 11733
Phone: (631)751-4350

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop and implement as software methods for entering, processing, and analyzing species distribution monitoring data, which is one of the most basic forms of biological information that comes from surveys, censuses, and other routine assessments. These methods will use basic monitoring data to (1) assess the status and trends of the monitored species at the population-level, and (2) estimate the input parameters for the more advanced quantitative models, thereby increasing the use of these models, which include population viability analysis models, habitat models and other GIS-based methods, and quantitative risk criteria, such those used by the World Conservation Union (IUCN) and the NatureServe. One of the major innovations of the proposed software will be its treatment of uncertainty. Ecological data are often scarce and uncertain, including spatial and temporal variation, measurement and sampling errors, and demographic variance. The methods to be implemented in the proposed software will account for this uncertainty and incorporate it into the assessment of status and other outputs produced.

Broader impacts of the project will include standardization of the monitoring process for a broad spectrum of species, significantly reducing the cost of processing and analyzing monitoring data and increasing the use of advanced quantitative models in relation to environmental issues. This will, in turn, increase the use of scientific information in environmental decision-making and policy formulation. The methods developed in this project will also allow incorporating data uncertainties in an objective, transparent, and credible way, thereby providing scientifically credible and sound summary of the status and trends of the species monitored. The proposed methods will be implemented as software. Expected commercial applications include software sales and contracts for specific applications of the software.

Title: SBIR Phase II: Speculative Compilation for Energy Efficiency

Award Number: 0348966
Program Manager: Errol B. Arkilic

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $500,000

Investigator: Csaba Moritz, andras@bluerisc.com
Company: BlueRISC Labs
28 Dana Street
Amherst, MA 01002
Phone: (413)545-2442

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop energy-aware compiler techniques to reduce power and energy consumption in microprocessors, without affecting performance. Over the past few years, energy consumption by computers has emerged as a major area of intellectual and commercial activity. A key principle behind this approach is to use speculative information available at compile time to reduce power and energy consumption. The key qualifier is speculative: the information does not have to be provably correct. Speculative information that turns out to be correct will enhance energy reduction; if it is incorrect, the worst that will happen is that a penalty (in terms of energy) will have to be paid. The use of such speculative compile-time information opens up a largely unexplored dimension in compilers and computer architectures, to target energy efficiency.

The outcome of the proposed effort will not merely be a set of products, but also a vastly increased understanding of the means by which compile-time information can be exploited for energy savings. It is expected that this development effort will have a considerable impact on the theoretical underpinnings of compilers and compiler-architecture interaction, as well as a significant commercial impact. With the increasing prevalence of battery-powered computing devices such as PDAs, mobile telephones, and notebooks, power-aware computing is becoming increasingly important commercially.

Title: SBIR Phase II: Authentication of Mobile Video Recordings (MVRs) Based on Real-Time Hybrid Digital Watermarking

Award Number: 0349602
Program Manager: Juan E. Figueroa

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Zhenyu Wu, zhenyu.wu@ieee.org
Company: MY EZ Communications LLC
580 Lake Drive
Princeton, NJ 08540
Phone: (609)713-3465

Abstract:

This Small Business Innovation Research (SBIR) Program Phase II project is aimed at the refinement and commercialization of the authentication technology developed during Phase I that enables the deployment of digital Mobile Video Recordings (MVR) system. A very large fleet of patrol vehicles operated by the law enforcement community that record events involving contact with civilians collects MVR data daily. Due to staggering costs associated with operating current analog, non-indexing system, there is an overwhelming needs for a computerized digital MVR technology. However, its deployment is hindered by legal acceptance, because digital medium can be easily altered. Authentication plays a critical enabling role by providing an effective means to safeguard the integrity of MVR content. To capitalize upon this emerging trend of digital MVR, the company proposes as a commercialization strategy to market the innovative technology in a package in an authenticated acquisition system, consisting of a digital video camera and a software suite for on-the-fly video watermarking, off-line MPEG compression and watermark verification. This compact and low-cost acquisition system leverages on existing in-car laptop for processing and storage, and is specifically designed to meet stringent operational requirements set forth by next generation MVR system. It integrates seamlessly with existing IT infrastructure and computerized MVR management systems. MVR has provided an effective way of protecting law enforcement agencies, their officers and the public they serve.

The MVR authentication provides an enabling technology for the acceptance and deployment of cost-saving computerized MVR technology for the law enforcement community nationwide. It allows for safe elimination of the labor-intensive process associated with safeguarding the integrity of MVR content, because watermarking is done on the fly and there is no time window at which MVR data are ever unprotected. With the deployment of digital MVR system equipped with watermark authentication technology, the costs associated with operating the system will be greatly reduced allowing for the savings to be redeployed to other law enforcement endeavors. Within the next three years a comprehensive national digital facial database will be created to support Homeland Security. As an integral component of the in-car laptop, this technology will serve as the front line in capturing the data for submission to the national database.

Title: SBIR Phase II: A Hydro Optical Analysis System (HOPAS) for Environmental Monitoring of Water Quality

Award Number: 0349581
Program Manager: Errol B. Arkilic

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $491,760

Investigator: Francis O'Brien, fjobrien@cox.net
Company: System Science Applications, Inc.
121 Via Pasqual
Redondo Beach, CA 90277
Phone: (310)375-9803

Abstract:

This Small Business Innovation Research (SBIR) Phase II research proposes to complete the development of an environmental information system - the Hydro-Optical Analysis System (HOPAS). HOPAS combines an advanced radiative transfer model with a powerful nonlinear programming algorithm to enable transforms of optical water measurements into information on the composition and concentration of materials that effect water quality. For the first time, measurements of the light field from satellites, aircraft, moorings, and ships can be rapidly inverted to obtain accurate estimates of phytoplankton, suspended mineral particles, and dissolved materials. HOPAS will enable scientists, environmental engineers, and aquatic resource managers to use easily obtained in situ or remotely sensed optical data to understand and manage aquatic ecosystems.

HOPAS will alleviate the need for expensive, labor-intensive laboratory analysis of water samples for use in addressing water quality issues, including microbial growth in drinking water supplies, surface pollutants from farms, industries, vessels, and domestic sources, algal blooms, fisheries and mariculture, and protection of coral reefs and sea grass beds.

Title: SBIR Phase II: Animated Real-Time Road Traffic Visualization for Broadcast and the Internet

Award Number: 0349460
Program Manager: Juan E. Figueroa

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $510,000

Investigator: Andre Gueziec, andre@trianglesoftware.com
Company: Triangle Software
1265 W. Knickerbocker Dr
Sunnyvale, CA 94087
Phone: (408)893-8798

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims at 2D/3D visualization of real-time traffic/traveler data (incidents, speed/density, public events) and computer traffic simulations. The rapid production of data-driven, information-rich animations has previously proved very difficult. With the notable exception of weather forecast animations, requiring highly expensive complex multi-computer systems, quality animations are routinely produced weeks ahead of time for television documentaries. Traffic/traveler data represents particular challenges such as the fact that data changes very frequently and becomes stale in minutes. Much of this data is in textual form, as reported on-scene by police or emergency crews. Reliability and utility to the traveler are concerns. Consequently, the four major weather broadcast companies have scarcely addressed the traffic market. This project will develop traveler data processing algorithms for predicting travel time, mining large databases of traffic information, and intelligent text- processing. It will also develop traffic micro-simulations, automating data-driven animation, and exploiting programmable graphics hardware for broadcast-quality real-time informative animations.

The expected results of this project are: (1) algorithms providing useful information to travelers/commuters from raw real-time police reports and sensor data; and (2) a product animating real-time traffic/traveler information for TV broadcast and the Internet, exploiting gradual improvements of raw data, as departments of transportation equip highways with speed/density sensors, and enforcement agencies open their servers. The Federal Highway Administration reports that the cost of traffic congestion in 1999 came to $78 billion nationwide, including 4.5 billion hours of lost time and 6.8 billion gallons of fuel wasted. Most transportation experts estimate that the ability to quickly provide accurate traffic information as proposed in this project has many benefits: (1) for drivers to plan alternative routes, keep on their schedules, and to reduce stress; (2) for overall congestion and better road maintenance; (3) for safety and road-rage mitigation; and (4) for improved pollution control.

# Teaching & Learning

Title: SBIR Phase II: Artificial Intelligence Tutoring and Assessment for Teacher Development

Award Number: 0822696
Program Manager: Ian M. Bennett

Start Date: July 15, 2008
Expires: June 30, 2010
Total Amount: $500,000

Investigator: Benny Johnson, johnson@quantumsimulations.com
Company: Quantum Simulations Incorporated
5275 Sardis Rd
Murrysville, PA 15668
Phone: (724) 733-8603

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project focuses on bringing the power and benefits of artificial intelligence tutoring technology to the arena of teacher professional development (PD). The proposed innovation is a teacher professional development system built on the principles of artificial intelligence, and delivered via the Internet. Similar to a flight simulator, this technology will offer a realistic but benign opportunity to test and expand a teacher's preparedness through practice with realistic classroom situations. A key objective is the creation of a classroom simulator which incorporates a virtual master teacher, to help teachers deepen their content understanding, learn to respond to student questions more effectively, practice proven pedagogical techniques for improving student understanding and conduct self-monitoring and assessment before getting in front of a live class. An increasing number of schools are forced to rely on new or out-of-field teachers to fill the gap for teaching science and mathematics, often resulting in a substantial decline in quality, depth and individual attention students receive. Because of the well-documented problems of teachers teaching out of their content areas, and low-performing schools having greater percentages of lesser-qualified teachers, states have established stronger criteria for in-service teachers and newly qualifying pre-service teachers. Middle and high school science and mathematics are the areas where most out-of-area teaching is occurring. In the National Center for Education Statistics (NCES) report, 'The Condition of Education', a key finding is that high school students in high-poverty, high-minority schools were more often taught science, mathematics and English courses by out-of-field teachers than their peers in low-poverty, low-minority schools. This research is expected to impact these issues and in addition address the goals of the American Competitiveness Initiative and the requirements for highly qualified teachers identified in the 'No Child Left Behind' initiative.

Title: SBIR Phase II: OptDiverse: Innovative Technology to Enhance Workforce Diversity, Capabilities, and Performance

Award Number: 0750045
Program Manager: Ian M. Bennett

Start Date: April 15, 2008
Expires: March 31, 2010
Total Amount: $439,646

Investigator: Fred Glover, glover@opttek.com
Company: OptTek Systems, Inc.
1919 Seventh Street
Boulder, CO 80302
Phone: (303) 447-3255

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to refine an algorithmic approach and develop prototype software for workforce optimization with a focus on diversity planning and management. This project is expected to achieve the following four major objectives: 1) further enhance and extend the core technology created during Phase I and endow it with added capabilities that will be valuable for marketability as well as effectiveness; 2) enhance external communications - the software must communicate effectively with the user and database systems. In Phase I, rudimentary communications were established. During Phase II, the system will be greatly enhanced to allow for more effective use; 3) develop software as a service architecture - for greatest market penetration, the software will be deployed via the web. The system architecture will be redesigned to accommodate this requirement; and 4) perform alpha-testing - internal and external testing is critical to releasing a high-quality product. The Phase II research will strengthen the technical aspects of the product while significantly improving its ease of use, producing a system ready to enter the market. The commercial applications anticipated for the software system are to first enhance the performance of workforce diversity planning and then evolve to supporting the optimization of the entire workforce. The technology is expected to have a significant impact on the broader inclusion of under-represented talent in the workforce. We also expect the technology to lead to improved organizational performance by enabling better decisions in recruitment and retention of all employees. The software will permit an organization to model and simulate critical patterns between policies, programs, initiatives, as well as other factors such as practices and compensation. The impacts of this research include the potential to: 1) design a more effective approach (simulation/optimization) to diversity planning and workforce optimization, increase workforce diversity, capabilities, and performance; 2) support a significant social and economic initiative; 3) become appealing to attract investments as it significantly increases return and minimizes risk in diversity and workforce planning; 4) add to the body of knowledge in human resource management and decision sciences that may be leveraged to permit additional research and development.

Title: SBIR Phase II: A Standards-Based High School Symbolic Geometry System

Award Number: 0750028
Program Manager: Ian M. Bennett

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $527,500

Investigator: Philip Todd, ptodd@saltire.com
Company: Saltire Software Inc
12700 SW Hall Blvd
Portland, OR 97223
Phone: (503) 968-6251

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an interactive symbolic geometry system that integrates algebra and geometry and focuses on high school mathematics. The absence of such a system has led to a technology gap in mathematics education between the geometry year in high school and the college level calculus sequence. The result of this project will be a software system along with learning materials which fills that gap. The National Council of Teachers of Mathematics (NCTM) standards include the visualization of three-dimensional figures and the mapping between certain three-dimensional surfaces and their two-dimensional unfolding or projection onto the plane. To address this, the project will create a three dimensional symbolic geometry system and in the process will break new ground both from an algorithmic and a user interface perspective. The creation of geometric models dependent on discrete but possibly indeterminate parameters, for example, a general n-gon, is an important pedagogic device for the study of the limits of geometrical figures. Such a facility poses new design and user interface challenges ranging from the definition of the general form of the dependence to the display of a geometrical figure with an indeterminate number of primitives. This Phase II project addresses the need for solid mathematics skills required for college-bound students and for those going directly into the workforce. Specifically, this project focuses on the learning of algebra, and its linkages with geometry. To date, no application exists that integrates algebra and geometry. The integration of technology itself within the learning of mathematics is one of the NCTM's six key principles of school mathematics. The project will incorporate geometrical constraints in addition to geometrical constructions and hence, unlike any other current educational system, directly address the workforce/professional requirements of a geometry system.

Title: SBIR Phase II: 3D Human Functional Anatomy for Middle and High School Education

Award Number: 0750352
Program Manager: Ian M. Bennett

Start Date: March 15, 2008
Expires: February 28, 2010
Total Amount: $493,537

Investigator: Robert Levine, rlevine@archiemd.com
Company: ArchieMD, Inc
1602 Alton Road #126
Miami Beach, FL 33139
Phone: (305) 981-4830

Abstract:

This Small Business Innovative Research (SBIR) Phase II Project combines 3-D computer graphics and gaming technology to provide a non-linear, immersive learning environment for science education in the human anatomy and physiology domain. Modern computer-simulations present a unique ability to present scientific information in an easy to understand manner. Technology advances in computer graphics present opportunities to present higher quality visual models in an interactive fashion that can convey the scientific process in a way which makes learning science fun and interesting for the students while capturing their enthusiasm for science. The proposed project will develop a toolkit consisting of 3-D visualizations for teaching human anatomy and physiology and interactive simulation environments for exploring the human body from a first person point of view. It is envisioned that simulations will be used in conjunction with traditional lectures while the interactive environments will provide immersive reinforcement learning. Phase II development will be validated by an independent evaluation that measures the products effects on achievement and interest in science. This project will play a role in increasing achievement and interest in science. In order for the nation to remain competitive in the life sciences, the nation must produce an adequate number of students who pursue degrees in life sciences. The proposed research is targeted at improving students' interest and achievement in science, and thus greatly impact the disturbing drop in recent years in United States' student interest in pursuing science education and careers, and the rapid increase in demand in the labor market for science-based degrees for the labor market.

Title: SBIR Phase II: Online Chapter Marketplace for Biology Learning Materials

Award Number: 0749862
Program Manager: Ian M. Bennett

Start Date: March 15, 2008
Expires: February 28, 2010
Total Amount: $499,999

Investigator: Eli Meir, meir@simbio.com
Company: SimBiotic Software
148 Grandview Ct
Ithaca, NY 14850
Phone: (212) 658-9104

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of an electronic replacement for reading materials currently used by the majority of biology undergraduate students. This replacement will combine smaller reading sections with more active learning components such as simulated experiments. The system to be developed will be open to contribution from a wide variety of authors and subject matter experts. Textbooks are currently used in most college biology environments to present material to students. However, learning through textbooks occurs primarily through memorization. This project is developing new innovative ways to facilitate productive learning techniques, and for configuring take-home assignments of biology students to be more active, without losing the content needed for understanding biological systems. This project has the potential to transform one of the pillars of science education, the textbook, from a passive reading instrument to an active learning tool. This could contribute to the improvement of learning gains for the at least one million students per year that participate in college level biology classes each year in the U.S. On a broad scale, this project eventually could help improve learning across all the sciences.

Title: SBIR Phase II: A Visual Language for Mathematical Model-Making

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| Award Number: | 0750432 |
| Program Manager: | Ian M. Bennett |
| Start Date: | March 1, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $532,000 |

Investigator: Christopher Hancock, ch@tertl.com
Company: Tertl Studos LLC
1 Hopkins St.
Montpelier, VT 5602
Phone: (802) 223-3044

Abstract:

This Small Business Innovative Research (SBIR) Phase II project continues the development of a visual interface that allows students to construct and investigate mathematical models. This research is undertaken with the goal of creating a general-purpose environment in which students, teachers, and content developers may benefit from being able to create such models for classroom use. The specific research objectives for this project address the following issues: 1) the underlying algorithmic support to achieve a concrete user interface; 2) the completion of the core functionality; 3) classroom usability and curricular integration; and 4) learning outcomes. The innovation embodied in this project responds to a national need for improved algebra education, and to increased emphasis on, and demand for, environments that provide visual, dynamic access to mathematical ideas and thinking processes.

Title: SBIR Phase II: Adaptive Authoring for Compound XML Documents: Collaboration Tools and eLearning Content Creation for STEM

Award Number: 0750520
Program Manager: Ian M. Bennett

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $499,920

Investigator: Samuel Dooley, sam@integretechpub.com
Company: Integre Technical Publishing Company, Inc.
4015 Carlisle NE, Suite A
Albuquerque, NM 87107
Phone: (505) 889-8189

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to develop rich-media adaptive authoring tools for e-learning content creation for collaborative documents for science and mathematics. The proposed objective is to remove technical barriers that impede development and deployment of e-learning content, and to advance tools that create structured content from multiple cooperating document types. The research objectives of this Phase II project will extend the Lexicon adaptive authoring framework developed in Phase I, as measured by compound document authoring issues exhibited by the QTI XML binding, which we will use as a vehicle to advance the adaptive authoring framework. The project will elaborate the Lexicon operator declarations to provide conventional authoring behavior needed for QTI markup elements, according to a progressive schedule of regular project milestones. At the end of the project, it is anticipated that the Lexicon will represent an adaptive authoring tool for rich-media collaborative documents with full language support for QTI markup, as a means for authoring and delivering e-learning content. Additional configuration language improvements and configuration authoring tools will position Lexicon to adapt to a wide range of compound XML document types for e-learning content, and extended programming interfaces will enable Lexicon to embed into a wide range of collaborative e-learning applications. Education in the U.S. is currently undergoing a transition to the digital age that will impact every aspect of teaching and learning. The current generation of collaboration tools are text-based,and do not support the notation needed to communicate mathematics. This project seeks to develop a suite of collaboration tools that have native support for mathematical notation, so that students and instructors can communicate scientific and mathematical concepts more effectively. This Phase II project aims to will extend the Lexicon adaptive authoring framework developed in Phase I, to support embedded semantic markup needed to deliver rich instructional content, and to position Lexicon to support a series of collaborative e-learning applications that are enabled by a relatively small amount of semantic markup: MathIM, an instant messaging application, prototyped during Phase I, that allows users include mathematical notation in person-to-person chat messages; MathWiki, a web-based forum application that supports communities of users who share an interest in topics that require mathematical notation; MathSpace, an online authoring environment for creating student worksheets; and MathME, or the Math Media Environment, a 'virtual notebook' in which students can record the work they are doing online.

Title: STTR Phase II: Intelligent Instruction Systems using Augmented Reality

Award Number: 0646587
Program Manager: Ian Bennett

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $499,022

Investigator: Jayfus Doswell, juxtopia@hotmail.com
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Phone: (703)989-1199

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project investigates the creation of intelligent instruction systems that exploit adaptive software mechanisms (i.e. intelligent software agents) and augmented virtual reality (AVR) techniques. Since it is common that production-line employees are required to wear goggles, intelligent agents could transfer their instructions via goggle-like wearable computers (i.e. AVR) that overlay the actual visual field with text and computer graphics. The proposed techniques will facilitate the real-time assessment of employees undergoing training and will allow the software agents to automatically and proactively reinforce weaker areas based on these assessments. An overall assessment model of all employees can characterize the entire workforce for a particular facility. For example, this overall assessment can be used to enhance resource management triggered by absenteeism or other factors, allowing planners to use such assessments for optimizing manufacturing processes by refactoring traditional, perhaps obsolete, production processes.

The broader impacts of the technology result from the use of intelligent agents to manage and direct the cross-training of employees in typical work environments where absenteeism and workforce turnover are important issues. Additionally, this technology, through workforce training broadly impacts the workforce to become more adaptive and agile with the resulting positive impact on overall product quality and productivity.

Title: SBIR Phase II: Understanding the Nature of Science

Award Number: 0620590
Program Manager: Ian Bennett

Start Date: September 15, 2006
Expires: August 31, 2008
Total Amount: $499,930

Investigator: Timothy Erickson, tim@eeps.com
Company: BigTime Science
5269 Miles Ave
Oakland, CA 94618
Phone: (510)653-3377

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will deliver simulations over the web for secondary and post-secondary science instruction which focus explicitly on students coming to understand the "nature of science." The nature of science implies that both the underlying logic of scientific discovery and the way that science is organized around the acquisition and dissemination of data and ideas. This is the big picture in science learning -- establishing the relationship between experiments and hypotheses; the idea that theories are models and not reality, and that the test of a theory is its predictive power. The research focuses on the careful design and testing of both the simulations and the lessons in which they are embedded, to ensure that they are as effective as possible.

Tomorrow's citizens need to know how science works. This project will help erase dangerous misconceptions about the origins and extent of scientific knowledge, and give students tools to evaluate scientific (and quasi-scientific) claims more effectively. This project also probes unusual models for both delivery of instruction and commercialization in the education world: it will use the Internet not to deliver content but to mediate a simulation and promote inter-group communication, usually within a single classroom rather than more widely; and will do so using subscriptions - a way that is cost-effective to the teacher in the short term.

Title: STTR Phase II: Lifelike Virtual Tutors to Support Authentic Learning

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| Award Number: | 0620486 |
| Program Manager: | Ian Bennett |
| Start Date: | August 24, 2006 |
| Expires: | August 31, 2008 |
| Total Amount: | $497,843 |

Investigator: Edward Sims, eds@vcom3d.com
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Orlando, FL 32817
Phone: (407)737-7310

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop proof-of-concept, Web- or CD-delivered Virtual Reality (VR) simulations that incorporate lifelike virtual tutors, capable of demonstrating and performing science experiments and communicating in written or spoken English or sign language, for Grades 5-8 curricula.

This project provides an opportunity to broaden participation of under-represented groups in authentic learning experiences, through the use of lifelike virtual tutor avatars. Originally conceived as a means to explain concepts visually and with sign language to deaf students with low English skills, these virtual tutors will benefit a broader range of learners who are otherwise isolated by language or reading barriers, or by lack of access to laboratory equipment.

Title: SBIR Phase II: Providing Tools for Richer eLearning Assessment

Award Number: 0620380
Program Manager: Ian Bennett

Start Date: August 3, 2006
Expires: July 31, 2008
Total Amount: $500,000

Investigator: Linda Chaput, lchaput@thinkfive.com
Company: Agile Mind
1100 South Main St
Grapevine, TX 76051
Phone: (817)424-2863

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will study effective models for carrying out assessments employing challenging puzzle-like questions that incorporate distractor analyses in which meaning is assigned to complex responses. Such distractor analyses apply where there is the possibility that the test taker can give alternative correct, partially correct, and incorrect answers. Metadata and distractor analyses will be combined to provide in-depth reports on student test performance. This new rule-based solution to distractor analysis meets a significant challenge in being able to include engaging problems in assessments of student progress in quantitative courses, such as Algebra and Geometry. The research will further develop question authoring and test construction tools.

As a consequence of this work, educators using these new technologies will be able to move beyond online testing based solely on multiple-choice, single-answer questions that are known to be unmotivating for many students. The goals are twofold: to provide varied, interesting, and even gamelike learning interactions that incorporate motivational and pedagogically valuable feedback; and to do so in a form in which empirical evidence can be used to improve the assessment corpus - both the metadata and the rules used for defining distractor analysis, especially where the items are novel question types.

Title: SBIR Phase II: Creating New Learning Opportunities: Platform-Independent, Wireless, Task-Oriented Communities

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| Award Number: | 0620327 |
| Program Manager: | Ian Bennett |
| Start Date: | August 3, 2006 |
| Expires: | July 31, 2008 |
| Total Amount: | $499,958 |

Investigator: Michael Curtis, curtis@goknow.com
Company: GoKnow
2084 South State St
Ann Arbor, MI 48104
Phone: (734)929-6602

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aimes to design and develop a challenging and critically important layer of communications' software that enables K-12 educational software developers to incorporate explicit support for collaborative learning activities into their existing applications quickly and at low-cost. The Elmer Software Development Kit (SDK) will enable students to collaborate using a broad range of handheld (or even desktop/laptop) computer platforms (Windows CE & XP, Linux, Mac OS X) since classrooms, as they are already beginning to experience, will be using non-homogenous computers side-by-side. The Intellectual Merit of this proposed effort stems from the need to construct new algorithms to automatically detect other devices, to reformat communications' messages to enable cross-platform (and cross-operating system) communication on a range of platforms. The outcome of this effort should be a software development kit that engenders the incorporation of collaborative learning strategies.

K-12 education is the cornerstone of America's democracy. As No Child Left Behind (NCLB) act acknowledges, America has some serious work to do in reinventing how we educate our children in order for America to continue to provide its people with the standard of living that is the American Promise. Technology is today's generation's tool of choice outside of school; we need to make technology an integral tool inside of school, too. Advocating for technology is the easy part - making the technology accessible, useful, and enjoyable remains the challenge. Our SBIR project goes directly to the core of helping K-12 realize the vision of technology positively impacting teaching and learning. In particular, the proposed research will enable educational software developers to create, quickly and at low cost, collaboration-enabled applications that teachers demand and that students find enjoyable and productive.

Title: SBIR Phase II: Visualization of Massive Multivariate Adaptive Mesh Refinement (AMR) Data

Award Number: 0548729
Program Manager: Sally Nerlove

Start Date: January 23, 2006
Expires: February 29, 2008
Total Amount: $430,385

Investigator: Lisa Avila, lisa.avila@kitware.com
Company: Kitware Inc
28 Corporate Dr #204
Clifton Park, NY 12065
Phone: (518)371-3971

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the lack of visualization technology for hierarchical structured grids created through an advanced simulation process known as Adaptive Mesh Refinement (AMR). Although the AMR structure makes possible simulations that are too computationally expensive using a uniform grid approach, it leaves the scientist with a lack of visualization tools to properly render the resulting volumetric data. With the successful completion of this Phase II effort, Kitware will meet this need by developing visualization tools that are focused on efficiently and effectively rendering the large, multivariate, time-varying data produced using the AMR technique. The primary technical accomplishment of the Phase II effort will be the development of a high performance volume rendering strategy for AMR data that runs across a variety of platforms from a standard desktop system to a large cluster of high-end workstations. Advanced transfer function techniques will aid scientific discovery by allowing scientists to visualize relationships in their data. Packaging these visualization tools into a user-friendly application will make this complex technology accessible to researchers. In addition, Kitware will adapt this technology to the clinical medical visualization market, where large, multivariate, hierarchical data will become commonplace in the near future.

The state-of-the-art AMR visualization technology developed during this Phase II project will be donated to the scientific community as part of two open-source packages. This technology will be available to software developers through the Visualization Toolkit (VTK), a C++ class library of visualization, graphics, and image processing algorithms. This technology will also be incorporated into the end-user scientific visualization application ParaView, which can run on a desktop computer or across a high performance cluster. Through the use of extreme programming principles, these open source packages are developed, tested, and released daily, allowing Kitware to deliver the latest technology for immediate use by the scientific community. In return, this provides Kitware with continual feedback from users and developers that will help the firm to improve not only the open source software, also the firm's commercial products that are built on top of this code base. Kitware intends to leverage the Research Opportunities for Undergraduates (REU) and Research Opportunities for Teachers (RET) programs to build a team of students and teachers who will generate educational material from the software including lesson plans, presentation materials, animations, and suggested projects. This material will be distributed to educators at the high school and undergraduate levels.

Title: SBIR Phase II: Advancing an Interactive Learning Platform by Integrating Multiplayer Game Technology

Award Number: 0548732
Program Manager: Sally Nerlove

Start Date: January 23, 2006
Expires: January 31, 2008
Total Amount: $500,000

Investigator: Douglas Seifert, douglas.seifert@syandus.com
Company: Syandus, Inc.
760 Constitution Drive
Exton, PA 19341
Phone: (610)321-2500

Abstract:

This Small Business Innovation Research (SBIR) Phase II project advances Syandus's interactive learning platform by integrating multiplayer game technology. Syandus's current interactive delivery platform allows pharmaceutical firms and content experts to communicate complex concepts to physicians and patients through interactive presentations, discussion groups or self-directed learning. The addition of network-enabled collaboration afforded by this proposed project creates the opportunity for interaction between users and content experts without the constraints of geography. The integration of multiplayer game technology into Syandus's platform requires the innovative application of this technology to serve a new purpose. This proposal will support modification of the existing platform to function in a collaborative setting, building a collaborative engine to synchronize application data between users, integration of a third party multiplayer networking solution and development of a prototype application to test collaborative functionality. Syandus has completed projects with several of the top 20 pharmaceutical companies for the delivery of innovative medical education products based on the existing platform. In the first business application derived from this proposed concept, physicians will be able to remotely connect with nationwide content experts to interactively learn the latest best practices and medical science in a more compelling way than currently available.

The pharmaceutical industry strives to communicate medical science innovation and new treatment methods through an information cascade from international and national level thought leaders, to regional physician thought leaders, to practicing physicians and their patients. The anticipated results from the proposed concept will be a learning tool for pharmaceutical companies that allow groups of physicians nationwide to have an interactive dialog about a disease state and appropriate treatment. Longer term, in the educational realm, Syandus's technology could be used to develop more sophisticated collaborative learning environments that allow students, regardless of geographical location, to assemble in a virtual biological world or system (such as a cell or organ) and work together as individuals or in groups to solve problems and optimize processes. A highly rewarding learning experience can be created through the free exchange of information and ideas enabled by a collaborative network coupled with compelling visuals, rich interactivity and the underlying intelligence of mathematical models. Transforming Syandus's existing platform with multi user capability adds rich human interaction into the remote learning process, brings scientific models to life, and allows greater dissemination of knowledge.

Title: SBIR Phase II: Incorporation of Knowledge Base into Statistical Machine Translation

Award Number: 0548763
Program Manager: Sally Nerlove

Start Date: January 11, 2006
Expires: December 31, 2007
Total Amount: $500,000

Investigator: Yookyung Kim, kim@sehda.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project embodies an innovative approach to machine translation. The proposed model aims to overcome two important bottlenecks in the development of a high quality statistical machine translation (SMT) system: (1) inability to handle structural problems and (2) dependence on huge amounts of parallel texts. The inability of statistics to sufficiently handle grammatical problems such as word order becomes more evident when the language pair is very different in structure and morphology, such as with English and Korean. The dependence on a huge amount of parallel texts is a great challenge especially to speech translation. Based on successful tests in the Phase I project, this project proposes a method to learn linguistic knowledge crucial to handling word order and non-local dependencies automatically from input and incorporate it into SMT along with simple transformations, maximizing the strength of both knowledge-based approaches and statistical approaches, and minimizing the need for ever-increasing amounts of bilingual data. The proposed approach aims to build a syntactic-phrase-based statistical machine translation engine that not only is more accurate than the existing word-based ones, but also can decrease the need for large data sources.

The primary impact of the proposed project is the potential for achieving automatic translation quality as high as the quality of the best knowledge-based machine translation engines; but with a minimum of handcrafting of knowledge and therefore at a much lower cost in terms of development time and human resources. While the research is specifically concerned with MT between English and Korean, the resulting translation models would potentially be usable for translation between any pair of languages. The result of the research will be used to develop a speech translation device, in particular to overcome language barriers in communication with patients in hospitals. It will provide a key technology that will accelerate development of speech translation applications in order to reduce costs of healthcare providers and to enhance the quality of healthcare. Additionally, the proposed method of learning linguistic features will have an impact on many different applications including speech recognition, search engines, genre and topic detection, and document search and query. Finally, the proposed research will have beneficial impacts nationally and globally by helping to solve the 'automatic translation' problem, an area of paramount importance to the economic welfare and security of the United States and the rest of the world.

Title: SBIR Phase II: Developing a Cost-Effective Method for Creating Cognitive Models for Cognitive Tutors

Award Number: 0548754
Program Manager: Sally Nerlove

Start Date: January 9, 2006
Expires: December 31, 2007
Total Amount: $509,999

Investigator: Stephen Gilbert, stephen@clearsighted.net
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Suilte 4210
Ames, IA 50010
Phone: (515)233-5137

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will make the creation of effective intelligent tutoring systems (ITSs) easier, and it will enable the dissemination of that technology to a broader audience than currently realized. ITSs have proven to be highly effective in delivering computer-based instruction, but they have historically been expensive and difficult to build, requiring specialized skill in artificial intelligence and production systems programming. Building upon Clearsighted's Phase I accomplishments, the firm will: (1) finish a fully-functional software development kit (SDK) that will allow non-cognitive scientists to create the cognitive model that powers an ITS; (2) develop technology that will enable an ITS to communicate to the vast majority of third-party software; (3) develop techniques that will allow an ITS to work with an institution's existing on-line learning system; and (4) evaluate the research team's work with respect to both time-savings in building ITSs and customers' return on investment. Two main results are anticipated: (1) a two- to three-fold decrease in the amount of time it takes to author an ITS; and (2) an estimated savings to customers of 30% per hour of the cost of traditional training time.

The success of ITSs is well documented (e.g., Koedinger, Anderson, Hadley, & Mark, 1997; Corbett, 2001; Morgan & Ritter, 2002). However, ITSs have not been broadly deployed, due to the high level of expertise needed and the cost to create. Furthermore, lack of viable options to interface the cognitive model of an ITS with already existing software impairs wider dissemination of that technology. By increasing technological understanding of how to reduce the amount of the expertise needed to create an ITS and how to accomplish interfacing ITSs with existing software, the result of this supported work will be a wider distribution of ITSs. Clearsighted is well poised to become a market leader in on-line technical training by leveraging this technology. Clearsighted has partnered with Carnegie Learning, the ITS leader in K-12 education to assist in these goals, and it has the additional expertise needed to perform the required work. By transitioning ITS technology from its currently very small market to a wider audience that includes not only education, but also corporate and industrial applications, the costs to the many companies and institutions that do on-line training will greatly decrease, and the productivity of their workers will increase.

Title: SBIR Phase II: Cognitive Agility Assessment Tool

Award Number: 0548631
Program Manager: Sally Nerlove

Start Date: January 6, 2006
Expires: March 31, 2008
Total Amount: $532,000

Investigator: Lia DiBello, lia@wtri.com
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Phone: (619)232-8054

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of an assessment tool that will enable users to profile a decision-maker's cognitive agility and expertise in high-level business situations. It is appropriate for evaluating decision makers in organizations and students who aspire to leadership roles. This version of the product can also be self-administered. It is based on results from recent basic research conducted by Workplace Technologies Research Inc. (WTRI) that revealed the cognitive mechanisms involved in the thinking of highly accomplished experts in business. It uses knowledge elicitation technology that WTRI has developed over several years to support research on the identification of intuitive expertise (in the sense of Dreyfus 1997). The proposal outlines a plan to develop an on-line Internet based version that is self-scoring and tested among well-known experts. The product will be field-tested for its ability to predict general vs. industry specific expertise. The expected outcome is an easy to use tool for professional evaluators, professors, students or individuals, which will assist in staff development and education. The profiles generated by the product will identify hidden strengths, areas of weakness, and suggestions for further development. The long-term goal is distribution by recruiters, coaches, universities and consultancies.

In the current climate of rapid workplace change, decision-makers need to continually evaluate their ability to adapt to changes and re-invent their organization's value and competitive future. Few assessment tools address the cognitive underpinnings of the skill set involved. Rather, they evaluate personal traits or sub-skills that have some correlation with leadership, broadly defined. Using an empirically verified model of expertise in business strategy development and performance prediction, the research team at WTRI has built an assessment tool that locates an individual with regard to this model; much like chess players are evaluated against a notion of a Chess Grand Master. When applied to individual client situations, this tool has been shown to have powerful predictive capability and thus has successfully informed staff development efforts. Its distinctive feature is assessment of the ability to analyze disparate sources information in order to make strategy level decisions and supporting tactical plans. Making the tool more widely available and usable by non-scientists could importantly contribute to efforts to increase the performance of both organizations and decision makers. Organizations, distributors and several institutions of higher learning have expressed interest in this technology, which they consider to be addressing an area of unmet need.

Title: SBIR Phase II: Customizable Question Answering System for Homeland Security and Commercial Applications

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| Award Number: | 0450599 |
| Program Manager: | Ian M. Bennett |
| Start Date: | September 15, 2005 |
| Expires: | August 31, 2007 |
| Total Amount: | $499,717 |

Investigator: Munirathnam Srikanth, srikanth@languagecomputer.com
Company: Language Computer Corporation
1701 North Collins Blvd.
Richardson TX, 75080
Phone: (972)231-0052

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will result in a novel question-answering technology. The features of this technology are as follows: (1) Automatic filtering of questions. During Phase I, Language Computer Corporation (LCC) developed a system that decomposes high-level questions into low-level, fact-seeking questions. Some of these questions, however, turn out to be nonsensical. In Phase II, the firm proposes to submit all of the decomposed questions to a knowledge-based system, which will eliminate questions that are inconsistent with tacit knowledge. All of the questions that survive filtering will be passed back for processing by the question-answering system. (2) Aligning domain ontologies with a large reference ontology. During Phase I, LCC developed a tool that generates domain ontologies from raw text. During Phase II, the firm will extend this tool so that the domain ontologies are automatically aligned with an overarching domain-independent ontology. This alignment will permit deeper expansion of query concepts, because it will allow domain-independent concepts to be augmented with domain-dependent content. (3) Formal evaluation of semantic relations. The foundation of the question-answering system is semantic relations extracted from queries and documents. These relations will be evaluated to assess the relative contribution of each one to question answering. The result of this evaluation will establish which aspects of semantics are most useful to question- answering.

This project will have a direct impact in the following areas: (1) The system can be deployed in commercial and government settings where the accuracy, coverage, reliability, and usability of the retrieved information are crucial. Ideal applications for the technology include homeland defense, CRM, education, medicine, and the law. (2) The system bridges the gap between domain-independent and domain-specific content. Domain ontologies are constructed automatically, and these ontologies are automatically aligned with a large reference ontology, so that queries can be simultaneously expanded into the terms appropriate to many different domains.

Title: SBIR Phase II: Enabling Pedagogical Choice and Cost-Efficiency in the Development of Web-based Curricula

Award Number: 0450380
Program Manager: Ian M. Bennett

Start Date: September 1, 2005
Expires: August 31, 2007
Total Amount: $500,000

Investigator: Linda Chaput, lchaput@thinkfive.com
Company: Agile Mind Inc
1100 South Main St
Grapevine TX, 76051
Phone: (650)906-8721

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will build a first-release Web-based system for content authoring and delivery that supports multiple approaches to pedagogical practice and provides efficient, easy to use methodologies with which course designers can employ system capabilities. Specifically, this project will continue the work started and demonstrated to be feasible in Phase I to create online authoring and complementary course management systems, which have features and benefits that are immediately available to innovative instructional designers. The goal is to enable the development of technology-mediated instruction through cost-effective means for producing new content and to do so with a focus on supporting instructional design innovation without compromising the capabilities of the technology. The goal is an innovation that will empower content providers to use principled learning theories and pedagogical practices for creating new online curricula that support technology-mediated instruction. The project will produce a new type of authoring and delivery system in which the functionality available to create course structure; manage multimedia content development; translate course specification into reliable production delivery; and access course-related activities for learners and their teachers or mentors, including dynamic learning interactions and real-time behavior tracking and reporting reflects the authors' preferred learning theories and pedagogies.

This project seeks to provide a set of enabling tools that support the development of technology-mediated instruction through cost-effective means for producing content, focused on supporting instructional design innovation without compromising the capabilities of the technology. The commercial applications of the research result are sales and licenses of the created systems, both with and without content, to content developers, publishers, and also middle and high schools, districts, and other local entities for use by individuals and groups who desire to create and to publish content and assessments for communities of practice and who are impeded by cost and time constraints. The resulting systems will address a major problem in education: the consolidation of content development and dissemination in the hands of a small number of publishing conglomerates and the consequent lack of quality and diversity of choice that have been a result of that consolidation. With an extensible authoring system, the company would be positioned to tap into a large market with a business model that supports both new business development and the legacy assets of publishers and eLearning providers, and to create major new opportunities for many other types of content providers.

Title: SBIR Phase II: Use of a Visual Programming Environment to Promote Bioinformatics Education

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| Award Number: | 0450526 |
| Program Manager: | Ian M. Bennett |
| Start Date: | August 1, 2005 |
| Expires: | July 31, 2007 |
| Total Amount: | $500,000 |

Investigator: Maciek Sasinowski, maciek@incogen.com
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Phone: (757)221-0550

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to provide a tool to improve bioinformatics education. This tool, VIBE-Ed, is a software product designed to augment bioinformatics at the college and university level by creating an interactive, integrated, and comprehensive approach to bioinformatics education using visual programming. During the Phase I project, INCOGEN demonstrated that its existing research tool, VIBE, provides an excellent foundation for an educational tool given its inherent technological attributes. VIBE employs visual programming for bioinformatics, and in this respect, VIBE-Ed will provide a novel approach to bioinformatics classroom instruction. The Phase I work demonstrated the effectiveness of visual programming in the learning process. In addition to visual programming, the architecture of VIBE supports the inclusion of extensive information about the bioinformatics tools contained therein, making VIBE-Ed well suited to host the large and complex amount of resources and documentation required by an educational tool. Finally, VIBE was created to be extensible, allowing it to be naturally extended into VIBE-Ed. As the bioinformatics community discovers and validates new analysis tools, these can easily be incorporated into VIBE-Ed, along with the educational features to support them.

Bioinformatics education is a growing field, driven by the great need for trained bioinformaticists in biological and biomedical research. Recent years have witnessed notable increases in the number of bioinformatics courses and degree programs at colleges and universities worldwide. Textbooks and lectures alone do not expose bioinformatics students to hands-on data analysis and, by themselves, they are insufficient for bioinformatics education. Despite the growing trend in bioinformatics education and the need for educationally focused tools, there is a significant lack of commercially available software tools specifically designed for bioinformatics education. Currently, bioinformatics instructors fill this gap by using either complicated and expensive research tools or collections of web-based tools. Bioinformatics research software is often cost prohibitive for an educational application, and the software itself is geared toward experts in the field rather than toward students. Web-based tools are often free of charge, but they are also frequently dispersed throughout the web, requiring excessive time and sometimes also requiring programming skill to combine the use of several tools. Many of the tools are not accompanied by instruction or related conceptual information, making them less suitable for education. VIBE-Ed successfully addresses these concerns and promises to have immediate impact on bioinformatics education and, ultimately, in knowledge discovery on life science research.

Title: SBIR Phase II: Sketchpad for Young Learners of Mathematics - Dynamic Visualization Software in Grades 3-8

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| Award Number: | 0521981 |
| Program Manager: | Ian M. Bennett |
| Start Date: | July 1, 2005 |
| Expires: | June 30, 2007 |
| Total Amount: | $499,808 |

Investigator: Nicholas Jackiw, njackiw@keypress.com
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Emeryville CA, 94608
Phone: (510)595-7000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to overcome barriers to the effective use of The Geometer's Sketchpad software in elementary and middle school math classes, and to deliver on the software's potential for transforming education at these levels. This research-based educational technology tool and its "Dynamic Geometry" interaction paradigm are well known at the secondary and higher level for their ability to foster visualization and exploration in mathematics and to enhance student learning. This project responds to clear calls for the software's application and adaptation to younger grades coming from teachers, from curriculum development and research communities, and from standards bodies such as the National Council of Teachers of Mathematics (NCTM). The proposed research, led by the team that created and maintains Sketchpad, first identifies and prototypes modifications to the software to add scope and age-relevant functionality and to remove barriers to access for young learners; and second pioneers new classroom activities-structures, materials, and vehicles-for supporting and extending standards-based curricula in grades 3-8 through the agency of Dynamic Geometry technology. The intellectual merit of the proposed activity reflects (a) the degree to which the activity responds to perceived pedagogic need (as cited, e. g., in the NCTM Principles and Standards 2000) for Dynamic Geometry technology at the elementary and middle school level; (b) the opportunity to extend the broad base and literature of research that exists on Dynamic Geometry at the secondary level to significantly earlier grade levels (particularly with respect to effective Dynamic Geometry activity design and Dynamic Geometry impact on student affect and cognition in the early grades); and (c) the resources this proposal brings to the question of how best to integrate effective, standards-based curriculum (in this case, the Connected Mathematics Project, Everyday Mathematics, and Math Workshop curricular programs) with effective, standards-based technology. The project brings together research experience in both curricular and software design; project staff includes Sketchpad's authors and project consultants include the author teams of each of the named curricula.

The broader impact of this project reaching its objectives will be the creation and availability, in primary and middle grades, of age-appropriate Dynamic Geometry mathematics education technologies and supporting curriculum similar to those which define Sketchpad at the secondary level, where the software is considered the "most valuable software for students" (Becker, 1999) by mathematics teachers across the country; and of research-driven solutions to the challenge of supporting standards-based curricula effectively with educational technology.

Title: SBIR Phase II: Digital Microscopy with Collaborative Learning

Award Number: 0450650
Program Manager: Ian M. Bennett

Start Date: April 15, 2005
Expires: March 31, 2007
Total Amount: $500,000

Investigator: Timothy Hall, tim@prime-ent.com
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Marietta GA, 30062
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to provide a model for integrating digital microscopy and web-based on-line collaborative learning in order to improve science education. In Phase I, Digital Blue developed a collaborative worksite, www.planetmicro.com and enrolled +400 students. In Phase II Digital Blue proposes to further this inquiry by building, in conjunction with the Concord Consortium, a state-of-the-art website where students use common digital microscopes and engage in a true collaborative educational experience. Digital Blue will undertake this work by scaffolding the website to improve interaction between members; improving the work flow in which users "tag" their digital images thus optimizing search engine productivity; developing common curriculum modules; developing an online professional development utility to empower teachers to use this technology in their coursework; and adding thousands of members to foster an innovative and successful collaborative community.

Digital Blue proffers an innovative product and service for the education market, namely Planetmicro.net, a collaborative workspace that is fully integrated with a proprietary digital microscope. The site would be the first collaborative workspace that interacts seamlessly with affordable digital laboratory equipment in each classroom. Other collaborative learning environments offer common methods and processes but fail to integrate uniform tools, creating a gap between the hands-on activity of the lab and the virtual activity. In contrast, Planetmicro.net would make it easy to integrate collaborative learning with traditional science pedagogy.

Title: SBIR Phase II: A Model for Virtual Dialogues with Master Teachers

Award Number: 0450567
Program Manager: Ian M. Bennett

Start Date: March 15, 2005
Expires: February 28, 2007
Total Amount: $500,000

Investigator: William Harless, wgharless@idrama.com
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Phone: (301)654-0676

Abstract:

This Small Business Innovation Research (SBIR) Phase II project describes software that combines speech recognition, digital video, and personal computer technologies to allow PC users to have "face-to-face" dialogues with video characters that are real people. This software, called Conversim (Registered Trademark), incorporates an independent speaker recognition engine so that any English-speaking user can spontaneously say the words and phrases known to the system and be understood. All Conversim (RT) programs include a non-directive, intelligent prompting algorithm. Each time the virtual character responds to the user, the system dynamically selects statements and questions that are specifically relevant to the character's last response and then displays three choices in a rhythmic scroll. Between questions, the character's active image remains on the monitor as if waiting for the next question. The Conversim (RT) dialogue model is unique since it enables the user to have a virtual conversation with a real person whose intellect, personality, and personae are intact and available. This very personal model opens the door to numerous innovative applications in education. Scientific research has shown that most users enjoy the virtual dialogue experience; many have significant, often accelerated, learning gains; and almost all feel as though they have met the person with whom they have been "talking." These findings strongly indicate the method merits further research in conventional educational settings.

This model represents a new paradigm in education, one that allows the student to learn through a one-on-one interview of the master teacher. The paradigm involves non-directive, independent learning by conducting face-to-face dialogues with master teachers in cyberspace, who are always present, always available, and always willing to converse with people who wish to engage them. Multimedia presentations can be used in concert with the dialogue to clarify concepts and complex topics. Also, the power of the computer for tracking and innovative, dynamic evaluation strategies are inherent in this model. The broad objective is to make this model and this new paradigm available in all educational institutions that would benefit from its use. It has potential to provide a means for students everywhere to gain access to and learn by engaging in dialogue with some of the best minds in the country; to be used to educate a broad range of students, from high school to the post-graduate level; to help students whose education is restricted by geographic location or economics; to enhance learning for all students by making them active participants in the learning process; and to provide high-quality education while significantly reducing per student costs.

Title: SBIR Phase II: Cheminformatics Teaching Tools for the Cheminformatics Virtual Classroom

Award Number: 0450457
Program Manager: Ian M. Bennett

Start Date: March 1, 2005
Expires: February 28, 2007
Total Amount: $519,956

Investigator: Norah MacCuish, norah.maccuish@mesaac.com
Company: Mesa Analytics & Computing, LLC
212 Corona St.
Santa Fe NM, 87501
Phone: (505)983-3449

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the development of virtual classroom software tools for cheminformatics training in academia and industry. Mesa Analytics & Computing, LLC provides a commercial, integrated suite of the leading-edge cheminformatics software tools for the pharmaceutical and biotech industry. However, these tools, incorporating the most recent research in cheminformatics by Mesa, and integrated with other leading cheminformatics vendors` software (OpenEye, eduSoft, ChemAxon, and AccuSoft), are for use in large-scale research and industrial applications, where the users already have experience in cheminformatics software, most often obtained through on-the-job training. The research goals of this project are to develop an easy to use, comprehensive, and competitively priced cheminformatics virtual classroom. This project will further the advanced research and development of software tools for interactive distance learning in cheminformatics topics, such as finding compound substructure commonalities, generation and use of structural and property compound descriptors, similarity searching, cluster analysis, compound library design, 3D drug design, compound databases, and Quantitative Structure Activity Relationship (QSAR). The project will produce a beta version of the cheminformatics virtual classroom ready for testing and marketing to the academic and industry markets.

There are a growing number of university departments worldwide offering courses and degrees in cheminformatics, across a range of life science disciplines. However, there is no comprehensive cheminformatics virtual classroom product. Software products used in the pharmaceutical and biotech industry are expensive, difficult to install, and of limited utility for introductory training. Converting Mesa`s tools and other vendors` software into a coherent set of Web-based training tools for concept learning, with the help of six diverse academic testing sites, will provide the necessary training tools for academia and industry. Web delivered training software is a cost effective means to provide distance learning for rural and urban academic institutions and industry sites here and abroad. The virtual classroom will help to lower the cost of on-the-job training for early phase drug discovery research efforts found in the pharmaceutical and biotech industries. The long term goal is to increase the quality and quantity of new researchers, with the potential benefit of increasing the number of drug leads, thereby improving the chances of finding more effective drugs for a wider range of serious diseases, and possibly lowering the cost to consumers.

Title: SBIR Phase II: Personal-Knowledge-Management eLearning System

Award Number: 0423443
Program Manager: Sara B. Nerlove

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $491,956

Investigator: Robert London, blondon@taxonomize.com
Company: Taxonomize
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Cupertino, CA 95014
Phone: (408)725-1658

Abstract:

This Small Business Innovation Research (SBIR) Phase II project improves access to knowledge by auto-organizing unstructured data to respond to specific individuals, groups, and their activities. Taxonomize Resource Aid (TRA) uses syntactic, semiotic, semantic and statistical techniques to generate and update resource taxonomies, which are multi-level indices into the information corpus (documents, web sites, etc.) specific to users' activities. These active taxonomies are practice-relevant and personalized, and they provide applications of enhanced search, auto-produced portals, personalized content management, and knowledge discovery. For example, TRA's coordinated knowledge directories produce discovery of trends in time-based documents (such as discussion groups); extraction of information from unstructured data (such as distributed themes); and notifications from monitoring multiple information sources for patterns of confluences (e.g., news relevant to collaborating partners) or discrepancies (e.g., knowledge missing in one area that can be filled from another). Phase II development will take the successful prototype that was tested in educational settings, and create a commercial product (initially as a SOAP/WSDL web service) that will be licensed to firms selling software solutions in the areas of e-learning, search, and knowledge management. Taxonomize Resource Aid (TRA) will provide knowledge tailored for individuals, groups, and activities, and thus will provide people who have been limited by accessibility, resources, or background ready access to resources of knowledge, instruction, and collaboration. The TRA prototype has already been shown to provide significant benefits to some university students who were learning how to do primary research. Those who have difficulty with the culture, language, or technology gain the greatest benefits from TRA, because it gives them accelerated access to knowledge that is automatically selected for relevance to their activities, based on Taxonomize's powerful auto-categorization capabilities. TRA can help in any field where people need to organize, manage, access and use large amounts of information and resources.

TRA can help improve education, healthcare, defense, and government organizations process information quickly, especially when dealing with immediate and critical situations. It can also help disadvantaged people find necessary resources, and keep updated with changes that would otherwise be infeasible to monitor. TRA improves knowledge accessibility, flexibility and adaptability and affordability of general learning capabilities, and so may benefit formal and informal learning in every area.

Tite: SBIR Phase II: Modular Online Simulations for Math and Science with Integrated Assessment of Complex, Standards-Aligned Learning Objectives

Award Number: 0422116
Program Manager: Sara B. Nerlove

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $499,246

Investigator: Paul Cholmsky, pcholmsky@explorelearning.com
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P.O. Box 2185
Charlottesville, VA 22902
Phone: (434)293-7043

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will produce a commercial version of PathfinderPlus, an online system that integrates assessment of complex, standards-based instructional objectives within interactive simulations and makes the resultant data available in a timely and efficient manner to students, teachers and administrators. In order to effectively implement curriculum standards-based educational reforms (e.g., as mandated by the No Child Left Behind Act), teachers need guidance in linking students' day-to-day learning to these standards and in adapting subsequent instruction based on students' progress against the standards. Existing educational technology products, however, are explicitly correlated only to the macro-level terminal objectives in each state's curriculum standards. As a result, these products do not provide diagnostic information regarding component knowledge and skills, and they thereby fail to support teachers in understanding more precisely where students are having difficulties within a given terminal objective. PathfinderPlus provides a comprehensive online library of highly interactive learning objects that track student' actions as they use them. The system analyzes the generated data to create assessment probes which yield results that are indexed against a hierarchy of component knowledge and skills related to each state's terminal objectives. This analysis provides students, teachers and other educational stakeholders with a roadmap to success in meeting their state's curriculum standards. In terms of broader impacts, the successful production of a fully functional, commercial PathfinderPlus product will break significant technical ground in the field of large online repositories of interactive learning objects. The deployment of ExploreLearning's XML specification HILO ML (Highly-Interactive Learning Object Markup Language) separates the pedagogical logic of a learning object's adaptive behavior from its technical instantiation. This separation enables the efficient development of the volume of scripts required by a system that covers entire courses (e.g., Algebra). The use of a four-tiered architecture to link fine-grained pedagogical events (i.e., pedagogically-meaningful interactions between students and the online simulations) to macro-level terminal objectives provides a flexible, modular foundation for the system.

In terms of impacts on K-12 education, PathfinderPlus will foster alignment with standards-based curricula, support teachers in integrating technology effectively and efficiently into their classrooms, and provide a new approach for measuring the impact of educational technology on student learning. In addition, the system's use of interactive simulations as the medium for assessment enables a broader range of more complex, higher-order instructional objectives to be assessed (e.g., problem solving strategies and skills), as compared to traditional probes used in computer-based applications such as multiple-choice questions.

Title: SBIR Phase II: Interactive Earth: Tools for Earth Systems Science

Award Number: 0349784
Program Manager: Sara B. Nerlove

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $531,998

Investigator: Kirk Bergstrom, worldlnk@well.com
Company: WorldLink Media, Inc.
San Francisco, CA 94115
Phone: (141)593-1695

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to research and develop ways to increase accessibility and utilization of Earth systems science data and visualizations for secondary school teachers and students. The commercial product will consist of a DVDROM, curriculum, and web site. Building on WorldLink Media, Inc.'s previously published CD product, Interactive Earth, the firm will develop an integrated tool set for data display and image interpretation that will enable students to inquire, hypothesize, analyze, discover, and communicate with peers-replicating the work of real scientists. Much more than a static software program, the Interactive Earth DVD-ROM will be part of a "learning platform" that includes an in-depth curriculum package, access to a rich archive of global data via the web, and professional development opportunities. Partnerships with NASA's Earth Observatory web site and the World Resources Institute's EarthTrends project will enable classroom access to extensive global data sets and visualizations. TERC, a research and education organization, will develop a curriculum that aligns with the National Science Education Standards. This SBIR project recognizes the vital interplay between a curriculum developer (TERC), data providers (NASA and World Resources Institute), and a media designer and tool-builder (WorldLink) in creating exemplary learning materials. Earth science is of national strategic importance as a field of research and innovation.

The potential contribution to our schools and students is not just in Earth systems science, but in the broader applicability of the skills developed by students to related domains of science, math, geography, and other fields. These thinking skills include inquiry, visual literacy, understanding systems and models, and the ability to apply knowledge and problem solving to a range of real-world issues.

# Universal Access

Title: SBIR Phase II: (IT-B5) Feasibility to run novel voice interface on a low-power microcontroller

Award Number: 0822743
Program Manager: Ian M. Bennett

Start Date: August 15, 2008
Expires: July 31, 2010
Total Amount: $500,000

Investigator: Seth Cameron, seth@cameronsound.com
Company: CameronSound, LLC
2004 Centennial Dr.
Great Falls, MT 59404
Phone: (801) 474-0134

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will implement a miniature information management system that is suitable to the access requirements for visually impaired users. Current information technologies for the visually impaired are slow and difficult to operate while holding a white cane or guide dog. Visually impaired people will benefit greatly from a hands-free/eyes-free information system that is much faster to operate and easier to access. The project will develop a voice-operated personal digital assistant (PDA), called Vivian, which performs 10 times faster than Braille PDAs. The outcome of the Phase I study demonstrated the feasibility of real-time speech processing algorithms on integrated microcontrollers without hardware floating-point arithmetic. The outcome of this Phase II project is anticipated to result in a wearable device similar to a state of the art media player with 10X faster processing and 10X smaller in size. With more than 160 million visually impaired people worldwide, 10 million in the US alone, the proposed research is a critical step towards a device that will address their mobile information management needs significantly better than current alternatives. Moreover, this device should impact mobile information management for sighted people. The results of usability trials with sighted users speaking multiple languages conducted during the Phase I project, indicate that the outcomes of a powerful and fast alternative human computer interface to graphical user interfaces for sighted and visually impaired users. Additionally, this voice technology is suitable for integration into mobile appliances such as mobile phones for which over 300 million were sold in 2007.

Title: SBIR Phase II: Electronic Orientation and Navigation System for People with Visual Impairments

Award Number: 0822972
Program Manager: Muralidharan S. Nair

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $500,000

Investigator: Michael Manning, michael@manningrf.com
Company: ManningRF, LLC
2718 Winningham Rd.
chapel hill, nc 27516
Phone: (919) 967-5438

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project will design, build and test a new type of orientation and navigation (O&N) system for people with visual impairments. While GPS-based solutions show promise in outdoor environments, there are currently no widespread O&N devices that are designed for use in indoor environments. This makes it difficult for people with visual impairments to navigate through indoor public spaces. The purpose of this research will be to complete development of a new type of radio frequency identification (RFID) system, in which intelligent, variable-range active RFID beacons are programmed with information about their locations and placed through indoor environments like schools, shopping malls and museums. This information will be accessible to people with visual impairments via a small RFID receiver worn on the user?s belt. Information will be conveyed to the user via a text-to-speech interface. Results from field testing have demonstrated that the device helps people with visual impairments to navigate through an unfamiliar environment. Phase II research will complete development of the communications protocols and interface techniques that give the system its unique capabilities for delivering speech-based information to people with visual impairments. There are 10.4 million people with visual impairments in the U.S., and this research will lead to an inexpensive commercial product that will greatly enhance their ability to navigate in unfamiliar surroundings. The market for this technology includes those who will purchase the RFID receivers and the RFID beacons. This includes people with visual impairments, as well as the owners and tenants of public spaces, such as office buildings, schools, malls, museums and government facilities. Also, because of the simplicity of the interface, the system will be useful to Orientation and Mobility educators working with young children to develop spatial concepts.

Title: STTR Phase II: Developing a Mixed Reality Rehabilitation System

Award Number: 0750551
Program Manager: Ian M. Bennett

Start Date: April 15, 2008
Expires: March 31, 2010
Total Amount: $500,000

Investigator: Mark Wiederhold, mwiederhold@vrphobia.com
Company: The Virtual Reality Medical Center
6160 Cornerstone Ct. East,
San Diego, CA 92121
Phone: (858) 642-0267

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project investigates further development of a mixed reality (MR) haptics-based virtual reality system in preparation for commercialization. This MR system will aid the physical rehabilitation of stroke patients with upper extremity disabilities. This MR system includes hardware and software designed to induce neuroplastic changes and increase mobility through mental practice, video capture body movement, and engaging mixed reality scenarios. The goals of this project will be to file the appropriate paperwork for regulatory approval of the system in preparation of use on the market, improve the system in scenarios, add mental practice and video capture scenarios, program metrics into the system, develop sensor tracking interface and telerehabilitation capabilities, and conduct clinical trial to determine system safety and efficacy. Headed by a collaborative team of qualified investigators from The Virtual Reality Medical Center, the University of Central Florida's Institute for Simulation and Training, and Kindred Hospital (consultant), this project will increase the understanding of state-of-the-art adjuncts to traditional stroke rehabilitation therapy. To date, no MR rehabilitation tool that facilitates mental practice, includes video capturing, and aids physical therapy, has ever been commercialized. The resulting marketable product will be sold to rehabilitation facilities. This STTR Phase II project will lead to the commercialization of new software and hardware that can be used for further technological developments in mixed reality systems, including those for other applications such as prosthetic limb rehabilitation for amputees. The success of this project will also add to the scientific knowledge base on what is known about mental practice in rehabilitation. With over twelve million families in the U.S. alone that have members with a physical development, success in this project will therefore pave the development and commercialization of future rehabilitation systems to help this broad and underserved population. By increasing stroke patients' upper extremity mobility and rate of recovery, this system will also increase their activities of daily, enable at-home physical therapy, relieve some of the burden of caregivers, and decrease costs in lost productivity and hospital length of stay. The commercial spin-out company resulting from success of this project will be located near the University of Central Florida's College of Medicine where future joint projects will include recruiting and training students (including those from underserved populations) in research. The commercial spin-out company will also create new jobs, taxable revenue, and income within the Florida High Tech Corridor.

Title: STTR Phase II: Low-Cost Portable Telerehabilitation System for Intelligent Stretching and Remote Assessment of Hypertonic Arm Joints

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| Award Number: | 0750515 |
| Program Manager: | Muralidharan S. Nair |
| Start Date: | March 1, 2008 |
| Expires: | February 28, 2010 |
| Total Amount: | $485,564 |


Investigator: Yupeng Ren, yupeng.r@gmail.com
Company: Rehabtek LLC
2510 Wilmette Ave.
Wilmette, IL 60091
Phone: (847) 853-8380



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II research project seeks to develop technologies needed for rehabilitation of post-stroke patients with neurological impairment. For those patients, physical therapy followed by timely examination is the cornerstone of the rehabilitation. However, not all patients receive sufficient therapy due to limited access to expert healthcare services. There is a need for a tele-rehabilitation system that can stretch the spastic/contractured joints under accurate control at a remote location and provide remote access to expert healthcare services. This Phase II research will focus on improving the technology and making it suitable for the market by improving the design of the tele-rehabilitation system for multi-purpose applications to treat/evaluate multiple joints in the arm. It will make the portable device stand-alone with built-in capabilities of passive stretching, voluntary movement exercise, and tele-assessment of joint range of motion, stiffness, spasticity, and catch displayed in an intuitive way. Finally, a clinical test of the tele-rehabilitation system on stroke survivors will be conducted. This portable and low-cost stretching device is suitable for home use, making frequent and convenient treatment accessible to a large number of patients. It can potentially have broad impact on rehabilitation of stroke and other neurological impairments. The intelligent stretching concept was developed to insure safe and effective treatment and it will also be useful in other applications dealing with human-machine interface.

Title: SBIR Phase II: Tactile Graphic Array

Award Number: 0450169
Program Manager: Ian M. Bennett

Start Date: February 1, 2007
Expires: January 31, 2007
Total Amount: $500,000

Investigator: Oleg Tretiakoff, oleg@catechnology.net
Company: C. A. Technology, Inc.
9500 S. Ocean Drive
Jensen Beach FL, 34957

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will conduct research leading to the development of working prototypes of new low cost and compact Tactile Graphic Displays and Braille Displays. The dominant technology today, displays driven by piezo-electric actuators, has two major deficiencies. It is very expensive, about $12 to $16 per tactile dot, and the actuator shape, a 50 to 70 mm long reed, significantly increases the volume of feasible displays, essentially limiting their use to single line Braille displays for desktop or portable devices. During the Phase I of the project, C.A.Technology performed extensive research on the design of a new Shape Memory Alloy single dot actuator and has demonstrated the feasibility of tactile displays based on this technology. This actuator uses a short and very thin Titanium-Nickel alloy wire, which will bring the cost per dot down to about $3 to $4, and will considerably reduce the display volume, allowing its use in hand-held devices. The Phase II effort will include the following: 1) detailed design, construction and user testing of the new tactile arrays; 2) development of software to interface these displays with various portable and hand-held devices, such as C.A.Technology's own Portable Print Reading Device; and 3) preliminary design of manufacturing tools and facilities.

In the mid-seventies, the appearance of the first electronic Braille displays changed the lives of blind individuals. Today, many have immediate and selective tactile access to textual information through refreshable electronic Braille displays. However, the high cost of these devices still severely limits their diffusion. By reducing their cost, their size and their weight, this new technology will increase the market penetration of Braille displays, making them accessible to many more blind and deaf-blind individuals and significantly improve their employment opportunities. Access to graphic symbols widely used for example in mathematics, chemistry and access to plain graphics is still only possible through slow, bulky and very costly graphic embossers. If a picture is "worth a thousand words", then a compact, low cost refreshable graphic tactile display proffers a significant new opportunity for the lives of blind students, blind engineers, blind physicists and blind people involved in almost any intellectual activity. In addition, it will also be important to those with low vision.

Title: SBIR Phase II: Individualized Guidance for the Blind (IGB)

Award Number: 0620511
Program Manager: Ian Bennett

Start Date: September 13, 2006
Expires: August 31, 2008
Total Amount: $467,488

Investigator: Gary Livshin, glivshin@talking-lights.com
Company: Talking Lights Co
28 Constitution Rd
Boston, MA 02129
Phone: (617)242-0050

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an Individualized Guidance for the Blind system which is an accurate, affordable, easy-to-use indoor/outdoor assistive navigation system to aid people who are blind in wayfinding and traveling. In a separate effort, a wayfinding system for the blind using GPS for outdoor location is now being designed and built. For indoor use, however, this system requires a complex inertial guidance system for location and guidance. In this project, inexpensive optical locators will be used to improve indoor wayfinding and supply GPS-like location indoors.

Software developed will allow Individualized Guidance for the Blind locators to provide GPS-like locator information indoors and permit the input of location to the personal data assistants (PDA), updating of location and elimination of errors. As a commerical product, application areas will include hospitals, care facilities, museums, malls, schools, retail stores, trade shows, transportation facilities and otherplaces where blind and people with limited vision require navigation assistance.

Title: SBIR Phase II: Folding Power Wheelchair with Modular Battery System

Award Number: 0548759
Program Manager: F.C. Thomas Allnutt

Start Date: February 16, 2006
Expires: February 29, 2008
Total Amount: $488,309

Investigator: Bart Kylstra, kylstra@gmail.com
Company: Daedalus
20 Scot Alley
San Francisco, CA 94107
Phone: (415)385-4508

Abstract:

This Small Business Innovative Research (SBIR) Phase II project aims to develop a lightweight modular wheelchair that can be easily lifted and handled by either the user or a companion. This wheelchair can be loaded into any vehicle, thus dramatically improving the mobility of the user. The research project focuses on designing the frame, drivetrain, motor and battery system to allow more of synergistic effect and lightweight to aid the user in his/her mobility.

The commercial and societal benefits from this project will result in not only greater mobility but also drastic increase in the quality of life for the user, improved family mobility.

Title: SBIR Phase II: Accessible Electronic Mathematical Content

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| Award Number: | 0522308 |
| Program Manager: | Ian M. Bennett |
| Start Date: | August 1, 2005 |
| Expires: | July 31, 2007 |
| Total Amount: | $499,959 |

Investigator: Neil Soiffer, neils@dessci.com
Company: Design Science, Inc.
140 Pine Ave
Long Beach CA, 90802
Phone: (562)432-2920

Abstract:

This Small Business Innovation Research (SBIR) Phase II project makes mathematical expressions in common electronic formats seamlessly accessible to people with print disabilities. Print disabilities include blindness, low vision, dyslexia and other learning disabilities. While others have explored aspects of accessibility in stand-alone applications, none have integrated access to mathematical content for those with print disabilities into users' existing screen readers or other assistive technology. The advantage of this project's approach to math accessibility is that it allows documents containing math to be read with standard browsers and document viewers. The electronic formats supported by this project are web pages that encode math using MathML, Microsoft Word documents, and PDF. Accessibility is achieved by providing software add-ons to Internet Explorer, Word, and Adobe Reader, and modifications to the industry leading authoring and publishing workflow tools to embed MathML into these formats. The project brings together work on various aspects of making mathematical content accessible. It pushes forward the state-of-the-art in audio rendering of mathematical expressions, navigation of mathematical expressions with audio feedback, and audio rendering synchronized with highlighting of the sub expression being spoken. The project provides a platform that allows other NSF-funded research projects to convert MathML to Braille math codes and other formats.

Accessibility of electronic content is a requirement of the Rehabilitation Act Amendments of 1998, Section 508. Many states have adopted similar requirements for state-funded entities. The Individuals with Disabilities Education Act (IDEA) mandates accessibility of school materials. Accessibility laws apply to all forms of content, not just textual content. Current solutions for math accessibility are so costly and time consuming that access to materials in a timely manner is not always provided to those that need the access despite legal mandates. The results of this project will present a fast and inexpensive route for publishers of textbooks with mathematical content to satisfy these laws. It will also provide a simple and painless way for people who author documents with math in them to make the document accessible to people with print disabilities. The availability of books and other material coupled with accessible authoring of mathematical content has the potential to dramatically enhance the way students with print disabilities are taught and learn mathematics, science, engineering and other technical fields.

Title: SBIR Phase II: Commercial Combustion Synthesis of Homogeneous Lots of Carbon Nanotubes

Award Number: 0522093
Program Manager: Rosemarie D. Wesson

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $499,482

Investigator: Henning Richter, hrichter@nano-c.com
Company: NANO-C, Inc
33 Southwest Park
Westwood MA, 02090
Phone: (781)407-9417

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is designed to achieve a pilot-plant demonstration of the technical and commercial feasibility of cost- and energy-efficient large-scale conversion of natural gas to single-walled carbon nanotubes (SWCNT). The research will include: (1) exothermic and selective synthesis of SWCNT by premixed combustion of natural gas after introduction of catalyst precursors with the cold gas mixture; (2) continuous collection of material by means of a bag-house filter; and, (3) detailed understanding of the correlations between operating conditions (pressure, type of catalyst, fuel-oxygen ratio, dilution with inert gas, cold gas velocity) and characteristics of the carbon nanotubes (single-, double-, or multi-walled, diameter, length, conductivity).

Results of this project are expected to have a significant impact on the development of the US nanotechnology sector and to strengthen its international competitiveness. Projected sales price of not more than $50/g will lead to a pronounced increase of the number of economically viable SWCNT applications.

Title: SBIR Phase II: Accessible Scalable Vector Graphic Authoring and Editing Applications

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| Award Number: | 0422218 |
| Program Manager: | Sara B. Nerlove |
| Start Date: | August 15, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $493,942 |

Investigator: Vladimir Bulatov, bulatov@viewplustech.com
Company: ViewPlus Technologies, Inc.
1853 SW Airport Ave.
Corvallis, OR 97333
Phone: (541)754-4002

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will support development and testing of Windows applications for creating and making available highly accessible SVG files. Scalable Vector Graphics (SVG) is a graphics markup language supporting features critical to accessibility by individuals with print disabilities. One application permits authors easily to create and/or edit mainstream graphical information as SVG files fully usable by individuals with print disabilities. Full accessibility requires only that authors supply names of important graphics objects, a task easily done with the SVG Editor. Most individuals with print disabilities can comprehend graphical information better by moving the mouse over text or graphics objects displayed in the ViewPlus SVG Reader, whereupon they hear the text or names of graphics objects spoken aloud. Blind users and those unable to use a normal mouse can also comprehend such information by creating a tactile copy on a ViewPlus Tiger embosser which can then be read with their fingers after placing it on a ViewPlus Touchpad. Sighted users can obtain an embossed color image with the new Color Embosser. Availability of an appropriate embosser and Touchpad means that even individuals with severe print disabilities can access mainstream graphical information without assistance by another human being. Computer users with severe print disabilities currently have good access to words but very poor access to graphical information. Lack of good access to graphs, charts, and diagrams severely affects quality of life and educational and professional opportunities, particularly in the STEM fields, i.e., science, technology, engineering, and mathematics.

Graphical information today is "made accessible" largely by written or verbal description. There is currently no practical way to make most graphical information available in a form usable by individuals who are severely dyslexic or for blind people, who may or may not read Braille. These new SVG applications will provide a user-friendly technology that fills that need. Graphical information can simply be created and displayed on the web or in electronic documents as SVG files that are usable by everybody. The hardware technologies needed by blind or severely dyslexic people should cost no more than a present-day Braille embosser, so it should be affordable for libraries and institutions to provide this capability thus to serve these clientele. The largest user base for the SVG Reader will probably be individuals with less severe print disabilities who can improve their comprehension by supplementing visual with audio information.

Title: SBIR Phase II: Creating Accessible Science Museums for Blind and Visually Impaired Visitors with User-Activated Audio Beacons

Award Number: 0421973
Program Manager: Sara B. Nerlove

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $499,710

Investigator: Steven Landau, sl@touchgraphics.com
Company: Touch Graphics
330 West 38 Street
New York, NY 10018
Phone: (646)515-3492

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will demonstrate the effectiveness of a new system for guiding visitors in science museums and other public spaces. Touch Graphics will design, implement, and evaluate an apparatus that will allow any museum visitor to dial in to, and then interact with, a computerized attendant, using the visitor's own cell phone or one lent to him/her. A special feature will allow blind and visually impaired users to navigate independently by following sounds from environmental audio beacons that they will control by pressing keys on their phones. Once a visitor arrives at the requested exhibit component, his or her phone will serve as an audio explainer and control interface. While the development of this concept has been motivated by the desire to accommodate the needs of visually impaired museum-goers; in Phase II, the small business will configure the system as a mainstream audio guide product that includes optional accessibility features. The small business will create an experimental installation of the envisioned system in a large science museum in New York City, where it will undergo two rounds of human subject testing. As part of this installation, an interactive touch model of rockets that are part of the museum's collection will be designed, fabricated and tested to study the effectiveness of users' cell phones as an accessible control interface for individual exhibit components. The project will also be complemented by a parallel study in which user-activated audio beacon technology is deployed in a different context; a phone-based navigation tool will be implemented and tested as a travel aid for blind and visually impaired bus riders in Austin, Texas who need to find public access information.

This user-activitated audio-beacon technology has the potential to improve access to important public resources, particularly science museums for individuals who have been excluded due to disabilities. It seeks to provide opportunities for the blind and visually impaired to experience the enrichment and entertainment offered at hundreds of facilities around the country. These institutions offer opportunities for informal science education that can inspire people to pursue careers in science and technology, and the Nation as a whole stands to benefit when more qualified young people are encouraged to enter these crucial fields. Improved science literacy for all citizens, young or old, is an important goal that this project seeks to promote.

Title: SBIR Phase II: Mobility Agents for Persons with Cognitive Disabilities

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| Award Number: | 0349663 |
| Program Manager: | Sara B. Nerlove |
| Start Date: | March 1, 2004 |
| Expires: | February 28, 2006 |
| Total Amount: | $500,000 |

Investigator: Alexander Repenning, alexander@agentsheets.com
Company: Agentsheets, Inc.
6560 Gunpark Drive, Suite D
Boulder, CO 80301
Phone: (303)530-1773

Abstract:

This Smal Business Innovation Research (SBIR) Phase II project will develop Mobility Agents that help persons with cognitive disabilities use public transportation systems. The realization of an operational system that wirelessly connects users to real-time bus information through Mobility Agents depends on the fact that public transportation systems are increasingly equipped with GPS (Global Positioning System) systems connected to control centers through dedicated wireless networks. Controllers use this infrastructure to schedule and optimize operations and avoid organizational problems such as bunching. Agentsheets proposes to use this existing infrastructure to compute highly personalized information and deliver it on PDAs or cell phones to persons with cognitive disabilities. Wireless devices with location aware Mobility Agent services that help travelers use public transportation systems, permit caregivers to customize these agents, and monitor the progress of travelers by means of utilizing The Pragmatic Web, a framework for highly customizable Web information; and Deductive Tracking, a combination of sensor fusion and minimalist common sense AI that creates more reliable tracking information. Agentsheets will explore design and implementation issues for agent-based real-time user interfaces on handheld devices; build the system, and test it in a real-world setting using the Boulder bus system as a public transportation test bed.

The Mobility Agents technology turns general GPS-based information into personalized, practical information. Customization mechanisms range from simple preferences to rule definition, and are relevant to the fields of End-User Development/Programming, Visual Languages, and Human Computer Interaction. Deductive Tracking contributes to Sensor Fusion and Artificial Intelligence. Parts of a Phase I 3D engine, used in the real-time transportation visualization, have been made available to other research organizations and are already in use. This technology proffers assistance to persons with cognitive disabilities. The elderly and other groups will also benefit from the same technological developments. This technology creates new service organizations. It reduces the need for human escorts, increases the autonomy of persons with cognitive disabilities, and decreases the need for federal support.

Title: SBIR Phase II: The Accessible Semantic Web

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| Award Number: | 0349718 |
| Program Manager: | Sara B. Nerlove |
| Start Date: | March 1, 2004 |
| Expires: | February 28, 2006 |
| Total Amount: | $532,208 |

Investigator: Edward Sims, eds@vcom3d.com
Company: VCOM3D, Inc.
3452 Lake Lynda Drive
Orlando, FL 32817
Phone: (407)737-7310

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project proposes to develop an Accessibility Markup Language (AML) that annotates digital representations of English text with linguistic information needed for proper translation into other modalities, as required by persons with physical or cognitive disabilities. As an exemplar of the technology, VCom3D will develop, demonstrate, and evaluate the application of AML to making Web content accessible in American Sign Language (ASL). This development will entail the implementation of an Encoder to create AML from English text, and a Decoder to generate grammatical ASL from AML. Multinational corporations and institutions have recognized the economic and social need to make information and instruction accessible to persons around the world for whom English is, at best, a second language. To address this issue, international organizations, including the World Wide Web Consortium (W3C) are defining methodologies for using Controlled Languages, systems of annotation and, in the future, the Semantic Web to increase accessibility in other languages. These same emerging technologies and infrastructure can provide an unprecedented opportunity to make information available to underserved Americans with sensory, cognitive, and cultural differences. This project will demonstrate the application of emerging information technology to make information accessible to Deaf persons, and will provide resources for further research into ASL linguistics.

The initial commercial product based on this technology will be a translation and authoring tool that substantially automates the creation of grammatical, animated ASL from English text. This product will be used to increase access by Deaf and Hard of Hearing children and adults to digital information and to promote inclusive education and employment in accordance with the New Freedom Initiative, recent amendments to Section 508 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA), and Section 255 of the Telecommunications Act.

# Environmentally Benign Technology

Title: SBIR Phase II: High Efficiency Low Cost Nitrogen Fertilizer Production from Fly Ash

Award Number: 0822738
Program Manager: Cheryl F. Albus

Start Date: August 1, 2008
Expires: July 31, 2010
Total Amount: $500,000

Investigator: Peng Zhang, info@unitedee.com
Company: United Environment & Energy, LLC
111 Ridge Road
horseheads, ny 14845
Phone: (607) 796-0830

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop innovative high efficiency, low cost nitrogen fertilizer manufacturing technology from fly ash. Fly ash is a recycled material from coal power plants that may contain high concentrations of mercury and carbon. Traditional nitrogen fertilizer production uses natural gas as the primary feedstock and is very costly. The traditional fertilizers are water-soluble compounds, resulting in significant loss of fertilizer which in turn pollutes streams and ground water. America's coal power plants produce more than 71.1 million tons of fly ash per year, and most of it is disposed in landfills. The high mercury content in the fly ash makes the disposal more difficult and costly. The Phase II project will bring the viable fly ash nitrogen fertilizer production technology from a laboratory scale to a pilot scale, and will determine the optimal pilot plant operation conditions, produce fertilizer for farmland field testing, and demonstrate its commercial viability. The pilot plant data will be used to understand the importance of design parameters and operating conditions on plant performance, refine the manufacturing plant design, and reduce the risk associated with construction of manufacturing plants. The broader impacts (commercial significance) if this project is successful will be a high volume and highly technical application for fly ash and a value-added high efficiency low cost nitrogen fertilizer. The production of this fertilizer will not be affected by the availability of natural gas. Moreover, the projected production cost of this nitrogen fertilizer is much lower than that of the traditional nitrogen fertilizer. The use of this new nitrogen fertilizer on farms will increase crop production profitability and prevent fertilizer loss and water pollution. By avoiding the landfill disposal of the fly ash, the coal power plants will save millions of dollars. If all the fly ash produced at coal power plants in the US were used to produce nitrogen fertilizer, the amount of nitrogen fertilizer produced could meet the entire US market demand. The success of this new technology will bring a revolutionary change to the traditional nitrogen fertilizer production process and will have substantial environmental, economic, and technical benefits.

Title: SBIR Phase II: Recycling Advanced Batteries

Award Number: 0750552
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $512,000

Investigator: Steven Sloop, ssloop@onto-technology.com
Company: OnTo Technologies
63221 Service Road Suite 6/F
Bend, OR 97701
Phone: (541) 389-7897

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop process conditions, recycled materials, and recycling of new battery technologies. Phase I demonstrated that the innovative recycling process can produce materials for new batteries from spent batteries. The Phase II recycling research objectives will (1) Survey advanced battery technologies (2) Improve process efficiency and (3) Recondition used materials. Starting with spent batteries, the project recovers materials, examines utility, and develops methods for recondition based upon physical or chemical limiting issues. The anticipated result of this development is establishment of the most efficient process to recycle high performance battery materials. The proposed project establishes the most environmentally friendly advanced battery recycling technology as the solution to the next generation's significant environmental challenge. Today's battery recycling options inefficiently bury, burn, or melt spent batteries. This project addresses needs from battery-reliant industries for low-cost recycling with minimal environmental impact; the developed recycling process is the basis for jobs fundamental to the future portable electronics and electrified vehicle markets. The innovation is based upon knowledge from battery life-limiting mechanisms coupled with green-chemical processing techniques. The research actively involves undergraduate researchers at Willamette University in the development and commercialization of energy efficient technologies.

Title: STTR Phase II: Ultraviolet Activated Chelation (UVAC) for the Recovery of Hg from Industrial Wastewater

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| Award Number: | 0750442 |
| Program Manager: | Cynthia A. Znati |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $502,423 |

Investigator: Anna Casasus, aicasasus@MazTechSolutions.com
Company: Sol-Gel Solutions, LLC
4110 SW 34th Street
Gainesville, FL 32608
Phone: (352) 378-4950

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II aims to further develop and optimize an advanced oxidation technology called Ultraviolet Activated Chelation (UVAC), which utilizes low-energy ultraviolet (UV) light for the removal of mercury (Hg) from industrial wastewaters. The Phase I project achieved Hg concentrations as low as 11 ppt (which is lower than the Hg levels commonly found in rainwater) via this process. The technology has been proven in the bench- and pilot-scales, but further work is required to consistently achieve Hg concentrations below 12 ppt and to obtain the most economical commercial design. The Phase II objectives will include the optimization of design parameters such as filtration, pH, residence time, and UV light characteristics. The effect of various water chemical characteristics on Hg removal will also be studied. It is anticipated that Phase II efforts will result in a robust and economical commercial system employing the UVAC technology for industries to comply with current and pending environmental regulations. The broader impact/commercial potential from this technology will be a process for Hg removal from water to trace levels, this technology is contributing to the protection of human health, wildlife, and the environment. Exposure to Hg, which can occur by consumption of contaminated fish, can affect cognitive thinking, memory, attention, language, and fine motor and visual spatial skills. Additionally some researchers have proposed a link between Hg and autism. A commercially viable solution for Hg removal from water to levels below 12 ppt is lacking. Development of the UVAC technology for the chlor-alkali industry may lead to the commercialization of the technology for other industries, such as coal-fired power plants and dental offices, among others. Further understanding of the UVAC process will enhance the scientific community's knowledge about Hg in the environment, particularly in relation to UV light.

Title: SBIR Phase II: An Innovative Method for Removing Resist from Wafers

Award Number: 0750623
Program Manager: Cheryl F. Albus

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $500,000

Investigator: Hang Ji, hji@uncopiers.com
Company: Uncopiers, Inc.
6923 Redbud Drive
Manhattan, KS 66503
Phone: (785)293-4917

Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop an innovative, environment friendly method for removing resist from semiconductor wafers. After every lithography step, and the following processing step, e.g., etching or ion implantation, the process-hardened resist must be stripped away and the wafer cleaned. Existing photoresist removal methods (plasma ashing and wet chemical stripping) are proving too aggressive for current state-of-the-art interconnect materials-they tend to degrade and damage low-k dielectrics and corrode copper; they are also detrimental to the delicate device structures. In this project the resist stripping and wafer cleaning are accomplished in a single process step through controlled microcavitation in ultrapure water with no damage to the underlying layers and features. Resist stripping is a growing $2.64B market. The proposed resist remover and wafer cleaner successfully overcome a critical technological barrier facing the IC manufacturing industry today. Beyond the IC manufacturing industry, the microcavitation based layer removal will find applications in all areas requiring controlled thin film removal,e.g., MEMS, PCB, optics, automotive (paint removal), and aerospace. This will be an enabling technology useful in thin film processing. Microcavitation is a chemical free, environmentally friendly technology.

Title: SBIR Phase II: Control and Optimization of Combustion Based on Multispectral Emission Tomography

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| Award Number: | 0724385 |
| Program Manager: | Rathindra DasGupta |
| Start Date: | August 15, 2007 |
| Expires: | July 31, 2009 |
| Total Amount: | $499,201 |


Investigator: Xuemin Jin, xjin@spectral.com
Company: Spectral Sciences Inc
4 Fourth Avenue
Burlington, MA 01803
Phone: (781)273-4770



Abstract:

The Small Business Innovation Research (SBIR) Phase II project investigates a novel approach for directly measuring critical combustion flow-field information required for active control to increase combustion efficiency and reduce harmful emissions. Combustion control systems can be based on non-intrusive in-situ measurement using passive optical probes that measure spectrally-resolved radiation from specific molecular products (H2O, CO, and CO2) in the hot flow field. Concentrations and temperatures can be directly determined from the observed spectral structure. The critical innovation in this proposal is the experimental determination of the functional relationship using spectral sensor technology and tomographic reconstruction techniques. Flow field characterization is achieved using a large number of measurements over multiple lines of sight through the flow.

The proposed Phase II research lays the scientific ground work for active control systems for a range of multi-burner combustors, including turbine engines, boilers, and process burners. These applications represent more than 50% of the global fossil energy usage; thus improvements in efficiency can have a major economic and societal impact. The proposed innovation is just one of the component technologies required for the development of active control systems, but it is an enabling component, with potential application in all industrial combustion markets.

Title: SBIR Phase II: One-Step Environmentally-Friendly Synthesis of Novel Organic/Inorganic Hybrid Pigments

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| Award Number: | 0724210 |
| Program Manager: | Rathindra DasGupta |
| Start Date: | August 1, 2007 |
| Expires: | July 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Lori Polette-Niewold, lpolette@utep.edu
Company: Mayan Pigments
500 W. University Ave.
El Paso, TX 79968
Phone: (915)747-6122



Abstract:

The Small Business Innovation Research (SBIR) Phase II project will support the commercialization of a novel line of high-performance Mayacrom pigments using a lower cost, solid-state, environmentally friendly one-step manufacturing process. The Mayacrom pigments exhibit superior properties compared with many commercially available pigments and may replace environmentally detrimental pigments such as cobalt and cadmium based colorants. The intellectual merit of the proposed work includes the advancement of knowledge of solid-state reactions in the fields of materials science and engineering. Environmentally, aspects of the proposal include creating a production process that is solvent free, consumes only a modest amount of energy, and releases only water during manufacturing, resulting in no negative ecological impacts.

Broader effects include the fundamental understanding of the solid-state thermodynamics and reaction kinetics that affect the physical and chemical properties of the pigments. Results of the influence of mixing intensity on reaction kinetics will also expand the knowledge for other industrial processes. Other broader impacts include continued collaborative research activities at the minority-based University of Texas at El Paso (UTEP) to expand the scientific understanding of these hybrid pigments and publish significant findings. If successfully commercialized, the one-step manufacturing process will create jobs in the United States and in the under-utilized El Paso, Texas border region.

Title: SBIR Phase II: Improved Methods to Manufacture Brominated-Carbon Adsorbents for Power-Plant Mercury-Emission Control

Award Number: 0620518
Program Manager: Rosemarie Wesson

Start Date: July 26, 2006
Expires: July 31, 2008
Total Amount: $499,714

Investigator: Yinzhi Zhang, YZhang@SorbentTechnologies.com
Company: Sorbent Technologies Corp
1664 Highland
Twinsburg, OH 44087
Phone: (330)425-2354

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to further develop an advanced manufacturing method to both lower the cost and increase the performance of brominated carbon sorbents for power plant mercury emission control. Fine brominated carbon, a newly-commercial material, has been demonstrating a superior affinity in full-scale sorbent-injection trials for scavenging toxic mercury from power plant flue gases. In the Phase I project various production parameters were experimentally examined and the feasibility of an improved manufacturing process was preliminarily established. The Phase II project will concentrate on further developing and testing the innovative manufacturing technique.

Coal-fired power-plant mercury emissions are increasingly recognized as injurious to the environment and, ultimately, to human health. A leading retrofit technology for this application is the injection of a new material, brominated carbon, ahead of existing plant particulate controls. Consequently, successful efforts to lower the production cost and to increase the performance of these new materials will have high economic returns, potentially saving the nation tens or hundreds of millions of dollars each year.

Title: STTR Phase II: Formulation of Environmentaly Friendly Lubricants Based on Polymeric Materials for Cold Forging Process

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| Award Number: | 0620290 |
| Program Manager: | Joseph Raksis |
| Start Date: | July 5, 2006 |
| Expires: | June 30, 2008 |
| Total Amount: | $487,141 |


Investigator: David Stark, tdstark@mindspring.com
Company: Sisu
840 Main Campus Drive,Suite 3580
Raleigh, NC 27606
Phone: (919)831-2246



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project proposes to develop a polymeric lubricant that is environmentally friendly for cold forging of metals, by using proprietary emulsion polymerication technology to synthesize polymers containing both polar functional groups that adhere to the metal surface, and hydrophobic groups to provide lubricity, and by replacing zinc phosphate typically used as a corrosion inhibitor, with a more benign material.

This technology could lead to new lubricants for metal forging processes that are more environmentally benign, thereby reducing a potential health and environmental threat, and enhancing the competitive manufacturing position of the US.

Title: SBIR Phase II: Novel Sensor for Control of Cleaning Processes During the Fabrication of Microstructures

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| Award Number: | 0548743 |
| Program Manager: | Murali Nair |
| Start Date: | January 23, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $470,050 |

Investigator: Bert Vermeire, bert@env-metrology.com
Company: EMC
6595 N Oracle Rd Ste 153B
Tucson, AR 85704
Phone: (520)742-3300

Abstract:

This Small Business Innovation Research (SBIR) Phase II project provides a unique and robust in-situ sensor for detection and control of impurities in microstructures and porous layers associated with manufacturing of semiconductor, MEMS, and emerging nanodevices. Use of impedance as a measure of contamination in bulk fluids is well established. However, applying it in micro-scale features is novel and has many promising applications. The proposed Electro-Chemical Residue Sensor (ECSR) technology is not aimed at developing yet another sensor to measure contaminants in fluids. It is rather aimed at the in-situ, real-time, and low-cost measurement of residual contamination inside and on the sidewalls of micro- and nano- features (the bottlenecks of cleaning, rinsing, and drying). The Phase II proposed plan is to design, fabricate, and test a prototype sensor assembly and develop its interface with process tools for cleaning, rinsing, and drying of micro-features.

The first planned application, amounting to annual commercial market revenue of $9M to $30M, will be in rinsing and drying of patterned wafers and porous films in micro-electronics manufacturing. Currently, these operations are often run with no adequate real-time control. Insufficient cleaning and drying have significant negative impact on manufacturing yields and device performance. On the other hand, excessive cleaning and drying results in damage to the micro-structures, increase in cost, and wasting of chemicals, water, and energy. The application of the ECRS technology to wafer rinsing alone is expected to reduce water usage by 40-60%.

Title: SBIR Phase II:  Compacting Fly Ash to Make Bricks

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| Award Number: | 0548719 |
| Program Manager: | George Vermont |
| Start Date: | January 23, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $497,506 |


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| Investigator: | Henry Liu, fpc_liuh@yahoo.com |
| Company: | FPC<br>2601 Maguire Blvd<br>Columbia, MO 62501 |
| Phone: | (573)442-0080 |



Abstract:

This Small Business Innovation Research (SBIR) Phase II project has the objective of conducting R&D needed for commercialization of new technology to make bricks using fly ash, which is a byproduct or waste material generated at coal-fired power plants.  Research conducted under Phase I demonstrated that the known freeze/thaw problem of fly ash bricks can be solved using air entrainment.  This process converts a high volume waste material into a useful product using a room temperature process, with cost, air pollution nd energy savings, compared to traditional processes.

The Phase II work will test key fly ash brick properties not tested in Phase I, investigate ways to vary the brick's color and shape, and study key steps in scaling up the process.

Title: SBIR Phase II: Neutralizing Utility Mercury Control Sorbents for Fly Ash Use in Concrete

Award Number: 0349752
Program Manager: Cheryl F. Albus

Start Date : January 1, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Qunhui Zhou, QZhou@sorbenttechnologies.com
Company: Sorbent Technologies Corporation
1664 East Highland Road
Twinsburg, OH 44087
Phone: (330)425-2354

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to optimize and commercially apply a newly discovered carbon material that simultaneously exhibits high gas-phase adsorption of mercury and low wet-concrete adsorption of organic surfactants. Such a material is necessary if coal-fired power plants are to inexpensively retrofit sorbent-injection technology to comply with new limits on mercury emissions while continuing to sell their fly ash wastes as substitutes for cement in concrete construction applications. The material will be tested at both the pilot and full scales, paving the way for product commercialization.

The broader impact that could be achieved from this project will be a solution a serious pending economic and environment problem. The substitution of power-plant fly ash for manufactured Portland cement in construction applications is one of America's biggest recycling successes. Fly ash could lower the construction-industry concrete costs, increase the technical performance of the concretes, and preserve the environment by conserving energy and reducing both waste disposal and CO2 emissions.

# Polymer, Powder, & Composite Systems

Title: SBIR Phase II: Compact membrane reactors for high-purity hydrogen

Award Number: 0750325
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December, 31, 2009
Total Amount: $490,317

Investigator: Subra Iyer, siyer@nrgtix.com
Company: Eneregtics Incorporated
P.O. Box 1745
Brea, CA 92886
Phone: (714) 993-9081

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop mini-channel membrane reformers to produce pure hydrogen from gaseous and liquid fuels. Fuel reforming of hydrocarbon fuels to yield high purity hydrogen is, at present, the only means for overcoming the lack of an established infrastructure for hydrogen. Fuel processors must be able to start up quickly, follow demand rapidly, be tolerant to sulfur, and operate efficiently over a wide range of conversion rates. The use of mini-channel reformers, with selective membrane removal of hydrogen at the site of production within the individual reformer stages, will lead to improved efficiency, thermodynamics and kinetics of reforming reactions. If successful, the proposed membrane reformer system will decrease system complexity, reduce costs, and allow ease of control, monitoring and transient response. The proposed technology has significant business opportunities in the business sector for high-purity merchant hydrogen, and in the civilian and military sectors for hydrogen fuel cells, used in portable power and distributed generation. Valuable scientific and technological understanding will also be gained about the behavior of hydrogen-permeable membranes and their use in high-temperature, sulfur-resistant, compact fuel reformers to produce high-purity hydrogen.

Title: STTR Phase II: Durable Functional Coloring of Fiber Reinforced Thermoplastic Structural Composites for High Strength Material Applications

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|---|---|
| Award Number: | 0750194 |
| Program Manager: | Cynthia A. Znati |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2009 |
| Total Amount: | $500,000 |

Investigator: James White, jwhite@shepherdcolor.com
Company: The Shepherd Color Company
4539 Dues Drive
Cincinnati, OH 45246
Phone: (513) 454-1231

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will demonstrate the ability to color structural composite parts made of thermoplastic polymers reinforced with long (3 mm to 25 mm in length) glass fibers. Today the options are black or natural resin color which limits their design appeal. Colorants are not used in thermoplastic composites for structural applications because they historically caused significant loss in key properties. This breakthrough of successfully using durable, high performance energy managing colorants in long glass fiber reinforced thermoplastic structural materials will open options for a wide range of products in construction, safety, sporting goods, furniture, industrial, transportation and recreational markets. Application prototypes for the transportation and industrial markets will be created in this project. By integrating durable color within structural composite parts, the speed of displacing traditional materials will increase. Thermoplastic composite materials provide clear advantages relative to metals of reduced weight in the part with equal or superior properties, corrosion resistance, and design flexibility, all resulting in significant cost savings. Painting processes can be eliminated with the incorporation of color. The structural long glass fiber reinforced thermoplastics are more durable and result in less waste over time and therefore are better for the environment.

Title: SBIR Phase II: Anti-Microbial Vinyl Nanocomposites

Award Number: 0646481
Program Manager: William Haines

Start Date: April 15, 2007
Expires: March 31, 2009
Total Amount: $500,000

Investigator: Andrew Myers, amyers@tda.com
Company: TDA Research, Inc
12345 W 52nd Ave
Wheat Ridge, CO 80033
Phone: (303)940-2301

Abstract:

This Small Business Innovation Research (SBIR ) Phase II project will develop biocidal nanocomposites to protect plastics such as polyvinyl chloride (PVC). Biocides can now be added as a component during the plastic manufacturing process to make it inherently resistant to microbial attack. PVC is a widely used plastic that requires antimicrobial protection in many applications, as it is often used near water (swimming pool liners and shower curtains) or in areas where sterile or clean surfaces are critical (flooring for hospitals or kitchens and bathrooms). PVC is currently protected from microbial attack by arsenic compounds or organic biocides that migrate slowly out of the protected material. Arsenic-based biocides are under increasing regulatory pressure, and an alternative would be welcomed by the industry. Unfortunately, current non-arsenic (organic) biocides leach out of PVC, contaminating the environment and allowing fungi to attack the PVC. TDA Research, (TDA) proposes to increase the permanence of biocides designed to disperse in PVC. Nanoparticle-based biocides would not migrate out of the thermoplastics, prolonging product lifetimes. The project will start by examining several active organic biocides that have been approved and regulated as biocides for thermoplastics. Following this will be tasks related to nanoparticle synthesis; formulation and testing of the nanocomposite; nanoparticle manufacturing scale-up; and performance and economic evaluation. The plan is to develop nonarsenic, non-migratory biocides for PVC.

Commercially, the proposed project will improve help eliminate the use of arsenic containing biocides; biocides which are particularly harmful because they persist in the environment. Despite their known dangers and the desire of manufacturers to discontinue their use, arsenic containing formulations continue to be used in several applications where the alternative organic biocides do not provide the needed long term protection. Further, the use of our technology will decrease the release of the organic biocides into the environment as well, keeping them in the polymer where they are needed.

Title: STTR Phase II: Formulation of Environmentaly Friendly Lubricants Based on Polymeric Materials for Cold Forging Process

Award Number: 0620290
Program Manager: Joseph Raksis

Start Date: July 5, 2006
Expires: June 30, 2008
Total Amount: $487,141

Investigator: David Stark, tdstark@mindspring.com
Company: Sisu
840 Main Campus Drive,Suite 3580
Raleigh, NC 27606
Phone: (919)831-2246

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project proposes to develop a polymeric lubricant that is environmentally friendly for cold forging of metals, by using proprietary emulsion polymerication technology to synthesize polymers containing both polar functional groups that adhere to the metal surface, and hydrophobic groups to provide lubricity, and by replacing zinc phosphate typically used as a corrosion inhibitor, with a more benign material.

This technology could lead to new lubricants for metal forging processes that are more environmentally benign, thereby reducing a potential health and environmental threat, and enhancing the competitive manufacturing position of the US.

Title: SBIR Phase II: Highly Efficient Exhaust Cleanup Technology for Environmentally Benign Processing

Award Number: 0548440
Program Manager: George Vermont

Start Date: January 10, 2006
Expires: December 31, 2007
Total Amount: $500,000

Investigator: Ofer Sneh, ofer@sundewtech.com
Company: Sundew Technologies
1619 Garnet St
Broomfield, CO 80020
Phone: (720)887-8166

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel, integrated reactive abatement model (IRAM) that effectively removes solidifying chemicals from the exhaust effluent of atomic layer deposition (ALD) manufacturing processes. ALD and related manufacturing technologies are widely used in the electronics industry and will be critical for emerging nanotechnology applications. However, a key issue is the emission of reactive, toxic and solidfying chemicals that clog and destroy equipment, requiring frequent cleanup and replacement, and create worker safety and environmental concerns.

Objectives of this project include developing suitable abatement chemistries and systems for several important generic ALD processes and deriving generalized IRAM methodology that can be used to produce a module that can be integrated into ALD equipment.

Title: SBIR Phase II: Development of Smart Material Using Natural Fiber Reinforced Composite

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| Award Number: | 0521905 |
| Program Manager: | Joseph E. Hennessey |
| Start Date: | August 1, 2005 |
| Expires: | July 31, 2007 |
| Total Amount: | $439,726 |

Investigator: Christopher Whitmer, cwhitmer@vibroacoustics-solutions.com
Company: Vibroacoustics Solutions Inc
2205 229th Place
Boone IA, 50036
Phone: (515)450-8997

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a suitable prototype based on the Active-Passive Natural Fiber Composite (APNFC0), the technical feasibility of which was demonstrated in the Phase I program. This innovative composite material concept is bio-based and hence environmentally friendly. The APNFC has excellent vibration and noise mitigation properties and can be used to control acoustic noise and structural vibrations in a wide variety of noisy environments. The unique design of this composite material will reduce noise transmission over a broad band of frequencies through a combination of absorption and dissipation phenomena. The prototype to be built during Phase II will consist of a thermoformed sandwiched material configuration where a polymer-based piezoelectric layer (PVdF) is formed between two passive layers composed of variable density natural fiber composite (VDNFC). This material will have an embedded control system with amplifiers and power supplies.

The commercial applications of the new technology include: home appliances, soundproof architectural doors, office furniture, operator cabins for agricultural and construction machinery, building materials, automobiles, and aircraft cabins. Collectively, these represent a multi-billion dollar market for parts and products to which the present core technology can be applied. The company has a focus commercialization plan with strategic partner support in the appliance application and the office and construction applications.

Title: SBIR Phase II: High Performance Transparent AlON via Novel Powder Synthesis

Award Number: 0349022
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: George Hida, Ghida@mercorp.com
Company: Materials and Electrochemical Research Corporation (MER)
7960 South Kolb Road
Tucson, AZ 85706
Phone: (520)574-1980

Abstract:

This Small Business Innovative Research (SBIR) Phase II project proposes to develop a high performance transparent aluminum oxynitride (AlON) material, with improved mechanical properties and low cost, via an innovative powder synthesis method. Using nanoparticle sintering, an IR transmission of 80% can be achieved. The smaller grain size leads to a MOR of 400 MPa.

The Phase II program proposes to extend the applications of AlON for wide spread commercial applications. Several major forming methods will be developed in this Phase II program so that the forming capability can be established to fulfill all of the different parts for different markets. These products include high intensity discharge lamps, security windows, semiconductor substrates, laser windows, consumer optic windows, orthodontic brackets, etc.

Title: SBIR Phase II: Commercialization of Perfluorocyclobutyl Polymers for Integrated Optics and Other High Performance Applications

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| Award Number: | 0349519 |
| Program Manager: | Rosemarie D. Wesson |
| Start Date: | January 1, 2004 |
| Expires: | December 31, 2005 |
| Total Amount: | $499,983 |


Investigator: Earl Wagener, ewagener@bellsouth.net
Company: Tetramer Technologies, L.L.c
501-8 Old Greenville Hwy, #325
Clemson, SC 29631
Phone: (864)653-4339



Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to pursue commercialization of perfluorocyclobutyl (PFCB) polymer products successfully developed during Phase I. High performance fluoropolymers, whose structure can be readily adjusted to achieve performance targets and which can be easily processed are in demand for next generation technologies including integrated optics, fuel cell membranes, gas separation membranes, and deep UV lithography. Tetramer's patented PFCB polymers exhibit superior processing and performance advantages including excellent molding and extrusion capability, unmatched thermal stability, zero by-products during polymerization and fabrication, and the ability to tune properties for these large market applications that promise significant growth from to their global economic attractiveness and strategic military importance to the United States.

This distinctive activity will enhance scientific and technological knowledge in both academia and industry for such diverse technically driven fields as lower cost higher data rate integrated optics, fuel cell membranes, white light LEDs, and gas separation membranes and particularly the discipline of polymer chemistry due to its structural versatility. After protecting intellectual property, Tetramer plans to share the results through published papers, and university and industrial seminars. This project will also contribute to US global leadership in the above fields of strategic commercial and military interest.

# Surface Treatments/Coatings

Title: STTR Phase II: A New Process for Boride Coatings for Manufacturing Applications

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| Award Number: | 0822598 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | July 7, 2008 |
| Expires: | June 30, 2010 |
| Total Amount: | $499,858 |


Investigator: Rabi Bhattacharya, rbhattacharya@ues.com
Company: UES, Inc.
4401 Dayton Xenia Rd
Dayton, OH 45432
Phone: (937) 426-6900



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project is seeking the transfer and further development and commercialization of a new low temperature metal-organic chemical vapor deposition (LT-MOCVD) technology for boride coatings. The project will work to develop coatings for characterizations of adhesion, microstructure, morphology, composition and hardness. Selected coatings will be tested for friction and wear and corrosion resistance under laboratory test conditions on various common engineering substrate materials. The precursor preparation process will be scaled up and deposition will be done in an industrial scale deposition system. The coating process will be optimized for high hardness and good adhesion. Optimized coatings will be applied to components for testing at end users' facilities under production conditions. The broader impact/commercial potential of wear and corrosion resistant coatings are very attractive for their high hardness and good chemical stability, and have potential for many applications in the manufacturing sector in United States. The process developed in this project, of deposition of borides, will enable a wide spectrum of applications including cutting tools, die casting dies and inserts, transfer rolls for flat glass, components for chemical processes, armament industries, automotive and aerospace industries.

Title: SBIR Phase II: Nanostructured WC/Co Coatings for Enhanced Wear Resistance Applications

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| Award Number: | 0646485 |
| Program Manager: | Deepak Bhat |
| Start Date: | April 1, 2007 |
| Expires: | March 31, 2009 |
| Total Amount: | $499,972 |


Investigator: Ralph Tapphorn, rtapphorn@inovati.com
Company: Innovative Technology Inc
Cabrillo Business Park
Goleta, CA 93117
Phone: (805)571-8384



Abstract:

This Small Business Innovation Research (SBIR) Phase II project continued development of nano-crystalline tungsten carbide-cobalt coatings by integrating two novel processes: i) a low temperature spray deposition process (kinetic metallization), and ii) a nano-crystalline powder deposition process. The results of Phase I research demonstrated that the two proposed methods can be synergistically combined to synthesize unique new compositions of powders for thermal spray coating process. The Phase II work is focused on the scaling and optimization of the powder manufacture and deposition techniques.

If successful, the process and material system can provide an environmentally acceptable replacement for chromium-based coatings. A nc-WC-Co coating system with good fatigue properties will certainly provide an alternative to hard Chrome coatings, if it can be fabricated cost effectively. The environmental benefit resulting from this will be significant. The proposed technique is also claimed to result in a deposition equipment at a lower cost of ownership as compared to curently available equipment. The technique has significant broad applications in a number of key industries, including aerospace, power generation, oil and gas drilling, defense and medical industries.

Title: SBIR Phase II: Nanoparticulate Based Coating Approach for Making Thin Film Batteries

Award Number: 0620596
Program Manager: Rosemarie Wesson

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Suvankar Sengupta, ssengupta@aol.com
Company: MetaMateria
1275 Kinnear Rd
Columbus, OH 43212
Phone: (614)340-1690

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop unique materials demonstrated with potential to provide higher performance nanostructured cathodes for a solid state lithium ion thin film battery using a lower cost, nanoparticulate based deposition approach. A unique nanocomposite anode consisting Sn nanoparticles deposited onto CNT has been developed, with capacities higher than typically found in conventional Li ion batteries  The cathode work will be directed toward development of improved cathode coatings.

The potential to cost-effectively eliminate the primary limitation to portable electronic advances will have a significant impact on industry and society. Lighter weight, more powerful and permanently rechargeable solid state devices that enable a new portable power "platform" will be an outcome of this endeavor. In addition, the nature of the solid-state design and materials is inherently disposable and environmentally friendly.

Title: SBIR Phase II: Nanocomposite Coating on Coronary Stents

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| Award Number: | 0620563 |
| Program Manager: | James Rudd |
| Start Date: | August 23, 2006 |
| Expires: | August 31, 2008 |
| Total Amount: | $490,533 |

Investigator: Robert Hoerr, bobhoerr@comcast.net
Company: Nanocopoeia
1479 Gortner Avenue, Suite 240
St. Paul, MN 55108
Phone: (651)624-3060

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is focused on designing, prototyping, and fully qualifying a proprietary manufacturing apparatus capable of applying a range of next-generation coronary stent coatings. First generation drug-eluting coronary stents have significantly improved clinical outcomes for heart patients, while concurrently highlighting the potential for substantial improvements. Next-generation methods are needed for improving the way drugs and other biologics are applied to the stent, as well as for active-agent release from the stent. The company successfully demonstrated in Phase I that its proprietary ElectroNanospray process could reproducibly apply nanocomposite drug/polymer coatings onto the intricate architecture of a coronary stent and could consistently meet preliminary specifications provided by a potential commercial partner. This Phase II project will extend that R&D by producing a manufacturing. Apparatus designed to significantly improve process control features and throughput. Rigorous step-wise hardware-qualification experiments will generate test lots of coated stents for further characterization and validation by the same partner. Feedback will guide design iterations needed to optimize this unique manufacturing capability, with the goal of producing an apparatus that coats stents with a broad range of novel nanocomposite coatings and drug-release properties for preclinical testing and meets the stringent performance requirements for commercial manufacturing in a regulated environment.

Commercially, sales of drug-eluting coronary stents will exceed $6 billion in 2006. With the first products entering the market in 2003, this represents the fastest market introduction in medical device history. The drug-eluting stent showed that the body's inflammatory and scarring response to the implanted bare metal stent, which resulted in re-blockage of the artery, could be overcome by applying thin layers of drug-releasing polymers to the stent surface. The broader implications are that coatings that enable site-specific delivery of biologically active compounds could improve the clinical performance of a wide variety of medical device implants, not only for cardiovascular indications, but also for use in orthopedic, neurology and tissue engineering applications. In addition, using the drug-eluting stent as an example, they offer the possibility of bringing about the same or improved clinical outcomes as existing therapies, while reducing cost, hospital length of stay, and loss of productivity by the patient. The novel manufacturing apparatus proposed in this research will have the ability to create and apply engineered nanocomposite coatings to device implants that incorporate novel active agents and controlled-release properties not possible with today's conventional coating processes, thereby offering the possibility of improved clinical outcomes for a wide variety of diseases.

Title: SBIR Phase II: Environmentally Benign Antifouling Coatings From Dendritic Nanotechnology

Award Number: 0522183
Program Manager: Joseph E. Hennessey

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $498,473

Investigator: Petar Dvornic, dvornic@dendritech.com
Company: Dendritech, Inc
3110 Schuette Rd
Midland MI, 48642
Phone: (989)496-2016

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to further the development of the technology to manufacture the first environmentally safe polymer coating that can successfully prevent aquatic biofouling on submerged man-made surfaces. The Phase I study clearly showed that the unique honeycomb-like structure of these novel nano-structured dendritic polymer coatings not only delivers very efficient anti-fouling protection, but also prevents environmental pollution.

The broader impact (commercial significance) of the program is the immediate application of this technology to coatings for ship/boat hulls used in marine and fresh water environments. These unique nano-structured antifouling coatings are also expected to have a very broad impact and large commercial effect in a variety of other water-based industries, ranging from shipping, fishing, tourism and defense, to production of energy in hydroelectric plants, protection of shorelines, production of potable water by desalination of sea water or from biofoulant-infested fresh-water sources.

Title: SBIR Phase II: Ultrananocrystalline Diamond as Wear Resistant and Protective Coating for Mechanical Shaft Seal Applications

Award Number: 0521596
Program Manager: Joseph E. Hennessey

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $511,530

Investigator: James Netzel, netzel@thindiamond.com
Company: Advanced Diamond Technologies
2001 S. First Street
Champaign IL, 61820
Phone: (217)239-1963

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new class of mechanical shaft seals based on the benefits of a novel material called Ultrananocrystalline (tm) diamond (UNCDtm) that will result in seals that last longer, save energy and reduce environmental emissions associated with industrial pumping and turbo-machinery applications. Mechanical shaft seals are used in almost every industry. The main functions of these seals are to ensure that the pumping fluid does not escape the system and to protect the fluids from contaminants. This program will build upon earlier results that showed that UNCD could reduce seal wear by orders of magnitude over SiC seals.

The project will include customer trials, securing industry standard qualification and developing manufacturing capabilities. New UNCD seal products will be developed for chemical, refinery, pharmaceutical, mining, and other demanding industrial applications. Several features of UNCD, including its fine grain size, high quality surface and its ability to be processed at reasonable temperatures, make it an ideal material to be leveraged other friction and wear
materials.

Title: SBIR Phase II: Temperature-Adaptive Nano-Crystalline Combinatorial Self-Lubricating Coating

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| Award Number: | 0422080 |
| Program Manager: | Errol B. Arkilic |
| Start Date: | September 15, 2004 |
| Expires: | August 31, 2006 |
| Total Amount: | $471,482 |

Investigator: Wenping Jiang, wjiang@virtual-incubation.com
Company: NanoMech Corporation
21 West Mountain
Fayetteville, AR 72701
Phone: (479)571-2592

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops a temperature-adaptive nanoparticles-based solid lubricant coating (ZnO and MoS2 and their metastable forms) on textured cBN/TiN for hard turning and dry machining applications. The uniquely coated tool inserts are able to constantly release the lubricants out of reservoirs on the textured cBN/TiN surface. Currently available solid lubricant coatings do not offer temperature-adaptive properties and are NOT suitable for hard turning applications. Hard turning can offer manufacturers large cost savings compared to grinding. However, the achievable surface finish is critical. The preliminary results indicate that the proposed solid lubricant coating will enhance hard turning surface finish and provide greater consistency. In addition, both environmental and competitive cost issues are causing manufacturers to migrate toward dry machining. Solid lubricant coatings can both improve surface finish and extend the tool life in dry machining applications by lowering the friction at the interface between the tool and the workpiece. Commercially available solid lubricants are primarily configured in layered structures. As wear progresses, the lubrication layer wears away and leaves the hard layer behind. Thus, the proposed novel configuration that provides temperature adaptability while also offering continuous long lasting lubrication has great potential. The proposed research is an excellent example of adding value to industrial products from the investment in nano science and engineering. The project will provide improved understanding of how the tribo-chemistry of nanoparticle coatings can offer temperature adaptive properties and affect machining performance. Also, it will provide insights regarding the micro tribology along the boundary of the particles and binder(s).

The primary application of the coating will be for cutting tools in hard turning and dry machining. These are very important and growing commercial markets. Additional markets could be for rotating machinery, dies and molds, and other wear parts. The successful development of the proposed coating will help reduce environmental waste and contaminants from the usage of coolants. The disposal of both the used cutting fluid and the contaminated metal chips that were removed during the cutting process is becoming harder and more costly. The cost of the coolant has been widely estimated as contributing over 15% of a typical part.s machining costs. The project will help facilitate the adoption of high speed machining techniques, which is considered a key factor for the United States maintaining its manufacturing base in the face of strong competition from low labor rate countries.

Title: SBIR Phase II: ACIM deBonder: Thin Film Integrity Testing Using Controlled Microcavitation

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|---|---|
| Award Number: | 0422191 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | August 1, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $500,000 |

Investigator: Sameer Madanshetty, sameer@ksu.edu
Company: Uncopiers, Inc.
6923 Redbud Drive
Manhattan, KS 66503
Phone: (785)293-4917

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new method of determining how strong a thin film anchors to a substrate. The ACIM deBonder(trade mark)uses controlled microcavitation to directly reveal a thin film's adhesion strength by subjecting it to controlled erosion. ACIM is a means of constructively controlling acoustic microcavitation. Substrates are not harmed. The ACIM deBonder(trade mark) will be applicable to any type of film or coating that can be eroded in a controlled manner by cavitation. It is essentially a nondestructive method that only uses small areas of films. No special sample preparation is needed and the method is capable of in situ inspection. The ACIM deBonder tool will be developed for use in microelectronic manufacture. Semiconductor chips rely on the various film layers of their constitution to bond reliably. Beyond semiconductors the deBonder could be useful in optical coatings, and all contexts involving surface modification involving films.

The broader impacts of this project will be a new method of determining the adhesion strength of thin films; it is expected to advance the science of thin film engineering. The controlled erosion of ACIM can itself be used to create nascent surfaces in preparation for thin film deposition. Ultimately, the principle of ACIM deBonder (trade mark) relies controlled caviational erosion, in fact it relies on controlling the very fundamental process of phase change, the control of nucleation--the ability to convert a liquid into a gas in the vicinity of a solid phase. This should have much wider applications in a variety of chemical processing, e.g. in the control of the boiling processes in chemical and nuclear reactors. The study of this acoustically mediated nucleation control could form an active field/area of research and education

Title: SBIR Phase II: Cubic Phase-Stabilized Zirconia Thermal Barrier Coatings Applied via a Novel Chemical Vapor Deposition Route

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| Award Number: | 0422242 |
| Program Manager: | Rosemarie D. Wesson |
| Start Date: | July 15, 2004 |
| Expires: | June 30, 2006 |
| Total Amount: | $427,752 |


Investigator: Jason Babcock, jason.babcock@ultramet.com
Company: Ultramet
12173 Montague Street
Pacoima, CA 91331
Phone: (818)899-0236



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will seek to develop a novel technique for applying thermal barrier coatings (TBCs) to turbine (jet) engine components. The use of low thermal conductivity TBCs has enabled higher temperatures and longer component life to be achieved, along with more efficient engine operation. Application of the state-of-the-art coating compositions via chemical vapor deposition (CVD) has the potential for an order-of-magnitude reduction in processing cost over the conventional technique employed. In addition, CVD is a non-line-of-sight technique capable of coating components and/or regions of components not possible by any other means

The next-generation TBC system to be developed in this project will provide superior reduction in actual part temperature and oxidation resistance compared with state-of-the-art coatings. In addition to the increased engine efficiency realized from the higher temperature operation these coatings will allow, this application method has the potential for an 80-90% reduction in cost. Improved TBCs will have wide application to commercial and military propulsion and power generation systems, including turbine and reciprocating engines.

Title: SBIR Phase II: Nanocrystalline Diamond Coated Cutting Tools

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| Award Number: | 0349769 |
| Program Manager: | T. James Rudd |
| Start Date: | January 1, 2004 |
| Expires: | December 31, 2005 |
| Total Amount | $509,999 |

Investigator: Raymond Thompson, rthompson@VistaEng.com
Company: Vista Engineering Inc.
2800 Milan Ct
Birmingham, AL 35211
Phone: (205)943-6720

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop nanocrystalline diamond coatings on tungsten-carbide cutting tools with technical attributes that surpass the current generation of chemical vapor deposited (CVD) diamond coatings as well as tools made from polycrystalline diamond (PCD) wafers. The problem with CVD diamond coatings for cutting tools is poor surface finish and weak adhesion. Nanocrystalline CVD diamond deposited using microwave plasma (MP) techniques overcomes these problems with a smooth finish that is well adhered. This makes the nanocrystalline diamond a potential competitor to PCD diamond by lowering the price and increasing productivity. The research proposed for Phase II will use a 30kW MP-CVD reactor to investigate the relationships between nanocrystalline structure and technical performance. The structure will be controlled by process variables. Technical performance will be measured by mechanical testing and field testing on the proposed target application of machining cast aluminum-silicon alloy. The anticipated technical result will be direct correlations between structure, properties and performance that can be used to optimize nanocrystalline diamond coatings for machining automotive drive-train components.

Commercial applications of nanocrystalline diamond coatings are far reaching due to applications in the cutting tool industry that promote the use of hard-to-finish advanced materials; applications in pulp and paper for cutting and guides, applications in textiles for guides and applications in various bearing surface applications such as deep-well oil drill-head bearings. The National Institute of Health is also sponsoring research on nanocrystalline diamond applications in biomedical hardware surfaces subject to wear. Additionally, environmental impact of cutting fluid and related waste from machining processes are driving manufacturers to implement dry machining processes. MP-CVD nanocrystalline diamond tooling is the ideal tool for dry machining nonferrous materials.

## Structural, Engineered, and High Temperature Materials

Title: STTR Phase II: Multi-Wall Carbon Nanotubes Inclusion for Thermal Conductivity Enhancement of Microencapsulated Phase Change Material Slurry

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| Award Number: | 0823115 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | July 15, 2008 |
| Expires: | June 30, 2010 |
| Total Amount: | $499,783 |


Investigator: Curt Thies, Thiesman@aol.com
Company: Thies Technology
921 American Pacific Dr.
Henderson, NV 89014
Phone: (702) 567-8206



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project seeks to investigate the commercial feasibility of new processes capable of incorporating phase change materials (PCMs) and multi-wall carbon nanotubes (MWCNT) into micro- and nano-capsules thereby producing particles with novel thermal and fluid properties. The primary objective is to take advantage of MWCNT exceptional thermal properties to enhance the thermal performance nano/microencapsulated phase change material (N/MPCM) slurry. Thermally enhanced N/MPCM slurries can provide palpable benefits in the thermal management of commercial and industrial processes and products, from microelectronics devices to large industrial facilities, by providing considerable additional heat capacity and better heat transfer performance. The combined effect of nano/microencapsulated MWCNTs and phase change materials present a unique opportunity to improve the performance of heat transfer fluids beyond current levels. A series of experiments will be carried out to quantify the degree durability, heat transfer enhancements in laminar and turbulent conditions, and in typical heat exchangers. The broader impact/commercial potential of this project will have a lasting impact on the entire heat transfer industry. Direct impacts include lower flow rates, lower pressure drop, smaller heat transfer area and improved heat transfer effectiveness. The project will also elucidate how the new fluid performs in commercially available heat exchangers. The project will also provide unique educational opportunities to undergraduate and graduate students. The success of the project will broaden scientific and technological understanding of enhanced heat transfer fluids in industry as well as in academia. Indirect impacts include enhanced living standard and improved competitiveness. Successful commercialization of the proposed concept will find applications in biomedical, aerospace, homeland security, and energy generation.

Title: SBIR Phase II: Low-Cost Hot Press Die Casting of Graphite-Metal Materials

Award Number: 0823012
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $499,734

Investigator: James Connell, jconnell@charter.net
Company: Advanced Thermal Technologies
91 S. Street
Upton, MA 1568
Phone: (508) 529-4413

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to develop an unique hot press die casting technology to be used to produce graphite-metal materials. These materials will be used to produce packaging components for use in high power electronics packaging. There is a critical need for advanced materials with improved thermal properties capable of meeting the thermal management requirements of current and future high power electronic systems. The heat dissipation rate of electronic systems has increased dramatically, as a result of ongoing advances in semiconductor materials, compression of circuit physical architecture, size reduction of packaging envelops and faster switching speed. The technology developed in this project will enable the manufacture of cost effective graphite-metal packaging that offers improved thermal properties critical to thermal management solutions for next generation power electronics. The broader impact/commercial potential of this project will be the development of the hot press die casting technology for use in producing graphite-metal billet materials. The adoption and wide-spread use of the graphite-metal packaging products for electronic systems will enable commercial electronic devices based upon more efficient higher power semiconductor materials that will provide benefit to society in the form of more efficient, longer life electronics; reduced energy consumption; and improved environmental quality.

Title: STTR Phase II: Low-Cost Processing of Nanoporous, Super-Hydrophilic, Multifunctional Coatings for Glass and Plastic Surfaces

Award Number: 0823108
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $499,999

Investigator: Uma Sampathkumaran, uma.sampathkumaran-1@innosense.us
Company: InnoSense LLC
2531 West 237Th St, Ste 127
Torrance, CA 90505
Phone: (310) 530-2011

Abstract:

This Small Business Technology Transfer Research (STTR) seeks to develop three significant permanent, self-cleaning, anti-fog coatings for plastic and glass surfaces. Fogging of the windows of a car is a hazard most drivers have experienced at one time or another. Fogging results in poor visibility, and unsafe driving or flying conditions. Durable, anti-fog coatings that provide a permanent solution to the problem have potential to satisfy critical needs, especially for the growing number of aging baby boomers. The broader impact/commercial potential of the coatings has been tested independently; these coatings will be fine-tuned for applications in aircraft cockpit windows, motorcycle helmet visors, and in related personal protective gear. These multifunctional hard coatings can be used as abrasion resistant, anti-fog and anti-reflection coatings on both glass and plastic surfaces. The coatings are made from inexpensive raw materials and simple processing techniques like dip or spray coating suited to forming conformal coatings.

Title: SBIR Phase II: Innovative Two-Phase High-Heat-Flux Heat Exchanger

Award Number: 0750416
Program Manager: Cheryl F. Albus

Start Date: March 1, 2008
Expires: February 28, 2010
Total Amount: $469,109

Investigator: Gregory Cole, gsc@mainstream-engr.com
Company: Mainstream Engineering Corporation
200 Yellow Place
Rockledge, FL 32955
Phone: (321) 631-3550

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to demonstrate an innovative multi-phase-fluid heat exchanger capable of revolutionizing heat transfer for high-heat-flux cooling applications. Initial experiments confirmed that metastable two-phase fluids can produce heat transfer coefficients 40% greater than single-phase fluids at the same flow rate and they have the potential to dissipate heat flux values. The broader impact/commercial potential from the technology will be result in a standardized family of two-phase cold plates that can be used by designers of electronics devices for a wide variety of applications. The new family of two-phase cold plates will be sold in sizes and configurations similar to existing air-cooled devices, but will have significantly increased heat flux dissipation rates and reduced thermal resistances. This project will also provide supporting design information and an Interactive Design Tool for use by the electrical packaging designer. The designer will then be free to package the remainder of the thermal management system based on basic vapor-compression design principals or purchase a system. Additionally, for applications where standard thermal components will not work, this project will provide custom solutions.

Title: SBIR Phase II: Innovative Isotropic Ultra-High Thermal Conductivity Diamond Composite Materials

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| Award Number: | 0750177 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | January 1, 2008 |
| Expires: | December 31, 2008 |
| Total Amount: | $531,726 |


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|---|---|
| Investigator: | David Curliss, david.curliss@p2si.com |
| Company: | Performance Polymer Solutions Inc.<br>91 Westpark Road<br>Centerville, OH 45459 |
| Phone: | (937) 298-3713 |



Abstract:

The Small Business Innovation Research (SBIR) Phase II project will further develop and demonstrate an innovative class of composite ultra-high thermal conductivity materials for solid state electronics thermal management applications. There exists a growing need for high thermal conductivity materials that exhibit greatly increased isotropic thermal conductivity and lower density compared to existing thermal conductivity materials and composites. Materials with these characteristics do not presently exist, but are enabling for many other future applications. Under the Phase II effort, the P2SI Team will develop these materials and characterize the fundamental structure-property-processing relationships to enable manufacturing scale-up and commercialization. The P2SI concept is for an "Engineered Material" where the processing behavior and the resulting macroscopic performance (thermal conductivity) is a unique function of the composite architecture. Building the proposed ultra-high isotropic thermal conductivity materials from a multi-scale constituent level represents a leap in technology that was first developed from the fundamental level and validated in the Phase I program. The impacts of this research are twofold: providing a foundation for a new technology in materials science research; and utilizing these fundamental findings to develop and engineer enabling materials to meet growing needs in industry for thermal management applications.

Title: STTR Phase II: Large Scale Freeform Fabrication for the Construction Industry

Award Number: 0646569
Program Manager: Deepak Bhat

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $500,000

Investigator: Charles Eason, charleseason@optemadevelopment.com
Company: OPTEMA
5179 Lakeshore Dr.
Fairfield, CA 94534
Phone: (800)427-8133

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop and commercialize a novel way to construct large, modular objects, such as concrete walls and components used in building a home, using a solid freeform fabrication process. The novelty of the proposed process is that is is capable of producing structures with wall thicknesses which are thickner than other similar methods. The structures can have contoured faces and alignment guides to permit quick assembly of layerwise construction. The proposed research will focus on aerated concrete as the structural materiaol, having proven the basic concept on structural foam in the Phase I research. The method is expected to result in rapid construction of homes with minimal labor and onsight assembly of pre-fabricated components.

The broader impacts of this project, if successful, would represent a radical departure in a notoriously conservative industry, leading to the construction of inexpensive, pre-fabricated homes. The technology will address a significant market in the U.S. and developing countries to provide affordable homes to a very large population of low-income consumers. Other applications where this technique could be employed include construction of large objects such as boat hulls (pleasurecraft).

Title: STTR Phase II: Support Material Characterization for Ultrasonic Rapid Prototyping

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| Award Number: | 0548721 |
| Program Manager: | George Vermont |
| Start Date: | January 11, 2006 |
| Expires: | December 31, 2007 |
| Total Amount: | $468,233 |

Investigator: Dawn White, dawn@solidica.com
Company: Solidica
3941 Research Park Dr C
Ann Arbor, Michigan 48108
Phone: (734)222-4680

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will complete the development of a support material for Ultrasonic Consolidation (UC) direct metal rapid prototyping and demonstrate the ability to build structures with high aspect ratios or overhanging features. This ability to apply UC to more complex shapes will enable engineers to design important parts more rapidly and less expensively. Basic iinformation developed on the mechanical properties of metals experiencing ultrasonic excitation will also be useful in other industrial processes, such as extrusion and ball milling.

The project will use the results from Phase I to identify a user friendly, cost effective, environmentally benign and easily removed support material, and demonstrate that its application can be integrated with the commercial UC platform.

Title:  SBIR Phase II: Reactive Multilayer Joining of Metals and Ceramics

Award Number: 0349727
Program Manager: Cheryl F. Albus

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: David Van Heerden, dvh@reactivenanotech.com
Company: Reactive NanoTechnologies
111 Lake Front
Hunt Valley, MD 21030
Phone: (410)771-9801

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop technology for joining metallic and ceramic components; this is a reactive joining process that uses reactive multilayer foils as local heat sources for melting solders. These foils are a new class of nano-engineered materials, in which self-propagating exothermic reactions can be initiated at room temperature using a hot filament or laser. By inserting a multilayer foil between two solder layers and two components, heat generated by the reaction in the foil melts the solder and consequently bonds the components. This new method of soldering eliminates the need for a furnace or protective atmospheres and, with very localized heating, avoids thermal damage to the components. The reactive bonding process is far more rapid than most competing technologies, and results in strong and cost-effective joints. The last and potentially most important benefit is the fact that joining with multilayer foils enables the use of lead free solders and therefore offers tremendous environmental benefits.

The broader impacts that could result from this project could be to microelectronic packaging facilities.

Title: STTR Phase II: Modulation-Assisted Deep Hole Drilling of Micro/Meso-Scale Biomedical Components

Award Number: 0822879
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $499,660


Investigator: James Mann, jbmann@m4sciences.com
Company: M4 Sciences Corporation
1800 Woodland Avenue
West Lafayette, IN 47906
Phone: (765) 479-6215



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project aims to develop a Modulation-Assisted Machining (MAM) system with novel capabilities for micro/meso-scale deep-hole drilling of biomedical components. The system is structured around a new device; an accessory developed for computer numerically controlled (CNC) machine tools. This new device superimposes a low-frequency sinusoidal modulation onto machining processes enabling controlled chip formation and easy disposal, enhanced lubrication of tool-chip contact, reduces energy consumption, and, potentially, a reduction in tool wear. When implemented in the appropriate system framework, unprecedented increases in productivity and efficiency of deep-hole drilling processes are envisaged. The broader impact/commercial potential of this project will be commercialize MAM technology in manufacturing of biomedical components and related applications in automotive and aerospace fluid systems manufacturing. Complemented by a strong education and training program. By driving the development of a class of clean machining processes with reduced effluent streams and energy consumption, and improved efficiency, this project will impact sustainable manufacturing for the discrete products sector, with broad societal benefits.

Title: SBIR Phase II: Micro-quantity Internal Cooling (MQuIC) of Cutting Tools for Increased Productivity via Micro-ducts

Award Number: 0646365
Program Manager: Cheryl F. Albus

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $499,951

Investigator: William Endres, wjendres@endresmachining.com
Company: Endres Machining Innov.
1402 E Sharon Ave, Ste 1001
Houghton, MI 49931
Phone: (906)487-9364

Abstract:

This Small Business Innovation Research (SBIR) Phase II research aims to develop and commercialize cutting tools with internal micro-geometric features to provide relatively direct and localized cooling of the tool-chip contact zone. The proposed innovation is (i) incorporation of micro-scale internal features and (ii) a production process that can provide high-volume manufacturing of these modified cutting tool inserts. Conventional approaches of using coatings for effective cooling during machining have limited effectiveness, but the proposed approach is claimed to provide a novel method of providing internal cooling mechanism to machine difficult-to-machine (DTM) materials.

If successful, this technology will enable better tool-life during the machining of hard-to-machine materials at finish feeds, which can have tremendous impact for machining of DTM alloys. By requiring minimal coolant use due to effective heat transfer from machining operation, the research will lead to new manufacturing methods with a positive impact on environmental pollution.

Title: STTR Phase II: Predictive Molding of Precision Glass Optics

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| Award Number: | 0646503 |
| Program Manager: | Rathindra DasGupta |
| Start Date: | March 15, 2007 |
| Expires: | February 28, 2009 |
| Total Amount: | $499,757 |

Investigator: Yazid Tohme, tohme@nanotechsys.com
Company: Nanotech
426A Winchester St
Keene, NH 3431
Phone: (603)352-3030

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will develop physics based computational models of the glass molding process that accurately predict the shape of the optic from knowledge of the mold geometry, the material properties of the glass, and the molding parameters. The computational models will be developed through systematic characterization of the properties of glasses at high temperatures, and incorporation of the viscoelastic response of the glass with thermal expansions and elastic deflections of the mold and glass. This project will also develop user interface software capable of building the finite element (FE) model directly from user input of coefficients of the industry-standard Asphere Equation and translating results of the FE analysis into Asphere coefficients.

The computational tools developed in the proposed research will eliminate the current need for production of more expensive trial mold geometries before discovering the proper mold geometry and processing parameters required to produce in-tolerance optics. The proposed research will allow manufacture of opto-electronic products with superior capabilities compared to those available today. In addition, the project will contribute to the development of science and engineering workforce through training of graduate students at the University of Florida and Clemson University.

Title: SBIR Phase II: Low Cost Pressure Infiltration Casting Process to Support High Volume Manufacture of Graphite-Metal Thermal Management Components

Award Number: 0646263
Program Manager: Rathindra DasGupta

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $499,963

Investigator: James Connell, jconnell@charter.net
Company: ATT
91 S. Streeet
Upton, MA 01568
Phone: (508)529-4413

Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop the use of a gas pressure infiltration casting process to manufacture graphite-metal billet materials that would be used to produce components for high power electronic device packaging. The heat dissipation rate of electronic devices has increased dramatically as a result of advances in semiconductor materials, faster switching speeds, compression of circuit physical architecture, and miniaturization of device envelops. These market trends are expected to continue and there is a critical need for advanced materials with improved thermal conductivity capable of meeting the package heat dissipation requirements of current and future high power electronic systems. In addition the materials will need to have a coefficient of thermal expansion (CTE) that minimizes the CTE mismatch that occurs at the interface between packaging components of different materials. The objective of the Phase II effort is the development and demonstration of cost-effective package assemblies that incorporate graphite-metal components with a thermal conductivity of from 500 to 600 W/m-oK and a coefficient of thermal expansion that can be adjusted between 5.0 and 10 ppm/oC.

The markets for packaging products based upon the graphite-metal material technology include: (1) RF power amplifiers for communications systems; (2) switching devices for power conversion systems; and (3) light emitting diode devices for solid state lighting. The research will produce the key knowledge required to enable the production of low-cost, high-volume graphite-metal components to satisfy the packaging requirements for the above applications. The packaging products supported by this manufacturing technology will benefit a broad spectrum of commercial, industrial, and military high power electronics end users. The adoption and wide-spread use of the graphite-metal packaging products for electronic systems will enable commercial electronic devices based upon more efficient higher power semiconductor materials that will provide benefit to society in the form of reduced energy consumption and improved environmental quality.

Title: SBIR Phase II: Advanced Tonnage Analysis System for Forging Processes

Award Number: 0620436
Program Manager: Rathindra Dasgupta

Start Date: September 1, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Tzyy-Shuh Chang, chang@ogtechnologies.com
Company: OG Technologies, Inc.
4300 Varsity Dr Suite C
Ann Arbor, MI 48108
Phone: (734)973-7500

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop an advanced tonnage signal processing system for the forging industry. This system will utilize advanced signal processing methods and statistical control techniques to distinguish between normal (in-control) and abnormal (out-of-control) tonnage signals, detect faulty process conditions (cold die, die wear, mismatch, improper lubrication, etc), and to conduct real-time process monitoring in the forging process.

The use of the advanced tonnage signal analysis system will contribute to reduction in energy consumption and carbon emissions, and improved tool (die) life in the forging process. This system also has the potential to be used in other deformation processes including rolling, stamping, extrusion, and drawing.

Title: SBIR Phase II: Long-Life Nozzles for Abrasive-Slurry-Jet Cutting

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| Award Number: | 0622266 |
| Program Manager: | Rathindra Dasgupta |
| Start Date: | August 31, 2006 |
| Expires: | August 31, 2008 |
| Total Amount: | $471,821 |

Investigator: Robert Dean, RCD@Synnovations.com
Company: Synergy Innovations, Inc.
10 Water St Ste 324
Lebanon, NH 03766
Phone: (603)448-5454

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop a high-pressure abrasive slurry jet cutting tool for almost all materials. The key aspect of this innovation is the elimination of nozzle grit erosion by fluid dynamic means. Past attempts to use abrasive slurry cutting tools have been troubled by unacceptable wear of the nozzles by the abrasive, and the associated loss of the abrasive.

The successful development of this technology will lead to a new generation of cutting equipment with reduced operating times and costs. This project will also provide internship opportunities for college undergraduates.

Title: SBIR Phase II: Ultrahigh-Pressure Flash Abrasive-Waterjets for Precision Machining

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| Award Number: | 0620277 |
| Program Manager: | Joseph Raksis |
| Start Date: | August 11, 2006 |
| Expires: | August 31, 2008 |
| Total Amount: | $345,708 |

Investigator: Peter Liu, peterl@omax.com
Company: OMX
21409-72nd Ave S
Kent, WA 98032
Phone: (253)872-2300

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and optimize a flash abrasive-waterjet for precision machining of delicate materials. The use of water in a phase change mode will offer advantages over abrasive waterjets, that can damage delicate materials, and liquid nitrogen abrasive cryogenic jets, that require expensive equipment.

The technology will be most useful for manufacturing parts with complex geometries from composites, glasses, laminates and other advanced materials, for use in the aerospace, electronics and defense industries.

Title: SBIR Phase II: Advanced Laser Patterning of Large Area Thin-Film Electrochromic Devices

Award Number: 0618631
Program Manager: Joseph Raksis

Start Date: July 13, 2006
Expires: June 30, 2008
Total Amount: $497,013

Investigator: Harvey Kalweit, hkalweit@sage-ec.com
Company: SAGE Electrochromics Inc
One Sage Way
Fairbuilt, MN 55021
Phone: (507)331-4902

Abstract:

This Small Business Innovation Research (SBIR) Phase II project has the objective of developing and transfering to the production line laser ablation technology for the manufacture of large area thin-film electrochromic (EC) windows. Shadow masking is commonly used to pattern the electrochromic coatings on glass, but it results in unacceptable edge definition and is expensive. Laser ablation can replace masking to allow precise definition of window areas, regardless of size and shape, and has the potential to significantly reduce manufacturing costs.

Broader acceptance of electrochromic windows for commercial and residential buildings will enable significant energy savings, and the laser ablation technology is applicable to non-flat shapes, which could extend use of EC windows to other applications.

Title: SBIR Phase II: Powder-Powder Mixing and Powder-Liquid Mixing by a Novel High-Intensity Vibrational Mixer

Award Number: 0548753
Program Manager: Joseph Raksis

Start Date: February 14, 2006
Expires: January 31, 2008
Total Amount: $460,987

Investigator: Joel Pierce, jpierce@resodyn.com
Company: Resodyn Corporation
130 N Main St Ste 600
Butte, MT 59701
Phone: (406)497-5252

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will enable the development of a high intensity, low frequency resonant-acoustic mixer for industrial uses, focusing on the incorporation of solid powders into liquids. Since there are no mixing blades or moving parts, issues of clean up and cross-contamination are minimized. The work will expand the scientific understanding of powder-liquid mixing in a high intensity resonant acoustic field, and provide an alternative mixing approach for emerging nano-sized materials.

Outcomes of the work will be a deeper understanding of the powder mixing phenomenon and a knowledge base for the design and optimization of complete industrial mixing systems.

Title: SBIR Phase II:  Non-Traditional Material Removal

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| Award Number: | 0548735 |
| Program Manager: | George Vermont |
| Start Date: | January 23, 2006 |
| Expires: | January 31, 2008 |
| Total Amount: | $337,214 |

Investigator: Aric Shorey, shorey@qedmrf.com
Company: QED
1040 University Ave
Rochester, NY 14607
Phone: (585)256-6540

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop abrasive jet technology for manufacturing/finishng microoptics.  Abrasion is accomplished by shear flow at the surface of the substrate submerged in an abrasive suspension and impinged upon by a bubble jet.  This technology will allow the precision finishing of surfaces with an aperture size as small as 1 millimeter, and provide a scientific basis for, and demonstrate the feasibility of, new technology for optics fabrication.

Enabling the finishing of small, high precision molds and lenses will allow manufacture of higher resolution cameras for camera phones and other consumer products, and for medical and surveillance devices.

Title: SBIR Phase II: A Multilevel Method for Rapid Evaluation of Sound Fields

Award Number: 0548629
Program Manager: Rosemarie Wesson

Start Date: December 29, 2005
Expires: December 31, 2007
Total Amount: $499,706

Investigator: Rajendra Gunda, rajendra.gunda@ansol.com
Company: Advanced Numerical Solutio
3554 Mark Twain Ct.
Hilliard, OH 43026
Phone: (614)771-4861

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to extend the current high frequency limit of acoustic analysis by two orders of magnitude and facilitate numerical simulation of extremely large sound structure interaction problems. The proposed method will advance the state of the art in numerical acoustics by integrating the Fast Multipole Method (FMM) with the direct and indirect formulations of the Boundary Element Method (BEM).

The FMM-BEM technology reduces analysis time in computational acoustics by two orders of magnitude. Accurate acoustic analysis of automotive and aircraft interiors in the entire audible frequency range will become practical for the first time. The technology will also allow detailed computation of the acoustic characteristic of submarine hulls, and quantitative assessment of the occupational safety concerns of workers subjected to jet engine noise at airport ramps.

Title: SBIR Phase II:  Modular Oxygen Enrichment Device to Improve Combustion Efficiency

Award Number: 0548714
Program Manager: Rosemarie Wesson

Start Date: December 13, 2005
Expires: January 31, 2008
Total Amount: $506,000

Investigator: David Walker, sdgroup@separationdesign.com
Company: SDGroup
931 Rolling Meadows Road
Waynesburg, PA 15370
Phone: (724)852-1035

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an innovative modular oxygen enrichment system. It is accepted that the reduction of cycle time can lead to a concurrent decrease in the mass of a sorptive separation system. However, ultra-rapid-cycle systems invariably create mechanical and physical challenges.  Specifically, limiting factors are the operational lifetime of the mechanical components, and the micro diffusion rate of the adsorbent system.  This project will remove these limitations by replacing mechanical valves with electro-kinetic pumps, and by utilizing microscale adsorbent structures that radically improve diffusion rates.

Conventional air separation units exhibit a poor mass/output ratio, which contributes to high cost. Oxy-air combustion offers the possibility of significant fuel savings and other environmental benefits.  The broad impact of this research is not only fuel savings attainable from improved combustion efficiency, but also application to other processes where oxygen is the rate limiting factor.  Fuel cells, aquaculture, biomass conversion, and water treatment will also profit from this exportable technology.

Title: SBIR Phase II: Development of Porous Lubricated Nozzles for Suppression of Nozzle Wear in Abrasive Water Jet Systems

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| Award Number: | 0422151 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | August 15, 2004 |
| Expires: | July 31, 2006 |
| Total Amount: | $485,362 |


Investigator: John Murphy, jbmurphy@jhu.edu
Company: Lubrijet, Inc
130 Starhill Lane
Baltimore, MD 21228
Phone: (410)516-5427


Abstract:


This Small Business Innovation Research (SBIR) Phase II project will develop technology for prevention of nozzle wear in abrasive water jets, which limits the lifetime and accuracy of jet cutting, and currently requires entrainment of abrasives downstream of the nozzle in a larger mixing tube. The method consists of a porous nozzle surrounded by a reservoir containing high viscosity lubricant pressurized by the same pump that drives the slurry in the nozzle. The lubricant is forced through the porous walls by the pressure difference generated due to the high-speed slurry flow, and creates a thin film, which protects the nozzles' interior walls. Pilot tests have successfully reduced the nozzle wear by more than an order of magnitude. Two systems are being developed: A Porous Lubricated Mixing Tube (PLMT) that can be retrofitted into existing commercial systems, and a Porous Lubricated Abrasive Suspension Jet (PLAS-Jet) with premixed particles prior to injection. The latter enables operation at lower pressures, and cutting of harder materials with smaller jets (micro-machining). Extensive cutting and nozzle wear tests during Phase II will optimize the nozzle material, geometry and manufacturing procedures, and will determine the lubricant properties and injection rate. Other components will also be improved including the particle and lubricant feed systems.

The broader impact (commercial potential) of the proposed technology will be abrasive water jets that can be utilized for cutting and machining of sheet metal, ceramics and composites by diverse users, ranging from small machine shops to the automotive and aircraft industries. Wear of the mixing tube in present systems adversely affects all the applications of jet cutting by limiting the lifetime of the nozzle and accuracy of the cut, by causing machine-down time, and by preventing commercial applications of micro-jets. A PLMT retrofitted with minimal investment into the thousands of abrasive jet systems already in the market will greatly reduce these adverse effects. The PLAS-Jet with premixed particles has several additional advantages that reduce the cost and extend the applications of jet cutting technology. Cost reduction results from the lower pressure required for achieving the same cutting effect (e.g. 10000 vs. 50000 PSI), the more efficient use of the abrasives, and the less frequent replacement of nozzles. The lower pressures also simplify the development of compact portable systems for remote applications in hazardous environments, such as during decommissioning of nuclear plants, and for military applications, e.g. removal of mines and other obstacles. Furthermore, unlike mixing tubes, the PLAS-Jet diameter can be reduced to levels enabling expansion of jet cutting to precision micromachining.

Title: SBIR Phase II: Spray Forming Titanium Alloys Using the Cold Spray Process

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| Award Number: | 0349787 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | February 15, 2004 |
| Expires: | January 31, 2006 |
| Total Amount: | $464,407 |

Investigator: Richard Blose, blose@ktech.com
Company: Ktech Corporation
2201 Buena Vista SE
Albuquerque, NM 87106
Phone: (505)998-5830

Abstract:

This Small Business Innovation Research Phase I project proposes to develop a new, low-cost methods for direct fabrication of metal parts at near-net shapes (NNS). This technology is critical for many industries and in particular, for manufacturing parts of expensive metals and alloys such as titanium. Such technologies have an impact on many industries because of the potential to quickly manufacture complicated parts with minimal waste. Currently used methods typically involve melting and solidification, which can cause high residual stresses, undesirable phases, and other problems. To solve the problems described a new method for spray forming is being used. This method is based on using the cold spray process avoiding undesired material, chemistry, and phase properties associated with thermal spray-forming methods. Studies conducted during Phase I demonstrated the feasibility of the cold spray process for rapid prototyping and direct fabrication of spray form shapes of Titanium alloys. The anticipated result of this activity is to deliver a technology yielding superior material properties of sprayed material and reduce cost of manufacturing.

The broader impacts of cold spraying near net-shapes technology could be very important technology for aerospace, including aircraft, military aircraft and spacecraft. This technology is promising for many other industries including automotive, medical, power, chemical, sport goods, and others. The proposed research activity will enhance scientific and technological understanding of the spray processes based on using high-speed particle flow.

# Manufacturing Process Control

Title: STTR Phase II: A Multi-Axis Planning System (MAPS) for Direct Fabrication Processes

Award Number: 0822739
Program Manager: Ian M. Bennett

Start Date: August 15, 2008
Expires: July 31, 2010
Total Amount: $500,000


Investigator: Jianzhong Ruan, jzruan@gmail.com
Company: Product Innovation and Engineering, L.L.C.
11513 Pine Forest Dr.
Rolla, MO 65401
Phone: (573) 308-7175



Abstract:

This Small Business Technology Transfer Research (STTR) (STTR) Phase II research project focuses on the development of an innovative Multi-Axis Planning System (MAPS), for layered manufacturing processes. By enabling current direct metal deposition systems to fully control and utilize multi-axis capability to make complex parts, MAPS will enable fully-automated process planning for multi-axis layered manufacturing processes to directly control metal deposition machines used in automated fabrication. The building of complicated shapes without support structures is a major challenge for current direct metal deposition processes. This proposed Phase II research will continue to research and develop the 'centroidal axis' algorithm in multi-axis slicing, with an emphasis on completeness and robustness for complicated shapes such as geometry with multiple loops and internal structures. This algorithm will allow manufacturing systems to handle parts with multiple loop features. Additional features to be developed under this Phase II project include a deposition visibility map for efficient computation on the collision-free slicing/deposition sequence in a multi-axis scenario, and a '3-D layer' toolpath generation which will provide an alternative turning algorithm for the deposition process. The proposed project will impact the manufacturing industry by incorporating fully-automated multi-axis control capability into the rapid manufacturing industry to produce fully functional metal parts with complicated shapes. This capability will lead to dramatic reductions in lead time and manufacturing costs for high-value, low-volume components with high performance material. Assuming the outcomes are successful, the project will several segments such as aerospace, military, motor sports, automotive, industrial machinery, medicine, dentistry, and consumer products.

Title: SBIR Phase II: Infrared Confocal Measurement System

Award Number: 0750368
Program Manager: Cheryl F. Albus

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $499,401

Investigator: David Marx, dmarx@tamartechnology.com
Company: Tamar Technology
996 Lawrence Drive
Newbury Park, CA 91320
Phone: (805) 480-3358

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will design and construct prototype measurement systems based on near infrared (NIR) chromatic confocal sensor technology. Silicon is transparent in the NIR, and thus the sensor measures the distance to the front and back surfaces of the wafer simultaneously. The sensor will measure deep trenches and vias from the back side so that their aspect ratios are of no consequence. The proposed innovations lie in the sensor design and integration. The proposed measurement systems will address the following semiconductor industry needs: 1) in situ wafer thickness measurement during wafer thinning operations; 2) wafer thickness and shape measurements of ultra-thin wafers; and 3) the measurement of deep, high aspect ratio, etched trenches and vias in silicon. Direct, in situ, measurements during wafer thinning are not currently possible. Neither is the nondestructive measurement of trench depth of many types of deep etched trenches and vias. The measurement of the thickness of ultra-thin wafers (<150 micron) requires greater accuracy for less cost than is currently available. Present technology does not have the resolution for measuring thickness in this thinner range, nor does it have sufficient spatial density on the wafer to accurately describe its shape.

Title: STTR Phase II: Development of an In-Line Cylinder Bore Inspection System

Award Number: 0723669
Program Manager: Cheryl F. Albus

Start Date: July 15, 2007
Expires: June 30, 2009
Total Amount: $500,000

Investigator: Stephen Segall, segall.ioms@gmail.com
Company: IOMS
1349 King George Blvd.
Ann Arbor, MI 48108
Phone: (734)971-1065

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project is working toward commercialization of cylinder bore probe inspection technology. During Phase II continued improvements and enhancements to the existing cylinder bore probe technology (in cooperation with the ERC for Reconfigurable Manufacturing at the University of Michigan) will continue. The scientific feasibility of this cylinder bore inspection technology was proven during the Phase I project; continued work on the operation of an automated inspection station with an array of probes working in parallel in a factory environment will be demonstrated during the Phase II project. Enhancing the technology may create opportunities for performing inspections at other locations on the engine block production line and for other cylindrical machined surfaces.

The broader impacts anticipated from this inspection process will be improved quality, reduced production costs and improve performance of vehicles used by hundreds of millions of people worldwide. It is also anticipated that this technology could lead to an optimized manufacturing process that would produce engines with reduced emissions, reduced oil consumption, improved efficiency and longer lives. Optimizing surface finish may have a greater effect on diesel engines, which are more efficient than gasoline engines.

Title: STTR Phase II: An Inference Engine for an Intelligent Imaging System for Detecting and Eliminating Hot Rolled Surface Defects

Award Number: 0646502
Program Manager: Rathindra DasGupta

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $500,000

Investigator: Tzyy-Shuh Chang, chang@ogtechnologies.com
Company: OG Technologies, Inc.
4300 Varsity Dr Ste C
Ann Arbor, MI 48108
Phone: (734)973-7500

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will develop an inference engine for an intelligent imaging system that can detect and eliminate surface defects in hot rolling operations. These defects account for roughly 50% of steel rejects. The proposed product is an automatic system that generates appropriate corrective actions for defect elimination. It is proposed to further develop the inference engine and validate it on selected industrial cases.

The potential value of the research is to reduce material waste by over 200,000 tons of steel, or $120 million in productivity, per year for the US steel industry. It is also expected to deliver benefits in North America with energy savings of 1.14 Tetra W-hr and reduced carbon-equivalent emission of 94,000 tons per year. Other benefits include reduced water usage and more efficient downstream processes. The project carries strong educational implication, with the company working closely with academia and facilitating student interns.

Title: SBIR Phase II: A Robust and Cost-Effective Tool for Diagnosing Manufacturing Noise Problems

Award Number: 0620287
Program Manager: Ian Bennett

Start Date: August 23, 2006
Expires: July 31, 2008
Total Amount: $500,000

Investigator: Manmohan Moondra, manmohan@sensound.com
Company: SenSound
221 Lewsiton Rd
Grosse Pointe Farms, MI 48236
Phone: (313)885-4550

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize a next generation quality control tool to assess the quality of any sound-generating product on a production line. The most significant scientific merit of this new technology is its capability to suppress the interference of background noise and extract the real acoustic characteristics of any target source in a noisy environment. Current measurement devices measure the overall signal, which includes the signal of a target source and background noise.

This research is expected to have broad impact on reducing noise pollution and improving workforce capabilities in a manufacturing environment. This technology will help the U.S. manufacturers to compete globally by reducing noise emissions, lowering warranty costs associated with noise related issues, and helping ensure compliance with a growing number of local and federal government regulations and laws on noise pollution.

Title: STTR Phase II: Advanced Control of Electron-Beam Deposition for High Precision Optical Coatings

| | |
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| Award Number: | 0548726 |
| Program Manager: | James Rudd |
| Start Date: | April 13, 2006 |
| Expires: | March 31, 2008 |
| Total Amount: | $505,940 |

Investigator: Douglas Smith, dsmith@vptec.com
Company: Cyber Materials
70 Industrial Park Road
Plymouth, MA 02360
Phone: (508)732-5107

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project leverages the substantial improvements in e-beam process control capability developed in Phase I into an integrated control system that can significantly increase yield and throughput for the $1.8 billion precision optical coating industry. Manufacturing partners indicate that the target performance levels would cut manufacturing costs by 35% and enable manufacturers to routinely achieve greater tolerances for advanced designs. This research is driven by a first-principles systems based approach that has created new intellectual property for monitoring, control, and process design.

Commercially, precision optical coatings are critical components for all optical instruments including microscopes, telescopes, vision and imaging systems, projection systems, and laser systems. Coatings have served these industries for years, but in a world where application requirements and scientific inquiry are constantly advancing, precision coatings are demanded that comply with even tighter tolerances. In particular, high energy laser science such as the NIF facility at Livermore require very precise and reliable coatings. This STTR research will be key to further improving manufacturing capabilities for a variety of important applications.

Title: SBIR Phase II: High Speed Optoelectronic Recognition of Al, Si, and Mg Alloys

Award Number: 0450452
Program Manager: Joseph E. Hennessey

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $499,998

Investigator: David Spencer, dbswte@aol.com
Company: wTe Corporation
7 Alfred Circle
Bedford MA, 01730
Phone: (617)275-6400

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project will apply an optoelectronic detection system into an integrated high-speed manufacturing system aimed at commercial identification and sortation of aluminum scrap by alloy type - particularly aluminum alloys containing various alloying elements such as silicon and perhaps magnesium. The goal of the program is to commercially sort mixed aluminum alloys from an automobile shredder. Commercial technologies in existence today sort automobile shredder nonferrous metals based on density, but there are no technologies in commercial operation that sort the metals into 1) cast and wrought alloys, 2) various aluminum alloy series (100, 200, 3000, 7000 etc.), or 3) into individual alloy types. Sorting aluminum alloys based on chemical composition is the objective of this SBIR Phase II program. A very sophisticated, proprietary sensor and detection system has been developed and demonstrated in Phase I in order to demonstrate the capabilities of the technology.

The broader impacts (commercial potential) of this proposed technology has the potential to transform the efficiency and utilization of scrap metal in the U.S. In 2001, the aluminum industry consumed nearly 800 trillion Btu, was responsible for 1.8% of the total manufacturing energy consumed, emitted 43.5 million tons of $CO_2$, and consumed 1.6% of all U.S. electricity - mostly from primary production. Secondary production is much more efficient - economically and environmentally. Recovering aluminum from scrap consumes only about 6% of the energy required to produce primary aluminum and requires only 10% of the capital. In spite of efficiencies in making aluminum from scrap, exports in 2003 were 562,090 million tons because the industry could not utilize much of its low-grade scrap. This technology will allow utilization of this scrap in existing U.S. plants because the scrap will be converted from low-grade to high-grade scrap which is more consistent with U.S. consumption and needs. The result will be job preservation, reduced emissions, reduced energy needs, reduced raw material imports, and a better balance of payments.

Title: SBIR Phase II: Hydrogen Production via Ultra-Rich Superadiabatic Combustion of Hydrogen Sulfide in a Reverse Flow Reactor

Award Number: 0646419
Program Manager: Rathindra DasGupta

Start Date: February 1, 2007
Expires: January 31, 2009
Total Amount: $499,999

Investigator: Jacques Bingue, jpbingue@innesol.com
Company: Innesol
9800 Connecticut Dr
Crownpoint, IN 46410
Phone: (219)794-1492

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a new process employing the superadiabatic reverse flow reactor to reform hydrogen sulfide into hydrogen with the simultaneous recovery of sulfur. Currently, the seven million tons of hydrogen sulfide produced each year as a byproduct of the reaction of sulfurous compounds with hydrogen are processed by Claus reactors into sulfur while wasting the much more valuable hydrogen content through oxidation. The successful development of the process would provide an economical means of dealing with hydrogen sulfide by retaining hydrogen. The Phase I project obtained the highest hydrogen yield ever achieved by a hydrogen sulfide process without the aid of external energy. Furthermore, the project attested that the reactor operates in regimes that eliminate sulfur dioxide. Building on the positive Phase I results; during this Phase II, a small pilot plant will be built and tested forming the basis for designing the commercial reactor with minimal modification.

The high price of gasoline and natural gas is partly due to the high cost of extracting sulfurous compounds in the crude oil refining process. This desulphurization process uses hydrogen, obtained mostly from natural gas, to react with the organosulphur species to form hydrogen sulfide. A process that can produce hydrogen as well as sulfur from hydrogen sulfide would save the energy industry hundreds of millions dollars per year in addition to decreasing the cost of gasoline, diesel, and natural gas for consumers. In addition, the process will also eliminate millions of tons of acid-rain-causing sulfur dioxide produced during disposal of hydrogen sulfide.

Title: SBIR Phase II: An Engineered Diffusion Barrier for Preparation of Pd Membranes on Tubular Porous Stainless Steel Substrate

Award Number: 0620528
Program Manager: Rosemarie Wesson

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $499,999

Investigator: Paul Liu, pliu@mediaandprocess.com
Company: M&P
1155 William Pitt Way
Pittsburgh, PA 15238
Phone: (412)826-3721

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of an innovative diffusion barrier for the preparation of Pd thin film on tubular porous stainless steel substrate. A thin Pd film supported on tubular porous SS substrate provides a commercially viable avenue for the use of palladium membranes for hydrogen production/recovery, particularly for large-scale applications. During Phase II the diffusion barrier will be developed to a commercial scale membrane unit for performing field tests. Pd membranes due to their excellent hydrogen permeability and selectivity can streamline existing hydrogen separation and purification processes dramatically for fuel cell and hydrogen separation applications.

The projected worldwide market size when fully matured is in the range of $1 billion/yr. Refineries' demand for hydrogen is expected to post annual growth in excess of 10% as refiners use more hydrogen to meet clean fuel regulations. A Pd-base hydrogen selective membrane suitable for large scale operations will play a major role in meeting this demand, particularly for the retrofit market, such as hydrogen recovery from waste refinery streams, as an add-on stage for existing steam reformer for incremental capacity, etc. In summary the proposed diffusion barrier could offer a practically viable Pd-based hydrogen separation device, which can benefit fuel cell and industrial hydrogen applications, and greenhouse gas reduction.

Title: STTR Phase II: Development of Fourth Generation High Temperature Materials

Award Number: 0548639
Program Manager: George Vermont

Start Date: December 21, 2005
Expires: March 31, 2008
Total Amount: $680,587

Investigator: Jason Lincoln, jason.lincoln@p2si.com
Company: P2SI
91 Westpark Road
Centreville, Ohio 45459
Phone: (937)298-3713

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop and characterize the structure-property-processing relationships for a novel class of thermosetting organic/inorganic hybrid polyimide resins. The resins will be used to fabricate structural composites; expected properties of the composites are higher extended use temperatures, compatibility with existing fabrication procedures, and mechanical and environmental stability properties as good as currently used materials. The project will provide a scientific basis for a new class of thhermosetting resing with broad value in defense, aerospace and deep sea drilling applications.

Project activities will include an experimental design to identify top performing structures, scale up and statistical analysis of batch to batch variations, preparation and testing of flat panels and targeted structures, and user testing of the structures.

Title: SBIR Phase II: Feasibility of On-line Metalloid Recovery in Gasification Systems

Award Number: 0422050
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $499,650

Investigator: Margaret Laumb, mlaumb@microbeam.com
Company: Microbeam Technologies Incorporated
4300 Dartmouth Drive
Grand Forks, ND 58203
Phone: (701)777-6530

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will demonstrate the ability to selectively condense and recover deposits rich in a valuable element from the gas-cooling regions of integrated gasification combined cycle (IGCC) plants. Deposits plugging gas-cooling heat exchangers in commercial coal IGCC systems are rich in a valuable element. The work will involve the design and construction of a pilot-scale on-line metalloid recovery (OMR) system that will be tested at bench scale on simulated synthesis gas, and on slipstreams from small-scale gasifiers. Phase II work will determine the effects of particulate matter and pressurized systems on the ability to concentrate and remove the valuable element from the gas stream. The on-line recovery of deposits rich in a valuable element will have two distinct commercial benefits. The first benefit is the cost savings associated with eliminating down time required for cleaning.

By eliminating one cleaning outage, a gasification plant could save $4.9 million. The second benefit is the creation of an additional revenue stream from the recovery of these deposits, which can be sold to a recycler.

Title: SBIR Phase II: Low-Cost Hydrogen for Next Generation Vehicles

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| Award Number: | 0422223 |
| Program Manager: | Rosemarie D. Wesson |
| Start Date: | July 15, 2004 |
| Expires: | June 30, 2006 |
| Total Amount: | $491,721 |

Investigator: Robert Copeland, copeland@tda.com
Company: TDA Research, Inc
12345 West 52nd Avenue
Wheat Ridge, CO 80033
Phone: (303)940-2301

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop a low cost process for producing high-pressure hydrogen. This process uses a proven, regenerable, low cost CO2 sorbent to minimize capital costs and improve efficiency. The key to the process is a sorbent that shifts the equilibrium of the reforming and shift reactions that convert hydrocarbons to hydrogen. The sorbent will be produced using commercial production equipment and tested to determine its lifetime and performance. In the near term, an improved hydrogen production process would significantly reduce the cost of the hydrogen used in oil refineries to make reformulated (cleaner burning) gasoline, and bulk chemicals such as fertilizers and chemical intermediates.

In the longer term, the new system can significantly reduce the cost of producing hydrogen to distribution centers that will be needed for hydrogen fueled vehicles and other fuel cell applications.

Title: SBIR Phase II: Purification of Metallic Nitride Nanomaterials by Chemical Separation

Award Number: 0349691
Program Manager: T. James Rudd

Start Date: January 1, 2004
Expires: December 31, 2006
Total Amount: $724,884

Investigator: Steven Stevenson, steven.Stevenson@usm.edu
Company: Luna Innovations, Incorporated
PO Box 11704
Blacksburg, VA 24062
Phone: (601)266-4119

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will involve production and purification of a powerful Magnetic Resonance Imaging (MRI) contrast agent based on a newly discovered nanomaterial (Trimetasphere), consisting of a metallic nitride nanocluster inside a fullerene type cage. Trimetaspheres recently demonstrated a factor of 21 times improved relaxivity over currently used MRI contrast agents. The project will involve designing and building a powder-feed continuous reactor, including large rod capability, developing chemically-based separations techniques and optimizing heat treatment of the chemically separated Trimetasphserses mixtures. The nanoproduction and chemical-based separations techniques for these Trimetasphere nanomaterials will provide the basis for the large-scale production of the Trimetasphere based MRI contrast agents.

Commercially, these Trimetaspheres have tremendous medical applications that will benefit US citizens with better medical care through improved diagnostics, new pharmaceuticals, and simultaneous diagnostic and treatment reagents, at a fraction of current cost. The development of more sensitive contrast agents, if translated into smaller, less expensive MRI instruments, will open entirely new markets for the equipment manufacturers.

# Novel Catalytic Systems

Title: STTR Phase II: Metal Oxide Nanofibers for Filter and Catalyst Support Structures

Award Number: 0822914
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $500,000


Investigator: Gary Carlson, carlson@mempro.com
Company: MemPro Ceramics Corporation
PO Box 3806
Copper Mountain, CO 80443
Phone: (303) 224-9999



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project seeks to take advantage of unique performance properties of ceramic nanofiber supported catalysts for applications in automotive, power generation, and chemical process industries. The efficiency of ceramic nanofiber composite materials to capture nano-sized particulates (inorganic and soot) is of particular interest to the automotive industry. Also, an opportunity to field test a composite catalyzed nanofiber material in a power generation facility to remove low-levels of NOx has been developed through commercialization activities within the power generation industry. This is a significant opportunity that will require the fabrication of a ceramic nanofiber/polymeric composite media and a field test apparatus. Successful completion of this opportunity will provide the background necessary to develop a first-generation ceramic nanofiber product. The broader impact/commercial potential of this project will provide the initial detailed examination of catalyst deactivation mechanisms using nanofiber support structures as well as providing a critical investigation of nano-sized particulate capture by nanofiber composite materials. This baseline information is beneficial to define and support future investigations of ceramic nanofiber materials. It is anticipated that catalyzed ceramic nanofiber/microfiber media will maximize the efficient use of catalytic materials (precious metals), enhance destruction of greenhouse gases (NOx and CO) from combustion processes, and capture harmful particulates from various gas process streams. These characteristics will help the power generation industry (fossil fuel burning), the motor vehicle, and the chemical industry meet current and future emission reduction standards while simultaneously benefiting the environment. Also as globalization leads to added pressures on U.S. companies to produce products and materials at a lower cost to remain competitive, reduction in the overall cost of energy production and transportation costs will improve U.S. competitiveness.

Title: SBIR Phase II: Catalytic Filter for Diesel Exhaust Purification

Award Number: 0750259
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $500,000

Investigator: Mark Fokema, fokema@aspensystems.com
Company: Aspen Products Group, Inc
184 Cedar Hill St
Marlborough, MA 1752
Phone:

Abstract:

This Small Business Innovation Research (SBIR) Phase II aims to develop a catalytically active filtration device for the continuous removal of particulate matter from diesel engine exhaust. Particulate emissions from diesel engines are viewed as a significant health hazard. New diesel fuel and exhaust emission regulations to be phased in through 2010 require that diesel engine exhaust be extensively cleaned; current purification products are considered too large, too expensive and impose too great a fuel economy penalty on the diesel engine. A particulate filtration system that continuously oxidizes particulate matter using oxygen contained in the engine exhaust and does not require regeneration will be prepared, characterized and refined. The technology that will be developed has the capability to remove ultra-fine particulates with dimensions as small as 20 nm. The broader impact/commercial potential from the technology will enhance the scientific understanding of the synthesis and stability of novel ceramic nanostructures as well as the interaction of soot with dispersed catalytic species. The successful application of this technology will lower the cost of purifying diesel engine exhaust, enabling wider application of highly fuel efficient diesel engines, which will in turn reduce the overall fuel consumption and pollutant emissions.

Title: SBIR Phase II: Enabling Low-Temperature Synthesis of Vertically Aligned Carbon-Nanotubes by Selective Heating of Catalyst

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| Award Number: | 0724878 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $499,820 |


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| Investigator: | Alexsey Vasenkov, jls@cfdrc.com |
| Company: | CFD Research Corporation<br>215 Wynn Dr NW FL 5<br>Huntsville, AL 35805 |
| Phone: | (256)726-4800 |



Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop, validate, and demonstrate a new technology for a low-temperature synthesis of vertically-aligned carbon nanotubes (VACNTs) and nanofibers (VACNFs). The low-temperature manufacturing process is critical to decrease the cost and improve the quality of VACNTs/VACNFs-based materials and devices. This project will further advance and demonstrate the low-temperature technology by producing: a novel research-grade reactor with four special components: a RF plasma source for vertical alignment of free-standing VACNT/VACNF, a pulsed RF power source with tunable frequency in the GHz range for inductive heating of catalytic nanoparticles,.a nonconducting substrate to eliminate substrate Joule heating; and a system for active cooling of the substrate.

The broader impacts anticipated from the proposed low-temperature synthesis approach will result in a novel research-grade reactor and a multiscale simulator for a direct, low-temperature synthesis of VACNTs at pre-selected locations on the surfaces of temperature-sensitive materials. This approach could lead to a new US-based high-technology manufacturing business.

Title: SBIR Phase II: Nanocomposite Carbon and Graphitic Foams Produced via a Catalytic Approach

Award Number: 0620353
Program Manager: Rosemarie Wesson

Start Date: September 6, 2006
Expires: August 31, 2008
Total Amount: $467,005

Investigator: Seng Tan, sctan@sprintmail.com
Company: Wright Materials Res Co
7155-H Columbia Gateway Drive
Coumbia, MD 21046
Phone: (410)730-8600

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will optimize and scale up the processing of the proposed rapid post-processing and nanocomposite technique for microcellular carbon and graphitic foams to possess superior insulating and conducting properties, respectively. Thermal conductivity and insulation properties may be tailored to either very high or very low. Thermal-mechanical properties of the nanocomposite carbon and nanocomposite graphitic foams after the optimization and scale up research will be characterized. The results of this work will demonstrate that the oxidation stabilization time may be reduced by an order of magnitude, meanwhile enhancing the mechanical properties, as compared to the conventional technique.

Lower processing cost and superior thermal-mechanical properties may result in widespread uses of microcellular nanocomposite carbon and graphitic foams for various applications including high-temperature insulation, space structures, and thermal management applications like heat exchangers.

Title: SBIR Phase II: Novel Polycarbonate Synthesis

Award Number: 0620438
Program Manager: Deepak Bhat

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Scott Allen, sda@novomer.com
Company: Novomer
South Hill Business Campus
Ithaca, NY 14850
Phone: (607)330-2321

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to commercialize a new class of biodegradable plastics from carbon dioxide and epoxides. The technology is based on an innovative catalyst system that significantly increases process efficiency and reduces cost. A novel approach for catalytic polymerization will be developed by directly incorporating carbon dioxide into the polymer, which will transform this greenhouse gas into a synthetic building block of a polycarbonate plastic material, with widespread industrial applications.

The project will demonstrate an alternative use of a significant greenhouse gas as an alternative feedstock for the plastic industry, which has the potential for greatly reducing the Nation's dependence on petroleum-based raw materials. In addition, the polycarbonate materials synthesized using the novel process will beneficially impact a number of industries, such as specialty adhesives, investment casting, ceramic binders and biomedical applications.

Title: SBIR Phase II: Compact, Lightweight Flexible Fuel Reformer for Solid Oxide Fuel Cells (SOFC)

Award Number: 0548677
Program Manager: Rosemarie Wesson

Start Date: January 23, 2006
Expires: February 29, 2008
Total Amount: $473,502

Investigator: William Whittenberger, waw@catacel.com
Company: Catacel
7998 Gotham Rd.
Garrett, OH 44231
Phone: (330)468-4984

Abstract:

This Small Business Innovation Research (SBIR) Phase II project demonstrates a flexible fuel reformer (FFR) that employs unique mechanical construction and operation to enable extended catalyst life in the presence of sulfur-containing heavy fuels. The FFR utilizes a low-cost heat exchanger that is constructed from metal foil and coated with a dual-function sulfur-tolerant catalyst. Combustion and steam reforming reactions occur simultaneously on opposite sides of the foil, allowing excellent heat transfer. Cycling the combustion and reforming reactions regenerates the catalyst by burning off carbon and sulfur deposits, resulting in continuous hydrogen production with low steam consumption. Selected catalyst formulations will be evaluated in the laboratory to understand their performance at conditions expected during both reforming and combustion. A 100 hour demonstration of a 1kw FFR that continuously produces hydrogen of a uniform composition from diesel fuel will complete the project.

The innovation demonstrates a new method of steam reforming, which shows high potential to yield a viable scheme for producing hydrogen from commercially available fuels. The FFR can operate with a variety of liquid fuels, including gasoline, diesel fuel, and jet fuel. Near-term SOFC commercial opportunities include fuel cell powered auxiliary power units for commercial trucks, aircraft, and military applications.

Title: SBIR Phase II: Solid Acid Catalyst with Optimally Distributed Active Sites

Award Number: 0548636
Program Manager: Rosemarie Wesson

Start Date: January 4, 2006
Expires: December 31, 2007
Total Amount: $513,600

Investigator: Mitrajit Mukherjee, mmukherjee@exelusinc.com
Company: Exelus, Inc.
99 Dorsa Ave
Livingston, NJ 07039
Phone: (973)740-2350

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a practical, cost-effective solid-acid catalyst alkylation technology, which will be an economically viable replacement for current alkylation processes, which use toxic liquid acids such as HF and H2SO4. The new technology will significantly reduce capital cost and operating expenses by using a novel multifunctional solid-acid catalyst that produces high-octane ultra-clean gasoline in a simple fixed-bed reactor. The multifunctional solid-acid catalyst significantly outperforms conventional solid-acid catalyst both in terms of catalyst activity and long-term stability. The octane number of the alkylate product obtained using this new catalyst is substantially higher than that obtained using a conventional solid-acid catalyst.

Fifty refineries in the US use hydrofluoric acid (HF) in their alkylation units. The new "green" iso-paraffin alkylation technology is an economically viable alternative to HF catalyzed processes, which would eliminate such risks posed by toxic liquid acids. The multifunctional catalyst promises significantly improves yields and selectivities, minimizing waste by-products and disposal problems associated with liquid acids, and reduces CO2 emissions.

# Photo/Electrochemical Applications

Title: STTR Phase II: Photochemically Switched Chiral Materials for Chiral Nematic Displays

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| Award Number: | 0750379 |
| Program Manager: | Cheryl F. Albus |
| Start Date: | February 15, 2008 |
| Expires: | January 31, 2010 |
| Total Amount: | $500,000 |


Investigator: J. William Doane, bdoane@kentdisplays.com
Company: Kent Displays Inc
343 Portage Blvd
Kent, OH 44240
Phone: (330) 673-8784



Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop an extremely low cost photodisplay for stored value cards such as gift cards, payroll and income support cards where, for the first time, the value of the card and other information can be displayed to the user updateable with each use. The enabling display technology based on photo switchable chiral materials provides displays that are thin, flexible, rugged, and above all, of such low cost that they add little to the cost of a card. Such photodisplays can provide a high resolution image without the need and cost of drive and control electronics necessary for electronic displays. The photodisplays are optically updated by a display writer in which images such as, numerical, bar codes, and other digital data can be repeatedly updated. The broader impact/commercial potential from this technology will advance the basic and applied science of photochemical chiral compounds for use in liquid crystalline materials by designing, synthesizing and studying new compounds to exploit their unique optical and electro optical effects. Thin, flexible photodisplays developed from these materials are similar to a photographic film, but with the advantage that the image can be erased, rewritten, hidden from view and made to reappear. The photodisplay films have the properties of an electronic display in which the image can be changed but without the driving electronics that forces electronic displays out of many markets. A further advantage of the photodisplay is that it can be mass produced by continuous roll-to-roll manufacturing equipment of the type already developed for the label industry. The photodisplay therefore opens new display markets in many applications such as stored value cards, point of purchase signs, identity and security tags, signage and many other uses where updatable displays were not possible before because of cost, bulkiness and inflexibility of existing electronic displays.

Title: SBIR Phase II: Cost-Effective Manufacture of High-Power Li-Ion Batteries for NGV

Award Number: 0349621
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $499,900

Investigator: Thomas Kaun, kauntd@juno.com
Company: InvenTek Corporation
320 Willow Street
New Lenox, IL 60451
Phone: (815)483-9564

Abstract:

This Small Business Innovative Research (SBIR) Phase II project proposes a prototype Lithium-ion battery that has inherent cost advantages for a NGV FreedomCar and hybrid electric vehicle, HEV, requiring compact pulse-power. The unique rolled-ribbon cell can meet the cost requirements and deliver thousands of pulses and recharges. The battery design projects power at 2-4kW/kg and power density at 7.5kW/liter similar to an ultracapacitor, with 20 times greater specific energy at 100- 120Wh/kg .

The rolled-ribbon design is a technology that enables US producers to compete by lowering the materials requirement, packaging and safeguard costs of a large high-power battery. It fulfills the need for high power at low cost. In addition, this disc-shaped design exhibits excellent passive thermal management with inherent safety. Gasoline savings will reduce air pollution and oil imports.

# Separations Technology

Title: SBIR Phase II: New Synthetic Approaches to Higher Performance, Lower Cost CO2/CH4 Gas Separation Membranes

Award Number: 0750637
Program Manager: Cheryl F. Albus

Start Date: January 15, 2008
Expires: December 31, 2009
Total Amount: $523,994

Investigator: Earl Wagener, ewagener@bellsouth.net
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a new gas separation polymer membrane technology created in Phase I to significantly improve the ability to separate carbon dioxide from methane. Successful utilization of this new technology to separation of these commercially important gases will provide better performance at lower cost than current methods for separating carbon dioxide and methane. The approach to this problem involves construction of new-to-the-world polymer architecture. The monomer units, which are the building blocks to the polymer membranes desired, will be individually designed to pass carbon dioxide molecules through the membrane faster than methane molecules. The broader impact/commercial potential from the technology developed in the project will be a commercially robust membrane able to resist degradation under operation in real field conditions, which will lead to the production of prototype gas separation modules for field testing and will further expand applications to other gas separations such as oxygen and nitrogen.

Title: SBIR Phase II: Catalytic Nanochannel Reactor Arrays for Fuel Reforming

| | |
|---|---|
| Award Number: | 0724408 |
| Program Manager: | Rathindra DasGupta |
| Start Date: | September 1, 2007 |
| Expires: | August 31, 2009 |
| Total Amount: | $500,000 |


Investigator: Dmitri Routkevitch, droutkevitch@synkera.com
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Abstract:


The Small Business Innovation Research (SBIR) Phase II project proposes to develop and commercialize advanced nanochannel array reactors for efficient and cost-effective fuel reforming for fuel cells and other applications. Conventional reformers have significant performance, size, reliability and cost issues that prevent broad-scale introduction of polymer electrolyte membrane (PEM) fuel cell systems, especially in the portable power market segment. To overcome these limitations, a highly innovative approach based on the nanoporous ceramics is being pursued to create ultra-light and ultra-compact reactors. That approach was successfully validated during Phase I. The results unequivocally demonstrated the feasibility of methanol reforming and confirmed the strong competitive advantages of the proposed architecture over conventional reactors.

The Phase II aims to develop application-specific reactor prototypes and to initiate their integration into PEM fuel cell systems. The expected outcome will be a manufacturing technology for low-cost and compact yet highly efficient and reliable reactors for point-of-use hydrogen generation. This technology has a potential to facilitate the development of more affordable fuel cell power system for broader government, commercial and consumer applications, especially in the portable power (0.1-1kW) market segments, and will benefit our society by contributing to energy security and availability of environmentally friendly energy solutions.

Title: SBIR Phase II: Low-cost Ceramic Membranes for Drinking Water Treatment

Award Number: 0724326
Program Manager: Rathindra DasGupta

Start Date: September 1, 2007
Expires: August 31, 2009
Total Amount: $500,000

Investigator: Christopher Hoffman, hoffman@ceramem.com
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Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop a novel approach for fabrication of ceramic membranes that would provide a significant reduction in fabrication costs. Membrane filtration is becoming an important process for drinking water treatment. Much of this growth is due to development of low-cost polymeric membranes that can compete economically with traditional methods of water treatment. Ceramic membranes can be used to achieve the same level of water quality as provided by polymeric membranes, with several distinct advantages: ceramic membranes provide higher fluxes, reduced fouling rates, and longer lifetimes with fewer integrity issues. Historically, ceramic membranes have not been competitive with traditional methods or polymeric membranes due to high manufacturing costs. Recent developments that offset the high manufacturing costs have allowed ceramics to be competitive with polymerics in some markets. By developing the proposed innovation, ceramic membrane module cost will be further reduced, giving ceramics an advantage over currently employed polymeric membranes.

Increased membrane usage in water treatment will lead to safer drinking water for the 90% of Americans that receive their water from community water systems. For the water systems that employ ceramic membranes, there will be less cost, maintenance, and concerns of system integrity failures. Additionally, the technology developed in this program would be applicable to ceramic microfiltration and ultrafiltration membranes for all food, beverage, chemicals, pharmaceutical, energy, wastewater, and water applications. Energy efficient separation processes requiring robust membranes would become more economically viable, potentially lowering the 4,500 T Btu of energy consumed annually for industrial separations.

Title: SBIR Phase II: High Flux Metal-Ceramic Hydrogen Separation Membranes

Award Number: 0548757
Program Manager: Rosemarie Wesson

Start Date: March 6, 2006
Expires: February 29, 2008
Total Amount: $422,292

Investigator: Dimitri Routkevitch, droutkevitch@synkera.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project targets development of an innovative membrane for separation of hydrogen. These membranes are based on an innovative nanostructured architecture and a unique fabrication process. The proposed approach enable an ultra-thin Pd separation layer, which can support a 10X or greater increase in hydrogen flux over the state of the art, with no reduction in hydrogen selectivity and superior reliability. The performance of the prototypes will be thoroughly validated in actual operating environments.

The expected result of the proposed work is a viable technology for the production of robust hydrogen separation membranes with advanced performance, superior reliability and lower cost. Such an enabling technology could facilitate a variety of current applications, such as hydrogen separation for fuel cells and point-of-use hydrogen purification. With further research and development, hydrogen could also serve as an alternative source of energy for heating and lighting homes, generating electricity, and transportation.

Title: SBIR Phase II: High-Efficiency Poly(Tetrafluoroethylene) (PTFE) Membranes

Award Number: 0522198
Program Manager: Rosemarie D. Wesson

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $505,994

Investigator: Hilton Pryce-Lewis, hilton@gvdcorp.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the need for improved filtration in the semiconductor industry, where exceptional chemical stability, thermal stability, and purity make poly(tetrafluoroethylene) (PTFE) the media of choice. GVD has successfully demonstrated unprecedented filtration efficiencies for the retention of 20 nm size particles using PTFE membranes. The asymmetric structure of the GVD membranes avoided > 90% of the increase in energy utilization traditionally associated with improved filtration efficiency. The asymmetry was created using GVD's unique initiated chemical vapor deposition (iCVD) technology. In Phase II, GVD will demonstrate large area production at a competitive cost by designing, building, and operating an iCVD roll-to-roll coater, the first of its kind in the world.

The improved economics of roll-to-roll manufacturing will permit entry of a new family of PTFE membranes into a variety of markets where improvements in product quality and efficacy can be enabled by advanced filtration. These membranes can also address the separations needs of emerging industries such as nanotechnology, where unit operations at the nanometer scale still remain a challenge. More broadly, iCVD technology can produce composite membranes which marry the beneficial surface properties of PTFE with the improved mechanical strength and performance of a less costly base membrane. This could result in a family of membranes with multifunctional separations capabilities that do not sacrifice cost for efficacy.

Title: SBIR Phase II: Multilayer Membrane-Based Permeation for Cost-Effective Olefin/Paraffin Separation

Award Number: 0421976
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $500,000

Investigator: Yingjie Qin, yjqin1@yahoo.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on olefin/paraffin separation. Ethylene and propylene are produced in larger quantities than any other organic chemicals. A new membrane system is under development, which provides high olefin recovery, extremely high olefin fluxes, drastically improved olefin/paraffin selectivities over conventional facilitated transport membranes, and long-term operation stability. During Phase II, a laboratory prototype will be demonstrated. Integration of this membrane system into an olefin plant will drastically improve ethylene, propylene and butadiene in a more energy efficient and economical way. Polymer-grade olefins can be easily produced with this membrane process with minor post-treatments.

Economic analysis showed that incorporation of the proposed membrane system into an ethylene plant can drastically reduce capital and operating costs of the entire plant. As a result of reduced power consumption, this membrane process will correspondingly reduce emission of greenhouse gas CO2.

Title: SBIR Phase II: Novel Lightweight, Low Cost Fuel Cell Membrane Electrode Assemblies

Award Number: 0422186
Program Manager: Rosemarie D. Wesson

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $500,000

Investigator: Anuncia Gonzalez-Martin, anuncia.gonzalez-martin@lynntech.com
Company: Lynntech, Inc
7607 Eastmark Drive, Suite 102
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project concerns the development of proton exchange membrane (PEM) fuel cells with improved power density (kW/L) and specific power (kW/kg), reduced cost, and simplified assembly. A new type of electrically conductive polymer sheet has been developed that can be used as both, gas diffusion layer and bipolar plate in PEM fuel cells. The material is light, inexpensive, highly conductive, chemically inert, easy to process, and corrosion resistant. The use of this conductive polymer in PEM fuel cells will reduce cell weight, volume, and cost, while simplifying cell assembly. During the Phase II project, the conductive polymer materials will be optimized as bipolar plates and gas diffusion layers, and they will be integrated into PEM fuel cell stacks.

The new material has significant commercial potential because of its multi-functionality, lightweight, effectiveness, and low cost. The potential customers are developers currently working with PEM fuel cells operating on hydrogen, methanol, and reformed hydrocarbon fuels. This includes all of the automotive manufacturers and the manufacturers of stationary fuel cell power systems.

Title: SBIR Phase II: Separation of Light Hydrocarbon Mixtures by Pervaporation

Award Number: 0349776
Program Manager: Rosemarie D. Wesson

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Ingo Pinnau, ipin@mtrinc.com
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Abstract:

This Small Business Innovative Research (SBIR) Phase II project focuses on the separation of light hydrocarbon mixtures-specifically, propylene/propane mixtures-by membrane pervaporation. A preliminary analysis indicated that the recovery of propylene from reactor purge gas streams using separation systems based on these materials is economically attractive. These purge streams are numerous-more than 400 streams of this type exist worldwide - but too small to be treated by distillation. Nonetheless, the amount of propylene involved is substantial. An estimated 685 million pounds of propylene are recoverable from reactor purge streams in the United States alone. In the Phase II project, the current best membrane will be optimized, scaled up and formed into bench-scale membrane modules.

This project involves the separation of propylene/propane mixtures; application to the separation of many other mixtures is possible. The proposed membrane pervaporation process addresses a market need - the economical recovery of propylene, a valuable chemical feedstock, from propane-containing waste gas streams that cannot be satisfied by alternative technologies.

Title: SBIR Phase II: Development of an Electrically Regenerated Diesel Particulate Filter

Award Number: 0349683
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $499,326

Investigator: Luke Ferguson, harmonics@hmnx.com
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Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop an effective diesel particulate filter (DPF) that can be reliably regenerated with integral electrical heating elements. A fabrication process will also be developed that ensures economical manufacturability of the filter in high volumes. The greatest challenge in the design of reliable particulate filter and trap systems has been achieving adequate regeneration, or the oxidation (burning) of particulates that accumulate in the filter substrate diesel engine operation. The objectives of Phase II will include designing an actively regenerating filter structure, optimization of EC material for use in the DPF substrate, development of manufacturing processes suitable for scale up to volume production, construction of prototype DPF substrates, testing, and ultimately integration of the EC-integrated DPF into a functioning DPF system ready for field testing. The anticipated result of the Phase II project is an actively regenerating EC-integrated DPF prototype substrate suitable for field testing in the US EPA.s Voluntary Retrofit Program. The EC-integrated DPF will fulfill new emissions controls scheduled to take effect in 2007.

There is presently a compelling need for a compact, simple-to-maintain, durable, and effective diesel particulate filter for both new and existing diesel- powered vehicles. The EC-integrated DPF could potentially reduce diesel particulate emissions by 9.5 million tons annually, preventing thousands of premature deaths due to respiratory illnesses, cancer and heart disease.