Detectors/Sensors/Instruments

Title: SBIR Phase II: Integrated Microsensors for Detection of Aqueous and Gas Phase Volatile Organic Compounds

Award Number: 0078726
Program Manager: Winslow L. Sargeant

Start Date: May 1, 2002
Expires: April 30, 2004
Total Amount: $400,000

Investigator: Eugene C. Aquino, arcova@swva.net
Company: American Research Corp of VA
PO Box 3406
Radford, VA 241433406
Phone: (540)731-0655

Abstract:

This Small Business Innovation Research (SBIR) Phase II project involves development of an integrated sensor system that will accurately and rapidly measure small quantities of volatile organic compounds (VOCs) both in air and in aqueous environments. At present, no inexpensive sensor system is sufficiently sensitive and rugged for use in continuously monitoring of VOCs in underground water streams, soil, effluent discharge, fugitive emissions and in spent liquid and vapor streams. To capture this business opportunity, this project involves the development of low-cost continuous organic chemical sensors based on the change of fluorescence of dyes embedded in polymeric and sol-gel thin films. This program is innovative in combining sensitive diode laser-excited fluorescence with total internal reflection methods of analysis to provide a continuous monitor of VOCs. The Phase I research program was successful in demonstrating the feasibility developing several highly sensitive polymer/dye films for use in detection of aqueous and gaseous phase VOCs. Detection limits in the part-per-billion (ppb) range for both aqueous and vapor phase trichloroethylene were achieved using fluorescence detection spectroscopy. The Phase II research and development program will accomplish the feasibility demonstrated in Phase I by developing a turnkey sensor system for multiple chemical analysis.

The Phase II Research Objectives include synthesis of polymer and sol-gel solid matrices with pendant functional groups, development of a fluorescence monitoring array and algorithms for multi-chemical analysis, design and integration of miniaturized total internal reflection fluorescence array instrument, acquisition of families of test data to establish instrument specifications, and demonstration of the total-internal reflection fluorescence instrument at environmental remediation facilities and a water treatment plant.

This sensor platform together with sensitive polymer/dye films is significant in providing rapid on-site identification and quantification of volatile organic compounds and environmental pollutants in groundwater, soil, effluent discharge and fugitive emissions.

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: 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: Novel Radial Magnetic Field Actuator for Fully Flexible Electromechanical Valve

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
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 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: 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: Advanced Phased Array Ultrasound Instrument for Nondestructive Evaluation (NDE)

Award Number: 0450553
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2007
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 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, 2007
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: 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: 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: 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 Device for Measuring Electric Field Strength from Dropsondes and Radiosondes

Award Number: 0450497
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2007
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 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: 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: 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: Development of an Automated Ballast Water Exchange Monitoring System Using 'Through-the-Hull' Acoustic Modems

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: Multi-Coil Surface NMR Instrumentation and Software for 3-D Groundwater Imaging

Award Number: 0450164
Program Manager: Muralidharan S. Nair

Start Date: February 1, 2007
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 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: Infrasonic Avalanche Identification

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: 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: Composite Structural Damage Self-Sensing via Electrical Resistance Measurement

Award Number: 0422146
Program Manager: Muralidharan 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: Development of a Low-Cost Harsh Environment Vibration Sensor

Award Number: 0422069
Program Manager: Muralidharan 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: Low-Pressure Microplasma Gas Analyzer

Award Number: 0422076
Program Manager: Muralidharan 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: Muralidharan 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 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: Self-Imaging Transmitters for Remote Sensing

Award Number: 0349771
Program Manager: Muralidharan 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 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.

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

Award Number: 0349694
Program Manager: Muralidharan 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: Delta-Sigma All-Digital Magnetometer

Award Number: 0321647
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $499,991

Investigator: James Deak, jdeak@nve.com
Company: NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and prototype a single-chip magnetometer based on an innovative approach to digital magnetic sensors. The traditional approach combines a physical sensor having an analog output with an electronic analog-to-digital converter. In this sensor, the analog-to-digital conversion occurs in the physical mechanism of the sensor itself. With this approach only inexpensive digital electronic circuits are needed to complete the sensor system, resulting in a robust design that can easily be manufactured. The unique properties of sub-micron sized magneto-resistive sensor elements are used. The small size of these elements allows only two magnetic states, i.e. the magnetic state represents a binary digit that is a function of the external magnetic fields. Using concepts borrowed from over-sampling delta-sigma analog-to-digital converters, it is possible to measure the analog magnitude of a magnetic field by repeatedly interrogating the magnetic state of the bit. Using the principles of delta-sigma converters, including noise shaping feedback and high over-sampling ratios, high resolution and an inherently linear response can be achieved.

This single-chip digital magnetometer would be a revolutionary advance in sensor technology since it is based on standard wafer-level integrated circuit processing techniques. It will thus be much smaller and cheaper to fabricate than existing equivalent magnetic sensor systems. The highly integrated nature of this product, low power consumption and the digital output will make it extremely attractive for remote and/or bussed sensor applications. Applications include digital compasses, geomagnetic surveying equipment, vehicle sensors for traffic control, intrusion detection, currency/document validation and portable biomedical assay devices.

Title: SBIR Phase II: Lobster-Eye X-Ray Imaging Sensor

Award Number: 0321674
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount $499994
Investigator: Paul Shnitser, pshnitser@poc.com
Company: Physical Optics Corporation
20600 Gramercy Place, Bldg 100
Torrance, CA 90501
Phone: (310)320-3088

Abstract:

This Small Business Innovation Research Phase II project will develop an innovative Lobster Eye X-ray Imaging Sensor (LEXIS) for the observation of x-ray precipitation during long-term high-altitude balloon flights. The pinhole x-ray cameras currently used in such flights have very limited spatial resolution, and need significantly improved sensitivity. The proposed sensor will have a large-field-of-view x-ray lens fabricated of long metal microchannels. With this lens, the LEXIS will have significantly higher angular resolution and higher sensitivity than pinhole cameras. Phase II efforts will culminate in fabrication and testing of a full-scale LEXIS prototype capable of focusing on both soft and hard x-rays. LEXIS will bring unprecedented resolution to the investigation of boreal sources of x-rays. The proposed research will yield a new kind of x-ray optics that overcomes the limitations and shortcomings of current instruments. The lobster eye optics will dramatically improve the resolution of security screening x-ray equipment. It will enhance the penetration capability of screening equipment, more reliably detecting hazardous or illegal materials within thick metal containers.

The technology to be developed for fabricating lobster eye optics will be applied to the fabrication of antiscatter grids for medical x-ray detector arrays.

Title: SBIR Phase II: Carbon Isotope Ratiometer

Award Number: 0320470
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $500,000

Investigator: Manish Gupta, mglgr@mindspring.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 Phase II project involves the development of a robust, field-portable gas analyzer capable of determining the carbon isotope ratio of carbon dioxide emitting from deep-sea hydrothermal vents. These vents provide access to water that has been trapped under the ocean in a unique, anaerobic environment that is devoid of photosynthesis and emulates the conditions believed to exist under the ice crusts of Europa and Callisto, beneath the surface of Mars, and on primordial Earth. Preliminary carbon isotope studies suggest that biological activity takes place in such an environment and novel instrumentation is sought to provide further evidence. The Phase II analyzer, based upon our proprietary Off-Axis ICOS technology, will determine the isotope ratio in-situ to within 1 angstrom, which is sufficient to discriminate between biogenic and geological carbon sources, and may provide evidence for a Subsurface Lithotrophic Microbiological Ecosystem (SLiME). The proposed instrument, which will interface with the Medusa seafloor sampling system developed by NASA Ames, will operate autonomously and be able to withstand the harsh underwater conditions found near deep-sea vents. The Phase II work will involve scientific development to enhance the prototype's specificity, deep-sea packaging to permit underwater deployment, and testing to demonstrate the analyzer's capabilities.

One of the most promising markets for our novel Off-Axis ICOS technology is in industrial process control (IPC). The Phase II instrument can be directly converted to an IPC analyzer due to its ability to autonomously operate in harsh environments, integration of compact control system, and use of sophisticated chemometric algorithms. Within the $1.67B IPC market, the targeted markets will be those in which current technology is either too expensive or insufficient, such as the niche in the fast analysis of acetylene contamination in ethylene.

Title: SBIR Phase II: Ultra-Sensitive Charge-Coupled Device (CCD) Technology: A Photon Counting Camera

Award Number: 0320531
Program Manager: Winslow L. Sargeant

Start Date; November 15, 2003
Expires: October 31, 2005
Total Amount: $474,174

Investigator: Mark Meisner, mmeisner@titanoptics.com
Company: Titan Optics & Engineering
7830 North Paseo Monserrat
Tucson, AZ 85704
Phone: (520)743-8315

Abstract:

This Small Business Innovation Research Phase II project will result in an innovative, technologically advanced, imaging system--with the potential of capturing and counting individual photons. The imaging system will be a compact avalanche-gain, charge-coupled device digital camera. The technology generated from this research effort will profoundly benefit many detection and discrimination applications. The innovation will offer high-photoresponse from the deep ultraviolet to the near infrared in very Low-Light-Level, as well as photopic light conditions. In addition, the camera system will have solid-state reliability without typical intensifier imaging tube limitations, such as, image burn-in and blooming. In short, the innovation will have significant cost savings over current conventional multi-spectrum imaging systems and will offer enhanced imaging performance.

A possible research, military, law enforcement, or homeland security application for the camera will be black-on-black detection--that is, when faint objects are difficult to discriminate from the background. This far-reaching technology will also be beneficial for many non-military applications: such as, Low-Light-Level physical, deep space and forensic sciences, as well as, photopic (daylight) medical and life sciences. In summary, the imaging system will have the most impact where real-time and lowest possible noise is required.

Title: SBIR Phase II: On-Line Optoelectronic Sensing of Molten Metal Chemistry

Award Number: 0321305
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $511,982

Investigator: Leigh Peritz, lapwte@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 develop a highly innovative, high-speed optoelectronic sensor system capable of continuously monitoring molten metal alloy compositions during casting and melting operations. The goal is to design and construct a commercially-viable sensor system capable of performing highly-accurate quantitative measurement of molten aluminum alloy compositions in an aggressive industrial setting. Development of this sensor is among the highest priority technology needs identified by both the metal casting industry and the aluminum industry in their industry roadmaps of the future. In order to effectively compete, U.S. metal industries must increase their use of low cost scrap and must also find ways to increase production efficiency. The proposed sensor will acquire critical compositional data thousands of times faster than current commercial methods and will operate on a real-time basis without the need to place the sensor in contact with the molten metal. At these speeds, a melt shop could produce one extra metal production batch ('heat') per day, resulting in a 15% increase in productivity. The incorporation of this innovative optoelectronic sensor system will result in a tremendous increase in production efficiency, providing for a 15% gain in productivity. Thus, the $30 billion aluminum smelting industry could realize a $4.5 billion increase in production output with little or no additional capital investment other than the cost of the sensor system. In fact, the most immediate broader impact of the proposed activity will be to enhance U.S. competitiveness of aluminum casters and smelters because of this productivity improvement. In addition, the proposed technology will have a significant positive effect on process control and quality assurance, thereby providing further competitive advantages.

Broader impact to our society will also be brought about through reduced emissions and energy savings resulting from shorter melting cycles. Similar improvements would be possible for zinc, copper, brass, bronze, iron, ceramic and glass industries that also have need for a similar continuous sensor system to monitor and control composition and quality on a real-time basis.

Title: SBIR Phase II: Ultrasonic Inspection of Internal Bond Strength in Paper Products

Award Number: 0237475
Program Manager: Winslow L. Sargeant

Start Date: April 1, 2004
Expires: March 31, 2006
Total Amount: $499,948
Investigator: Gary Wood, tceltd@earthlink.net
Company: SoniSys, LLC
1734 Cooper Lake Dr.
Smyrna, GA 30080
Phone: (414)226-9925

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of an ultrasound technology that measures internal bond strength (IBS) in paper and paperboard materials. IBS is a very important quality control parameter because it provides an assessment of bond strength between wood pulp fibers and between plies in multi-ply grades. Two standardized test methods are widely used throughout the paper industry to evaluate IBS: Z-direction tensile (ZDT) and Scott Plybond. However, these methods are problematic in many ways: they require destructive testing, are technically deficient, are labor and time intensive, and cannot be integrated into automated paper testing equipment in quality control laboratories. Since the propagation of ultrasonic waves in paper is sensitive to bonding between fibers, an ultrasonic IBS method has the potential to address all shortcomings of existing methods. Preliminary results gathered during Phase I confirmed correlations between ultrasonic IBS, ZDT and Scott Plybond. Phase II involves additional work on the ultrasound technology to improve its accuracy, reliability, and universality. Also, it includes the development of an engineering prototype instrument for paper mill quality control testing, a comprehensive statistical study comparing ultrasonic IBS, ZDT, and Scott Plybond, and the drafting of a standardized test method.

The worldwide market of ZDT and Scotty Plybond Instruments is estimated at 400 units, largely in QC labs. Expected sales are $11M. Commercialization of a few hundred units would be considered as a tremendous success in the paper industry. The successful deployment of ultrasonic IBS in the QC lab could support the future development of real-time IBS monitoring during production.

Title: SBIR Phase II: A Trace Contaminant Sensor for Semiconductor Process Gases

Award Number: 9983349
Program Manager: Winslow L. Sargeant

Start Date: July 1, 2000
Expires: December 31, 2002
Total Amount: $400,000
Investigator: David Bomse, dbomse@swsciences.com
Company: Southwest Sciences Inc
1570 Pacheco Street, E-11
Santa Fe, NM 87505
Phone: (505)984-1322

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will test a novel sensor for real-time detection of trace impurities important in micoelectronics manufacturing. Gas feedstock quality is an important measurement for any process control strategy because contamination at the part-per-billion (ppb) level may limit product yield. This project's technique, called wavelength modulated photo-acoustic spectroscopy, has the potential to achieve these detection levels at a significantly lower cost than is possible with current technology. This technology is compatible with both corrosive and non-corrosive gases. The Phase II will construct and field test a prototype trace moisture sensor that is expected to achieve 10-ppb detection limits in corrosive gases such as hydrogen chloride and ammonia.

Potential commercial applications are expected in on-line removal of trace impurities important in micoelectronics manufacturing.

Title: SBIR Phase II: Development of High-Tc Superconducting Quantum Interference Device (SQUID) Magnetometers for Unshielded Operation

Award Number:	9983502
Program Manager:	Winslow L. Sargeant
Start Date:	April 1, 2000
Expires:	March 31, 2002
Total Amount:	$399,974

Investigator(s) Mark DiIorio, markd@magnes.com
Company: Magnesensors, Inc. (MSI)
9717-A Pacific Heights Boulevard
San Diego, CA 92121
Phone: (619)458-5752

Abstract:

This Small Business Innovation Research Phase II project is aimed at developing an ultra-sensitive magnetic sensor technology that is capable of operation in an unshielded environment. These compact sensors will be based on superconducting quantum interference devices (SQUIDs) that are fabricated from high temperature (high-Tc) superconducting materials. A collaborative effort between MagneSensors and U.C. Berkeley will employ novel design and materials processing solutions to produce high-Tc SQUIDs operating in ambient fields with an unprecedented level of sensitivity. The program will test the developed sensors on real-world applications at both low and high frequencies to demonstrate operation in the presence of large background magnetic field interference. This new enabling technology seeks to overcome the limitations in sensitivity, bandwidth, size, and spatial resolution, which restrict the more widespread application of present conventional magnetic field sensors. The eventual goal is the development of a low-cost, portable system with much greater sensitivity than is available with any other instrumentation.

This technology will enable the development of an entirely new generation of instrumentation that will find use in a wide variety of applications. Such applications include non-destructive evaluation of cracks and corrosion in aircraft, inspection of integrated circuits, homogeneous immunoassays and DNA probes using magnetic labels, geophysical surveying, environmental monitoring, detection of unexploded ordnance, diagnosis of intestinal ischemia, and screening for cardiac arrhythmias The potential market size for some of the applications reaches over $1 billion.

Title: SBIR Phase II: Very Large Scale Integrated (VLSI) Implementations of Neuromorphic Virtual Sensors for Intelligent Diagnostics and Control

Award Number: 9981852
Program Manager: Rosemarie D. Wesson

Start Date: May 15, 2000
Expires: November 30, 2003
Total Amount: $600,000
Investigator: Alexander Moopenn, alex@mosaixtech.com
Company: Mosaix, LLC
176 Melrose Avenue
Monrovia, CA 91016
Phone: (626)305-5550

Abstract:

This Small Business Innovation Research Phase II project will develop a novel, compact, low-cost adaptive neuroprocessor chip for advanced diagnostics and control in the next generation of low emission "environmentally friendly" vehicles. This digital CMOS VLSI electronic neural network device combines on-chip integration of a fully reconfigurable feed-forward/time-lagged recurrent neuroprocessor module with backpropagation-through-time (BPTT) weight training module. Specifically, the technical objectives are to develop a neuroprocessor chip suitable for direct insertion into an automobile's electronic engine computer (EEC). This stand-alone electronic neural network will function as a co-processor to the EEC's central processing unit (CPU), off-loading it of computationally intensive neural based tasks and enabling event rate automotive diagnostics and control. The neuroprocesor is programmable, allowing it to execute multiple neural network applications on-the-fly; is capable of event rate computational throughput (<<50 microseconds) per appli-cation; is a system-on-a-chip (SOAC) design (stand-alone neuroprocessor with on-chip weight training); and cost effective (<$5/chip). On-chip adaptation will not only enable adaptive control, but will address the problem of fixed weight networks - namely that of enabling on-board self-calibration of electronic and mechanical systems for optimal performance.

Applications areas of the proposed neural network formalism cover the following industry sectors: (1) advanced diagnostic and control strategies for low emision vehicles & hybrid electric vehicles in the automotive industry; (2) prognostics and diagnostics of jet engines for the aerospace industry; (3) and adaptive equaliza-tion of cell phones for superior noise rejection in the communication industry.

Title: STTR Phase II: Microsensors for In-Situ, Real-Time Detection and Characterization of Toxic Oganic Substances

Award Number: 0080128
Program Manager: Om P. Sahai

Start Date: August 1, 2000
Expires: January 31, 2003
Total Amount: $448,547
Investigator: James Carter, James_Carter@eeg-inc.com
Company: Environmental Engineering Group, Incorporated
11020 Solway School Road
Knoxville, TN 37931
Phone: (423)927-3717

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project has as the primary focus the development and commercialization of a novel microsensor for the in-situ, real-time detection of toxic organic chemicals. The proposed microsensor will be capable of operating under field conditions, with sufficient sensitivity to permit high detection rates, and with sufficient selectivity to prevent high false alarm rates. Using a revolutionary photo-thermal concept, the detector will operate with both high chemical selectivity and a less than parts per billion sensitivity. The technological concept of the proposed detector (CalSpec) won the 1998 R&D 100 award. The chemical sensitivity can be substantially enhanced to a less than parts per trillion level by simply operating in an integrating chemical detection mode.

The objective of this research is to demonstrate highly specific, sensitive and selective detection of organic chemical compounds and to develop a multichemical detector which can detect toxic organics with concentrations varying from a few parts per thousand to a few parts per trillion. Sensitive monitoring and detection is an area of continuing importance to EPA, DOD, DOE and other federal agencies. The CalSpec detector could be used in a variety of applications, including process monitoring and control, environmental compliance (including emissions monitoring), ambient air monitoring, airport security, personal dosimeters for toxic gases or metal vapor, and smoke and fire constituent detection.

Title: SBIR Phase II: Disposable Infrared Water Vapor Sensor

Award Number: 9983307
Program Manager: Winslow L. Sargeant

Start Date: May 15, 2000
Expires: April 30, 2003
Total Amount: $749,890
Investigator: Edward Johnson, ejohnson@ion-optics.com
Company: Ion Optics, Inc.
411 Waverly Oaks Road, Suite 144
Waltham, MA 02154
Phone: (617)788-8777

Abstract:

This Small Business Innovation Research Phase II project will develop a prototype instrument ready for field-testing. Phase I research demonstrated the feasibility of a radically simpler infrared gas sensor based on MEMS photonic bandgap structures. This instrument will sensitive enough to compete with water vapor measurements made by much larger, more complex equipment, but cheap enough to be treated as a 'throw-away' device. Unlike current infrared instruments, assembled from many discrete components, it features a highly integrated 'sensor-on-a-chip' employing advanced surface modification technology and semiconductor fabrication methods. This new, integrated approach replaces discrete-component instruments in much the same way integrated circuits have superseded distributed elements in electronic systems. In addition to the potential for atmospheric research applications, the proposed device is a stepping-stone to next-generation gas sensors for environmental and industrial monitoring. The phase I project showed proof-of-concept while establishing sensitivity and signal-to-noise performance and developed drive circuits and other components to achieve necessary stability. Most important, this project achieved a breakthrough by demonstrating tunable, narrow-band, emission from a photonic bandgap surface structure.

The proposed device is a simple, low-cost, lightweight alternative to conventional infrared absorption instruments. By reducing weight, complexity, and cost, it opens applications beyond the reach of current infrared instruments. It is the first step towards next-generation gas sensors for indoor air quality, environmental research, and industrial controls.

Title: SBIR Phase II: Advanced Micro-Pixelized Scintillator for Structural Biology

Award Number: 9983337
Program Manager: Om P. Sahai

Start Date: June 1, 2000
Expires: May 31, 2003
Total Amount: $550,000

Investigator: Vivek Nagarkar, vnagarkar@rmdinc.com
Company: Radiation Monitoring Devices Inc
44 Hunt Street
Watertown, MA 02472
Phone: (617)926-1167

Abstract:

This Small Business Innovation Research Phase II project is aimed at developing a novel digital x-ray detector for macromolecular crystallography. This detector is based on a new generation micro-pixelized scintillator optically coupled to a large area digital readout array. The micro-pixelized scintillator will provide a unique combination of very high sensitivity, spatial resolution, and signal to noise ratios resulting in excellent point spread function (PSF), thus improving the quality of the measured Bragg peak data.

When integrated with a large area digital optical detector it will allow a wide dynamic range and substantially enhanced throughput at relatively low costs. In addition to the structural biology application, the proposed detector would find widespread use in instrumentation wherever high-resolution x-ray imaging is used.

Title: SBIR Phase II: Integration and Distribution of Low-Jitter On-Chip Clock for High-Speed Analog-to-Digital Converters

Award Number: 9983361
Program Manager: Winslow L. Sargeant

Start Date: April 1, 2000
Expires: September 30, 2003
Total Amount: $645,271
Investigator: Deepnarayan Gupta, gupta@hypres.com
Company: HYPRES, Inc.
175 Clearbrook Road
Elmsford, NY 10523
Phone: (914)592-1190

Abstract:

This Small Business Innovation Research Phase II project aims to integrate two superconducting technologies (rapid-single-flux-quantum (RSFQ) and long-Josephson junction (LJJ)) to build a wide-bandwidth digitizer with on-chip clocking. The performance of a Flash analog-to-digital converter (ADC) can be enhanced by replacing the external high-frequency clock generator with an on-chip clock with very low timing jitter. In Phase I, we demonstrated an on-chip 10-50 GHz RSFQ clock source using an LJJ resonator with a quality factor of 106. We also built a clock selector circuit that allows the user to select different clock frequencies. We also implemented ballistic transport of SFQ pulses on impedance-matched striplines. In Phase II, we will integrate the high-quality LJJ oscillator along with associated circuitry with a Flash ADC through a hybrid stripline/JTL (Josephson transmission line) clock distribution network. A phase-locked loop (PLL) will be built to synchronize the LJJ oscillator with an external stable low-frequency reference to ensure long-term stability. The LJJ oscillator together with the PLL will constitute a self contained clock module capable of generating 10-100 GHz SFQ clock with femtosecond time jitter. This universal clock module can be used in almost all future superconducting electronic circuits and systems. A transient digitizer instrument capable of sampling rates above 10 GSamples/s is not commercially available today, in spite of a growing demand in fields such as inertial confinement fusion and high-energy physics. HYPRES is developing such an instrument focusing on the $630M/year market for digitizer instruments. Elimination of expensive multi-GHz external clock generators will simplify the digitizer design, lower power consumption, simplify packaging and reduce its cost. Other applications of a wideband ADC include communication signal processors and microscan receivers. A by-product of the Phase II work will be a self-contained multi-GHz clock module that can be used as on-chip clock for a variety of superconducting circuits, including processors for a petaflops-scale supercomputer currently being developed.

The LJJ oscillator coupled with the fluxon sender circuit, developed in Phase I, can be used for building instantaneous clock recovery and data re-timing circuits for handling burst-mode data in data communication networks.

Title: SBIR Phase II: A Self-Triggered Pulse Acquisition System with Greater than 10 GHz Bandwidth

Award Number: 9983345
Program Manager: Winslow L. Sargeant

Start Date: April 15, 2000
Expires: March 31, 2002
Total Amount: $400,000
Investigator: Steven Kaplan, steve.kaplan@hypres.com
Company: HYPRES, Inc.
175 Clearbrook Road
Elmsford, NY 10523
Phone: (914)592-1190

Abstract

This Small Business Innovation Research Phase II project will result in a demonstration of a self-triggered transient digitizer chip containing a flash analog-to-digital converter (ADC) and advanced triggering circuits. The self-triggering circuit designed during Phase I will be improved such that an arbitrary delay can be imposed. This will enable parts of single-shot signals occurring before the triggering point to be captured. The advanced comparator work begun in Phase I will be completed in Phase II to result in an error-correcting comparator with sub-picosecond accuracy. The resulting self-triggering transient digitizer chip will be able to trigger either by the signal itself, or an externally supplied trigger pulse. This generalization of our previous transient digitizer chip, together with the advanced architecture developed under other programs, will operate with greater than 10 GHz input bandwidth, and at a sampling rate of up to 20 GSa/s. The Tektronix SCD-5000 transient digitizer provided the highest bandwidth and performance of any digitizer based on an analog-to-digital converter.

The removal of this product from the market provides a significant business opportunity. Potential customers from the National Ignition Facility and the Relativistic Heavy Ion Accelerator at Brookhaven National Laboratory have expressed interest in our potential product

Title: SBIR Phase II: Wireless Acoustic Emission Technology (AET) Sensor System for Quantitative Nondestructive Evaluation and In Situ Testing of Prestressed Concrete Cylinder Pipe

Award Number: 9984235
Program Manager: Winslow L. Sargeant

Start Date: March 15, 2000
Expires: February 28, 2002
Total Amount: $398,328
Investigator: Will Worthington, will@pipetech.com
Company: Pipeline Technologies, Inc.
1435 North Hayden Road
Scottsdale, AZ 85257
Phone: (602)990-2466

Abstract:

This Small Business Innovation Research Phase II Project will further develop the passive acoustic system to non-destructively pressure test concrete water pipelines. It will locate points of structural weakness in these water pipes to permit reinforcement, and in so doing it will avoid the costs and consequences of catastrophic ruptures. The established goals of the project include: (1) Autonomous Hydrophone System Enhancement - The AH-3 acoustic test system developed and demonstrated during Phase I will be enhanced to incorporate those improvements that will make the system commercially viable; (2) Pipeline Distress Research - The characteristics of concrete pressure water pipe deterioration will be replicated under field conditions in cooperation with one of the major pipe manufacturers. This will provide greater insight into the process of pipe deterioration as well as providing a proving ground for the field testing of the acoustic system; (3) Commercial Feasibility - The research has the potential to greatly prolong the useful life and reliability of the $40 billion U.S. water pipeline infrastructure.

PTI has seen significant growth in revenue fueled in part by commercial acceptance of its early technology.

Title: SBIR Phase II: Development of Self-Sensing Active Control Foil Bearing

Award Number: 9986107
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2000
Expires: July 31, 2002
Total Amount: $385,466

Investigator: Lei Wang, lwang@bcea.com
Company: B&C Engineering Associates, Inc.
411 Wolf Ledges Parkway, Ste 104
Akron, OH 44311
Phone: (330)375-1632

Abstract:

This Small Business Innovation and Research (SBIR) Phase II project will develop a 'Self-Sensing Active Control Foil Bearing' (SSACFB). Through the use of a stack of piezoelectric ceramic elements attached at the lower side of foil elements, the load on the foil element can be determined from the voltage generated by the piezoelectric elements. At the same time, the piezoelectric stack also acts as an actuator to push/pull the foil element from the shaft to increase the loading capacity of the bearing and/or to ensure lift-off at low shaft rotational speeds. The novelty of the concept is in elimination of the sensing system, the integration of sensing and control in a single unit, and the active control of the bearing to provide long-life, lower power loss, and larger loading capacity. In addition, elastic bed and diamond-like coatings on the foil element will be addressed in this proposal. Phase I found the self-sensing and controllability in this bearing to be feasible. Construction and testing of a fully instrumented, prototype self-sensing controllable foil bearing will be performed in Phase II. Potential commercial applications are planned in the $1.5 billion bearing market, which is growing presently at about 11% annually with moderate growth forecasted in the future.

The SSACFB technology is aimed at commercial needs for oilless high-speed controllable bearings. Successful development of SSACFB will impact high speed bearing applications, especially in the aerospace/aeronautic and other high speed precision manufacturing industries.

Title: SBIR Phase II: Improvement of Spatial Resolution in Scanning Microwave Microscopy

Award Number: 0078486
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $396,537

Investigator: Andrew Schwartz, Schwartz@neocera.com
Company: Neocera, Inc.
10000 Virginia Manor Rd, Ste 300
Beltsville, MD 20705
Phone: (301)210-1010

Abstract:

This Small Business Innovation Research (SBIR)Phase II project focuses on the improvement of spatial resolution in microwave microscopy, reducing in particular the measurement sampling area over which sheet resistance and dielectric permittivity at 1 GHz - 20 GHz can be determined with numerical accuracy. A particular focus will be on proprietary semiconductor applications and on the imaging of dielectric properties. Modifications of the existing prototype as required for this goal will lead to additional applications in fields of economic and academic importance, including the non-contact measurement of the electric field dependence and the frequency dependence of the dielectric permittivity at microwave frequencies. Work at Neocera will include instrument modifications, test sample preparation, and a thorough analysis of the probe-sample interactions. Numerical simulations, semiconductor sample preparation, and comparison to an instrument based on a different feedback mechanism will be performed through a subcontract with the University of Maryland.

The result of this Phase II SBIR will be an instrument developed for a particular (proprietary) semiconductor application, leading to a multi-million dollar market. In addition, the technology will be available for various research applications, with universities being potential customers

Title: SBIR Phase II: Advanced Positron Beam Source

Award Number: 0078468
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2000
Expires: March 31, 2004
Total Amount: $588,491
Investigator: Rod Greaves, greaves@firstpsi.com
Company: First Point Scientific, Inc.
5330 Derry Avenue, Suite J
Agoura Hills, CA 91301
Phone: (818)707-1131

Abstract:

This Small Business Innovation Research Phase II project will develop and demonstrate a laboratory prototype of the Advanced Positron Beam Source (APBS) that will provide a high quality pulsed positron beam suitable for a range of analytical instruments for materials science. The project extends the latest developments in techniques to accumulate positrons from a radioactive source in Penning traps. The technical objectives of the Phase I project were fully achieved. The technical objectives of Phase II are: (1) to develop a compact, low-cost, two-stage positron trap; (2) to develop an advanced cryogenic positron moderator system; (3) to develop a high- performance positron buncher; (4) to refine the Phase I approach for extracting positrons from the magnetic field of the trap; and (5) to assemble and demonstrate the APBS system. If successful, this project will provide the basis for commercialization of the APBS in Phase III.

A major obstacle to the commercial exploitation of positron-based surface analytical techniques has been the lack of a suitable slow positron beam source. The APBS will fill this need by providing a compact, low-cost, user-friendly positron beam source that can function ultimately as a turnkey system in an industrial environment. The APBS will have advanced performance characteristics that are not available from any other system.

Title: SBIR Phase II: Cavity Ringdown Evanescent Wave Fiber Optic Sensor

Award Number: 0078367
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $399,352

Investigator: Anthony O'Keefe, aoklgr@ix.netcom.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 Phase II project plans to develop a new fiber based chemical sensor technology that can be used to make rapid trace chemical analysis of gaseous and liquid environments without the need for time consuming sample extraction and preparation. This new miniature sensing technology will combine aspects of fiber optics, enhanced absorption analysis techniques, and ultimately wireless internet communications. This technology will provide commercial and government users a chemical monitoring system which can be inexpensively networked over wide areas. Such a network of sensors can be monitored in real time from any secured computer via the Internet, providing real time information relating to chemical processing and transport, as well as for the monitoring of leaks and hazardous accidents. Such a system could be used as a warning network for large plant facilities and neighborhoods.

This technology is being developed for commercial application in several areas in collaboration with an established fiber sensor supplier for trace detection of chemicals around storage facilities and industrial facilities.

Title: SBIR Phase II: Sol-Gel Processed Thin-Film Nitrogen Oxides Sensors

Award Number: 0078730
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2000
Expires: July 31, 2002
Total Amount: $400,000

Investigator: Ayyasamy Aruchamy, amsen@mindspring.com
Company: Amsen Technologies
1684 South Research Loop
Tucson, AZ 85710
Phone: (520)546-6944

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop thin-film nitrogen oxide sensors based on novel binary-phased nanocomposites by sol-gel processing. Sol-gel processing offers many advantages for sensor fabrication, including facility and versatility for nano-engineering of the microstructure. In Phase I, such sensor elements have shown much improved microstructure, enhanced sensitivity, and faster response speed than powder-derived sensor elements of the same composition by conventional processing. Thin-film sensors can be readily incorporated with silicon microelectronic technology and conveniently allow miniaturization, low process costs, and high reproducibility. Phase II will systematically optimize the processing, microstructure, and performance of the binary-phased thin-film nitrogen oxides sensors by sol-gel processing.

Potential commercial applications of the research are expected in reliable, compact solid-state chemical sensors. This innovation is expected to provide highly stable and sensitive thin-film nitrogen oxides sensors for automotive emission control, industrial processing control, and environmental monitoring. These sensors may be used as stand-alone sensing devices or as sensing units to be integrated into on-chip multifunctional sensors and smart structures

Title: SBIR Phase II: Enhanced Phase Sensitive Spectroscopy Using Matched Gratings

Award Number: 0233846 (Formerly 0078887)
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2000
Expires: July 31, 2002
Total Amount: $399,387

Investigator: Rand Swanson, swanson@resonon.com
Company: Resonon Inc.
611 N. Wallace Avenue, Suite 7
Bozeman, MT 59715
Phone: (406)586-3356

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a trace-gas detection system based on a novel laser spectroscopic technique called Phase Sensitive Spectroscopy. This new spectroscopy technique may increase sensitivity by an order of magnitude compared to existing capabilities, and it is expected have lower capital and operating costs as well. The proposed technique relies on measurements of phase shifts of an amplitude modulated laser beam that occur when the laser is tune through a molecular resonance. Unlike current technologies, the measured quantity is insensitive to variations in the amplitude of the frequency components within the modulated laser beam. This fundamental difference promises to eliminate the need for calibrations that are currently required. Phase II will develop the fundamental understanding and lay the groundwork for commercialization. A prototype instrument will be fabricated by utilizing the 'backbone' of an existing commercially successful laser based trace-gas detector. The detection limit, stability, and cost of the prototype instrument will be characterized.

Potential commercial applications are expected in monitoring gases in aluminum production and in other industries as environmental regulation and work place safety may require. Point source monitoring.

Title: SBIR Phase II: A Large Mosaic Liquid Crystal Fabry-Perot Etalon for Atmospheric Sensing

Award Number: 0079163
Program Manager: Winslow L. Sargeant

Start Date: January 1, 2001
Expires: December 31, 2002
Total Amount: $397,788

Investigator: Robert Kerr, kerr@sci-sol.com
Company Scientific Solutions Incorporated
55 Middlesex Street
North Chelmsford, MA 01863
Phone: (978)251-4554

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the traditional size limit of the Fabry-Perot interferometer (FPI) input aperture. This limit (approximately 8-inches) is imposed by (1) practical fabrication limits to the size of glass flats that can be polished to a surface figure of lambda/100 and (2) by cost limitations. Although an array of smaller glass plates might be used to expand the collecting area of the FPI, coordination of spectral scans over the array elements requires unwieldy control systems or else is not possible with conventional barometric or piezo-electric FRI systems. This research establishes arrays of innovative FPI etalons that use liquid crystal (LC) in the FPI resonant cavity. Spectral scanning of these devices is accomplished by application of a low current to conducting layers applied to the glass substrates. The electric field imposed upon liquid crystal in the resonant cavity alters the orientation of the LC, and thus the index of refraction of the material in the resonant cavity. The ease of electronic control over the refractive index in the FPI cavity permits simple, low weight, low power coordination of multiple LC filled cells and thus makes possible a large array of FPI cells, scanning a spectrum in unison.

Phase II will design and fabricate two 10-inch diameter arrays of LC FPI (LCFP) filters. One array will be configured for Doppler measurements of atmospheric emissions and the other for 0.16-nanometer spectral resolution. Potential commercial applications are expected in (1) atmospheric lidar, (2) space-based environmental sensing, (3) passive airglow sensing, (4) clear-air turbulence detection, and (5) target detection.

Title: SBIR Phase II: Rapid Detection of Cyanide

Award Number: 0078718
Program Manager: Winslow L. Sargeant

Start Date: July 15, 2000
Expires: December 31, 2002
Total Amount: $400,000

Investigator: Eugene L. Watson, ewatson@wyoming.com
Company: CC Technology
PO Box 610
Laramie, WY 82073
Phone: (307)745-9148

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project will result in the development of two detection systems utilizing Surface Enhanced Raman Spectroscopy (SERS) capable of rapidly measuring the concentration of cyanide, a highly toxic substance used in large quantities in the extractive metals industry. A portable system will be well suited for use in the field for on-site measurements of cyanide for environmental compliance monitoring. An automated system will be useful for the measurement of cyanide levels in process control of precious metal extractive processes, and in monitoring wells for environmental compliance. Current methods of cyanide analysis give either the total amount of cyanide present in all forms, or that of free cyanide in combination with cyanide in weak acid dissociable (WAD) metal complexes. Our method of cyanide determination will be markedly superior to these methods because it will yield the concentration of free cyanide in addition to that of WAD cyanide.

This has very important practical and economic implications for the precious metals extractive industries (e.g., gold and silver mining), since it is free cyanide which is of importance in optimizing metal extraction efficiency, and it is free cyanide which is the species of primary interest from an environmental regulatory standpoint.

Title: SBIR/STTR Phase II: Microchip-Laser-Based Optical Alloy Analysis Instrument

Award Number: 0216309
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2002
Expires: September 30, 2004
Total Amount: $499,957

Investigator: Joda C. Wormhoudt, jody@aerodyne.com
Company: Aerodyne Research Inc.
45 Manning Road
Billerica, MA 01821-3934
Phone: (508)663-9500

Abstract:

This Small Business Innovation Research (SBIR) Phase II project concerns the development of an optical alloy composition sensor based on laser induced plasma spectroscopy. A key element of the sensor is the use of a microchip laser excitation source. The technology has the capability to detect industrially relevant compositions in steel alloys and possibly aluminum alloys. The Phase I results indicated the efficacy of the technique for the analysis of iron alloys. The Phase II project will focus on the development of a small, lightweight and mobile field prototype, which will be able to analyze various alloy samples.

The key commercial application of this technology is aluminum and iron scrap metal analysis, substantial market niches which are not effectively covered by existing analysis technology. The major market is for steel and aluminum alloys that have significant components of light elements. These precision instrument currents have sales worldwide in excess of $10 million per year.

Title: SBIR Phase II: Enhanced Phase Sensitive Spectroscopy Using Matched Gratings

Award Number: 0233846
Program Manager: Winslow L. Sargeant

Start Date: June 30, 2002
Expires: July 31, 2003
Total Amount: $59909
Investigator: Rand Swanson, swanson@resonon.com
Company: Resonon
611 North Wallace
Bozeman, MT 59715-3082
Phone: (406)586-3356

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a trace-gas detection system based on a novel laser spectroscopic technique called Phase Sensitive Spectroscopy. This new spectroscopy technique may increase sensitivity by an order of magnitude compared to existing capabilities, and it is expected have lower capital and operating costs as well. The proposed technique relies on measurements of phase shifts of an amplitude modulated laser beam that occur when the laser is tune through a molecular resonance. Unlike current technologies, the measured quantity is insensitive to variations in the amplitude of the frequency components within the modulated laser beam. This fundamental difference promises to eliminate the need for calibrations that are currently required. Phase II will develop the fundamental understanding and lay the groundwork for commercialization. A prototype instrument will be fabricated by utilizing the 'backbone' of an existing commercially successful laser based trace-gas detector. The detection limit, stability, and cost of the prototype instrument will be characterized.

Potential commercial applications are expected in monitoring gases in aluminum production and in other industries as environmental regulation and work place safety may require point source monitoring.

Title: STTR Phase II: Low Cost, Nano-Crystalline Sensors, for Real-Time Monitoring of Carbon Monoxide and Volatile Organic Compounds

Award Number: 0091388
Program Manager: Winslow L. Sargeant

Start Date: March 1, 2001
Expires: February 28, 2003
Total Amount: $492,908
Investigator: Nicholas J. Smilanich, Nsmilanich@aol.com
Company: Sensor Development Corp.
3449 Delmar Drive
Rocky River, OH 44116
Phone: 440/895-9520

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop a fully functional, cost-effective, prototype sensor for carbon monoxide and volatile organic contaminants in air. Phase I results suggest that a sensor array based on catalyst-doped, nano-crystalline metal oxide films will provide a marked improvement in detection of contaminants, such as formaldehyde, and thereby upgrade control of indoor air quality. Phase II will develop this sensor technology with objectives of long-term use, low cost, high sensitivity, and sufficient selectivity for commercial applications.

These applications include indoor air quality monitoring, environmental air monitoring, oil referencing, chemical manufacturing, automotive emission control systems, and industrial process.

Title: SBIR Phase II: An Imaging Sensor for Measuring and Controlling the Particle Conditions in Thermal Sprays

Award Number: 0091451
Program Manager: Winslow L. Sargeant

Start Date: January 15, 2001
Expires: September 30, 2003
Total Amount: $484,747
Investigator: James E. Craig, Info@stratonics.com
Company: Stratonics Inc
23151 Verdugo Drive Ste 114
Laguna Hills, CA 92653-1340
Phone: (949)461-7060

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a short-exposure imaging sensor for measuring and controlling particle temperature and velocity of thermal sprays. Thermal spray is a rapidly growing element of the metals processing industry, which needs process control. Currently, there are no direct particle condition controls, for lack of a sensor to provide real-time measurements. This imaging sensor technology will continuously view the entire particle stream, utilize the entire emission across the spectral range of the sensor, and employ fast image processing algorithms to obtain on-line measurements. Phase II will develop a sensor response model, hardware and software design, and prototype sensors will be constructed and calibration tested. These sensors will be incorporated in process control systems and operated in an industrial environment.

Thermal spray technology is changing and improving the way high quality metal parts are manufactured for the automotive, aerospace, energy, and heavy equipment industries. Sensor and thermal spray controls will provide new levels of cost efficiency and consistency to challenges in material processing, namely thermal, wear and corrosion, by coating the surface with metals and ceramics.

Title: SBIR Phase II: Novel Ultrasensitive Gas Chromatography (GC) Detector with Highly Specific Response to Aromatic Hydrocarbons

Award Number: 0238545
Program Manager: Winslow L. Sargeant

Start Date: January 1, 2003
Expires: December 31, 2004
Total Amount: $500,000
Investigator: Brian E. Very, bvery@dakotatechnologies.com
Company: Dakota Technologies, Inc.
2201A 12th Street North
Fargo, ND 58102-1808
Phone: (701)237-4908

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will advance commercialization of an aromatic-specific laser ionization detector (ArSLID). The photoionization detectors (PIDs) that are widely used as gas chromatography (GC) detectors and hand-held organic vapor analyzers form a natural basis of comparison for the ArSLID concept. The ArSLID uses a high repetition rate pulsed laser instead of a vacuum ultraviolet lamp to create molecular ions. The prototype ArSLID built and tested in Phase I is approximately 10-times more sensitive, has ten-times shorter response time, and is several orders of magnitude more selective toward aromatic hydrocarbons than any commercially available PID. The linear dynamic range is at least 5 orders-of-magnitude. The ArSLID is also immune from interferences by water vapor or oxygen. Technical improvements planned for Phase II include improving the resolution by 4 bits and correction for variations in the laser pulse repetition frequency. Features will be added to facilitate easy integration of the ArSLID with existing GCs. Another focus of Phase II will be applications development to show the versatility and value of ArSLID. The Phase I work, which emphasized GC detection, will be expanded to HPLC detection, which opens up tremendous opportunities in the Life Sciences.

The aromatic-specific detector will find a wide range of applications as the detector for gas chromatography, high performance liquid chromatography (HPLC), general vapor monitoring, and specialized environmental techniques. Of these, the HPLC detector has the greatest commercial potential as a highly sensitive, low cost alternative the liquid chromatography-mass spectrometer.

Title: SBIR Phase II: Nonintrusive Species Specific Velocimeter

Award Number: 0215930
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $499,930

Investigator: Allen Flusberg, allen.flusberg.@srl.com
Company: Science Research Lab Inc
15 Ward Street
Somerville, MA 02143
Phone: (617)547-1122

Abstract:

This Small Business Innovation Research Phase II project will develop a passive, nonintrusive species-specific velocimeter (SSV) that simultaneously measures spatially resolved velocities of multiple species in a flame, sorting the information by species and spatial scale size. The SSV will be geared to spatially resolve the mixing and chemical dynamics occurring within flames, and to track these effects in real time. No instruments are available that can make such measurements passively and non-invasively in a compact geometry. The SSV will play a critical role in a novel deposition process, combustion chemical vapor deposition (CCVD). CCVD is a continuous open-air deposition process that is targeting a wide spectrum of thin-film-coating markets, including electronics, glass, anti-corrosives, superconductors, catalytics, polymers, and nanopowders. Phase 1 demonstrated feasibility by measuring spatially resolved, species-specific CCVD flame velocities on different spatial scales. Phase 2 will be a proof-of-principal program to (1) construct an engineering prototype, (2) demonstrate the correlation between SSV data and bottom-line CCVD film properties, and (3) design an SSV-based CCVD controller that can be fabricated economically and commercialized in a privately funded This technology will facilitate smart deposition that streamlines the reliability of CCVD. Incorporated into a CCVD system, the SSV will become the central element of a feedback control module that maintains the consistency of the flame and maximizes deposition efficiency.

The commercial market for this technology generates about $50 million annually. This project addresses the interest in advanced control techniques for manufacturing. It supports the development of improved and more reliable coatings that will enhance technology and lower the cost of many common products, e.g. electronic memory devices in computers, appliances, and automobiles.

Title: SBIR Phase II: Nonintrusive Diode Laser Sensor for Bottled Drugs

Award Number: 0215797
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $500,000

Investigator: Mark E. Paige, mpaige@swsciences.com
Company: Southwest Sciences Inc
1570 Pacheco Street
Santa Fe, NM 87505-3993
Phone: (505)984-1322

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is designed to develop a nonintrusive diode laser sensor for detecting oxygen in the headspace of pharmaceutical vials. Many drugs are oxygen sensitive and must be bottled in an oxygen free environment. There are no nonintrusive methods available to measure residual oxygen levels in sealed product vials. A nonintrusive sensor would generate large cost savings for pharmaceutical manufacturers. During the Phase II project, a prototype off-line instrument will be constructed. This instrument will be tested at pharmaceutical manufacturing facilities. In addition if time permits, on-line experimental measurements will be performed.

In addition to being useful for the pharmaceutical industry, this technology will be extendable to a variety of packaged products in other industries. These industries include the food, alcoholic beverage, and medical instrument markets. This technology can also be used to detect other species in packaged products such as water vapor or carbon dioxide.

Title: SBIR Phase II: Revitalizing Spectrofluorimeters with Cryogenic Fiber Optic Probes, Fluorescence Lifetime Capability, and Tunable Laser Sources

Award Number: 0110432
Program Manager: Winslow L. Sargeant

Start Date: November 15, 2001
Expires: October 31, 2003
Total Amount: $500,000

Investigator: Gregory D. Gillispie, gillispie@dakotatechnologies.com
Company: Dakota Technologies, Inc.
2201A 12th Street North
Fargo, ND 581021808
Phone: (701)237-4908

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop new instrumentation for fluorescence and phosphorescence spectral measurements. Phase I produced a customized spectrofluorimeter equipped with a tunable laser source, fluorescence lifetime capability, and fiber optic probe for cryogenic measurements. However, better methods are needed to analyze benzo[c] fluorene, which researchers now believe may be an environmental concern comparable to benzo [a] pyrene. Phase II will develop an upgraded new instrument, capable of retrofitting the low temperature probe, fluorescence lifetime, and tunable laser capabilities onto laboratory spectrofluorimeters. The emission monochromator, photomultiplier tube detector, and control/analysis computer can be retained from the spectrofluorimeter, and none of its functionality will be lost. Phase II is expected to produce several models of commercial spectrofluorimeters, test data for publication in technical journals and trade magazines, and instrument upgrade options as a commercial service.

The market for these upgrades presently has an estimated 30,000-40,000 spectrofluorimeters in service. An additional 4,000 individuals or institutions purchase new units each year. The new instrument upgrades will be used in research and development, analytical services, quality control, environmental studies and surveys, and teaching and other applications.

Title: STTR Phase II: Development of an Autonomous Equilibrating pCO2 Sensor

Award Number: 0110500
Program Manager: Winslow L. Sargeant

Start Date: November 15, 2001
Expires: October 31, 2003
Total Amount: $495,996

Investigator: Regis Cook, regis_cook@compuserve.com
Company: General Oceanics Inc
1295 NW 163 St
Miami, FL 33169-5830

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will develop and test an autonomous, low cost, robust, precise, and miniaturized partial and total carbon dioxide measurement system. This system will be able to characterize the carbon dioxide exchange between ocean surface waters and the atmosphere, thus helping to analyze the "greenhouse effect" and assess global warming on a worldwide basis. The partial and total carbon dioxide systems are miniaturized for deployment by the International SeaKeepers Society in ocean and atmospheric monitoring modules on cargo ships, cruise ships, and super yachts around the world as well as for use on piers, ocean buoys, and other platforms. The prototype partial carbon dioxide system, developed in Phase I, measures carbon dioxide in seawater that has been equilibrated with air using an infrared detector. It is sensitive to five parts per million and responds to rapid changes in carbon dioxide. The prototype miniaturized total carbon dioxide system has a precision of three parts per million. Phase II will miniaturize and test both systems in the laboratory and in the field. Based on these tests and any modifications required, final commercial partial and total carbon dioxide measurement systems will be produced.

The International SeaKeepers Society is expected to deploy hundreds of these carbon dioxide sensor systems. Other purchasers would include government agencies worldwide performing research and monitoring on the global warming phenomenon.

Title: SBIR Phase II: Active Control of Gas Turbine Engines Using Eddy Current Sensors

Award Number: 0110316
Program Manager: Winslow L. Sargeant

Start Date: September 15, 2001
Expires: October 31, 2003
Total Amount: $500,000
Investigator: Carole A. Teolis, carole@technosci.com
Company: Techno-Sciences
10001 Derekwood Lane Ste 204
Lanham-Seabrook, MD 20706
Phone: (301)577-6000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and test algorithms for active control of blade vibration and engine stability (stall and surge) using an eddy current sensor (ECS) array. The approach utilizes signal analysis and diagnostic tools in active control algorithms for the detection of engine faults. Phase II will extend the functionality of the ECS system beyond diagnostics to active and automatic real-time control of gas turbine engines.

An ECS array is currently the favored sensor system for installation on the Joint Strike Fighter, in which a software system upgrade capable of using ECS data to compute the necessary indicators and estimate the disturbances needed, is desirable for active vibration and engine stability control. It would reduce the number of new sensors needed for active control and potentially save millions of dollars. Large commercial markets are indicated in commercial aircraft and gas turbine power plants.

Title: SBIR Phase II: Innovation of Real-Time, Integrative Computer Vision System for Accurate, Full-Field Characterization of Complex Component Response

Award Number: 0091520
Program Manager: Winslow L. Sargeant

Start Date: July 1, 2001
Expires: June 30, 2004
Total Amount: $500,000

Investigator: Scott J. Echerer, echerer@alphamfg.com
Company: Alpha Mfg.
100 Old Barnwell Road
West Columbia, SC 29170
Phone: (803)739-4500

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will advance full-field, three-dimensional image correlation measurement technology to a level far beyond the current state-of-the-art. The research will produce a prototype commercial measurement system that will present a cost effective solution to a wide range of deformation measurement problems. The four areas of research for this project are: system calibration, algorithm development, distributed computing and system validation. The completion of this project will result in an easy-to-use, real-time measurement system applicable to a wide range of size scales with high accuracy and a known level of uncertainty.

The unique ability to simultaneously measure surface shape, displacement and strain with high accuracy meets industrial measurement demands in many areas. The method is ideally suited for structural evaluation, computer model verification, non-destructive testing, material property measurement and shape measurement. Among others, the technology has applications in the following industries: automotive industry, commercial aviation manufacturers, space vehicle manufacturers, academic research institutions, government laboratories, and the biomedical and electronic packaging industry.

Title: STTR Phase II: Long-Gage Fiber Bragg Sensors for Structural Health Monitoring and Damage Identification

Award Number: 0131967
Program Manager: Winslow L. Sargeant

Start Date: February 15, 2002
Expires: January 31, 2004
Total Amount: $499,349
Investigator: Sean G. Calvert, sean@bluerr.com
Company: Blue Road Research
Clear Creek Business Park
Gresham, OR 97030
Phone: (503)667-7772

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will further explore the use of long-gage fiber Bragg grating strain sensors in conjunction with vibration-based system identification techniques for health monitoring and damage identification of civil structures. In phase I, the proof of concept was shown based on static and dynamic laboratory experiments on small-scale structural models. In this Phase II effort, field tests on bridges identified in Oregon and California will be performed to further validate this very promising tool for structural health monitoring and damage identification. These bridges provide unique opportunities as two of them are scheduled for demolition and both State Departments of Transportation have agreed to support testing as these bridges are systematically damaged to provide a true real-world test of the damage identification system. These field tests will be an important step in providing feasibility data for future commercialization of the structural health monitoring and damage identification system. Once the proposed methods are debugged and validated for s, the California and Oregon DOT's will strongly consider adopting them for widespread use in their structural health-monitoring and bridge rehabilitation programs.

The proposed structural health monitoring and damage identification system offers very promising advanced solutions to the triple problem of: (1) monitoring the state-of-health of the civil infrastructure system for optimum allocation of rehabilitation resources, (2) optimally designing the rehabilitation scheme for a specific deficient civil structure, and (3) evaluating the efficacy of the rehabilitation measure.

Title: SBIR Phase II: Development of a Dynamic, High-Resolution Volumetric Dilatometer

Award Number: 0321272
Program Manager: Winslow L. Sargeant

Start Date: February 1, 2003
Expires: July 31, 2003
Total Amount: $275,000
Investigator: Sean M. Christian, schristian@stellarnet.us
Company: StellarNet
13801 McCormick Drive
Tampa, FL 33626-3017
Phone: (813)855-8687

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop innovations pertaining to optrodes (optical sensors) and electro-optical instrumentation for advanced material characterization. Specifically, this project will develop the first commercially available high-resolution volumetric dilatometer. In addition, the innovations will allow for: (1) a linear dilatometer that possesses a resolution that is 2-3 orders of magnitude better than its conventional linear counterparts; (2) an optical control system for micro-translation stages; (3) an optrode for thin film characterization that possesses a linear resolution exceeding 1 nanometer; and (4) an ultra-fast, high-resolution spectrometer that will enable commercialization of three optical sensors (pressure, temperature, and load) suitable for harsh environments.

Potential commercial applications are expected in electronics and microelectronics manufacturing for dilatometry, thin films analysis, micro-translation stages, ultra-fast spectroscopy, and various optical sensors.

Title: SBIR Phase II: Micro Pulse Lidar for Water Vapor Profiling

Award Number: 0078664
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2001
Expires: May 31, 2004
Total Amount: $399,881
Investigator: Dave Shannon, dave.shannon@aculight.com
Company: Aculight Corporation
11805 North Creek Pkwy S.
Bothell, WA 980118803
Phone: (206)451-9558

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the need for a new generation of laser transmitters for differential absorption lidar (DIAL) measurements of water vapor. Phase II will develop a new laser technology for mini-DIAL measurements of water vapor. DIAL transmitter requirements will be achieved using a revolutionary technology that allows diffraction limited performance from diode bars. These ultra bright diode bars enable efficient end pumped, q-switched, low-gain, quasi-three level lasers. Recently, a laser material that operates directly at the 944.1 nanometer water vapor absorption line has become commercially available. Coupling these two technologies will result in an efficient compact DIAL transmitter. This technology will result in a new class of compact, efficient, and low-cost DIAL transmitters for atmospheric water vapor profiling.

Low cost DIAL transmitters are important for future improvements in weather forecasting, global climate models, and understanding of the transmission of communication signals in the atmosphere. In addition, potential commercial applications will be found in the medical and material processing industries.

Title: SBIR Phase II: Development of a Dynamic, High-Resolution Volumetric Dilatometer

Award Number: 0110317
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2001
Expires: May 31, 2003
Total Amount: $500,000
Investigator: Sean M. Christian, schristian@airak.com
Company: Airak, Inc.
9058 Euclid Avenue
Manassas, VA 20111-1053
Phone: (703)330-4961

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop innovations pertaining to optrodes (optical sensors) and electro-optical instrumentation for advanced material characterization. Specifically, this project will develop the first commercially available high-resolution volumetric dilatometer. In addition, the innovations will allow for: (1) a linear dilatometer that possesses a resolution that is 2-3 orders of magnitude better than its conventional linear counterparts; (2) an optical control system for micro-translation stages; (3) an optrode for thin film characterization that possesses a linear resolution exceeding 1 nanometer; and (4) an ultra-fast, high-resolution spectrometer that will enable commercialization of three optical sensors (pressure, temperature, and load) suitable for harsh environments.

Potential commercial applications are expected in electronics and microelectronics manufacturing for dilatometry, thin films analysis, micro-translation stages, ultra-fast spectroscopy, and various optical sensors.

Title: STTR Phase II: Integrated Water Quality Monitoring System

Award Number: 0091512
Program Manager: Winslow L. Sargeant

Start Date: February 1, 2001
Expires: January 31, 2003
Total Amount: $500,000

Investigator: Paul G. Duncan, pduncan@airak.com
Company: Airak, Inc.
9058 Euclid Avenue
Manassas, VA 20111-1053
Phone: 703/330-4961

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop optical sensors, called optrodes, and their systems for monitoring environmental water quality. Phase I research demonstrated the ability of optrodes to gather long-term environmental water quality data in harsh environments. Phase II technical issues are concerned with: (1) analyte specific probe chemistries; (2) optical coatings; and (3) optical configurations. With respect to systems, Phase I found lifetime phase-base measurement systems superior to traditional intensity-based systems. Phase II will develop an integrated phase-based analyzer capable of: (1) resolving dissolved oxygen, dissolved carbon dioxide, acidity, and temperature; and (2) transmission by remote data telemetry.

These innovations in optrode technology will: (1) improve mapping of geophysical fields; (2) substantially reduce direct labor costs associated with conventional monitoring technologies; (3) produce robust data for enhanced modeling capabilities; and (4) enable other technology for protecting natural resources.

Title: SBIR Phase II: Focused Beam Total X-Ray Fluorescence Analysis Using Doubly-Curved Crystals

Award Number: 0215914
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $499,864
Investigator: Zewu Chen, zchen@xos.com
Company: X-Ray Optical Systems, Inc
15 Tech Valley Drive
East Greenbush, NY 12061
Phone: (518)880-1500

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to meet the demand from the microelectronics industry for improved wafer contamination analysis. Wafer contamination control is critical for Ultra Large Scale Integrated (ULSI) technology and there is a strong demand for a non-destructive analytical tool with improved sensitivity and spatial resolution over the conventional total x-ray fluorescence (TXRF) method. A new technique, focused beam TXRF, can meet this important market need. Based on point-focusing toroidal crystal optics, focused beam TXRF will improve the spatial resolution by a factor of more than 100 and provide 30 times better detection sensitivity for local contaminants on Si as compared to the conventional TXRF method. This technique also has potential for low-level Al, Na and other low Z elements analysis on Si that cannot be addressed effectively by the conventional TXRF and other techniques. In this project, preliminary focused beam TXRF data will be collected using WL1 excitation provided by a toroidal Si (220) crystal to demonstrate the improvement of sensitivity and resolution for transition metal detection. Theoretical calculation will be also carried out to determine the feasibility for Al and Na detection for wafer contamination control at 10^ 9 to 10^10 atoms/cm^2 level.

Focused beam TXRF analysis has commercial applications in the microelectronics industry for wafer contamination control including localized and homogeneous contaminants with high resolution. These contaminants include many important elements such as transition metals, Al, Na and other low Z elements. By being able to identify these contaminants, the quality of silicon wafers can be improved. This will be a tremendous cost savings to a multi-billion dollar industry.

Title: SBIR Phase II: Non-Contact Measurement of Residual Strain in Composites

Award Number: 0110524
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2001
Expires: September 30, 2003
Total Amount: $499,978

Investigator: Stephanie A. Vierkotter, stephie.vierkotter@qm.com
Company: Quantum Magnetics, Inc.
7740 Kenamar Court
San Diego, CA 92121-2425
Phone: (858)566-9200

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel non-contact strain sensor for quality control in production of polymers and fiber-reinforced composites. By measuring residual strains, good parts can be distinguished from bad parts in the production stream. Internal and surface residual strains will be measured by a strain gauge based on the principle of nuclear quadrupole resonance (NQR). A small percentage of tiny additive crystals are blended into the resin during fabrication of the composite. For strain measurement, the composite is irradiated with radio frequencies (RF) to evoke a strain-dependent NQR response from the embedded crystals. Phase I manufactured parts with embedded additive via compression molding. Phase II will build a single-sided strain prototype and measure residual strains in pultruded parts. The NQR-active additive will be introduced into the pultrusion process, and several batches of different types of composites, e.g., fiberglass, will be manufactured. Pultrusion will permit several large batches of samples to obtain the statistics needed to obtain the NQR-based quality control method.

Potential commercial applications are expected in many industries, such as civil infrastructure, automotive, sporting goods, aerospace, and many others utilizing composite materials.

Title: STTR Phase II: Development of a Compact Cloud Spectrometer and Impactor

Award Number: 0110358
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2001
Expires: September 30, 2003
Total Amount: $460,945

Investigator: Gregory L. Kok, glkok@dropletmeasurement.com
Company: Droplet Measurement Technologies
2400 Central Ave Suite B2
Boulder, CO 80301
Phone: (303)44055

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will develop a compact cloud spectrometer and impactor (CSI) for the measurement and study of condensed water in the atmosphere. Condensed water includes cloud droplets and ice particles. Phase I demonstrated the feasibility of integrating a counterflow virtual impactor (CVI) for condensed water content (CWC) measurement together with a new forward scattering spectrometer system for measurement of the cloud droplet size distribution. This combined airborne instrument will be considerably lighter than previous versions of the two separate instruments, and easier to use. The objective of Phase II is a commercial, integrated instrument for the study of atmospheric condensed water content and droplet size distribution.

The accurate measurement of these parameters is important in weather prediction as well as understanding global climate change. This instrumentation will have worldwide application, and the users will be government, university, and commercial atmospheric research institutions.

Title: SBIR Phase II: Low-Cost, High-Efficiency Power Amplifiers for Magnetic-Resonance Imaging

Award Number: 0237474
Program Manager: Winslow L. Sargeant

Start Date: March 15, 2003
Expires: February 28, 2005
Total Amount: $500,000
Investigator: Frederick H. Raab, f.raab@ieee.org
Company: Green Mountain Radio Research Co.
50 Vermont Avenue
Colchester, VT 05446-3125
Phone: (802)655-9670

Abstract:

This Small Business Innovation Research Phase II will develop and test a prototype low-cost, high-efficiency transmitter for magnetic-resonance-imaging (MRI) systems. Existing MRI transmitters use conventional power amplifiers (PAs), which makes them inefficient and consequently large, heavy, and expensive. Phase I has demonstrated the feasibility of using developed high-efficiency amplification techniques to produce significantly more power from a given transistor, thus lowering the cost. Also demonstrated was the feasibility of using these amplifiers to produce the pulsed-RF signals used by MRI. Phase II will develop a prototype transmitter that combines high-efficiency power amplification with digital signal processing to provide both low cost and superior signal quality. This in turn will produce superior image quality, resulting in improved diagnostics. The transmitter will be organized into broadband RF-power modules that can be combined in building-block fashion to produce transmitters for different MRI applications. The prototype transmitter will be configured into a manufacture able form to facilitate transition to Phase-III commercialization. Finally, the prototype transmitter will be tested in an MRI system and images obtained will be compared to those obtained with a conventional transmitter.

The primary commercial application for the new transmitter is medical imaging. Every MRI system includes a high-power RF transmitter. The manufacturers of MRI systems purchase transmitters from smaller manufacturers. The RF transmitter is the most expensive subsystem, and keeping the cost down is of great interest. The building-block approach allows all market segments to be addressed, beginning with the lower-power "1-T" systems for specialized applications and moving subsequently to higher-power "3-T" systems for high-resolution whole body scans. The combination of lower cost and superior signal quality is expected to make the proposed transmitter very attractive to systems manufacturers. Secondary applications include security systems such as suitcase scanners and communication radios for both civilian and military applications.

Title: SBIR Phase II: Novel Electric Field Probe for High-Speed Integrated Circuits and Semiconductor Devices

Award Number: 0091454
Program Manager: Winslow L. Sargeant

Start Date: April 1, 2001
Expires: March 31, 2003
Total Amount: $500,000

Investigator: Daniel J. Kane, djkane@swsciences.com
Company: Southwest Sciences Inc
1570 Pacheco Street
Santa Fe, NM 87505-3993
Phone: (505)984-1322

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a prototype high speed, non-invasive, optical probe for electric fields, and hence waveforms, in semiconductor devices. The technique is designed to work on any semiconductor regardless of its crystal structure and can be used for both imaging and single point detection without degradation of temporal resolution. Because the technique is optically based, no parasitic capacitance is added to the device being measured. A femtosecond laser probes the device to be measured, and temporal resolution is several orders of magnitude faster than the time resolution required to probe present devices. Bandwidths of greater than 10 terahertz should be possible.

This non-invasive probe technique will be applied to silicon-based devices, in their production and testing in the semiconductor industry.

Title: SBIR Phase II: A Parallax Barrier Technique for Autostereoscopic Displays

Award Number: 0238857
Program Manager: Winslow L. Sargeant

Start Date: February 15, 2003
Expires: January 31, 2005
Total Amount: $500,000
Investigator: Jesse B. Eichenlaub, jbe@dti3d.com
Company: Dimension Technologies Inc
315 Mount Read Boulevard
Rochester, NY 14611-1911
Phone: (716)436-3530

Abstract:

The Small Business Innovation Research (SBIR) Phase II project is designed to leverage the success in polarized strip development. It will also advance two configurations for 2D and 3D capable auto stereoscopic display products, and initiate customer evaluation of these products. Specific objectives of the project include: completion of the technical developments necessary to produce 2D/3D products using the proprietary Strip Polarizer Parallax Barrier (SPPB) technique for flat panel displays; collaboration with a target customer to design and develop a market specific product; initiation of a pilot-manufacturing run to produce prototypes for initial market feedback; qualification of the initial prototypes in terms of performance, quality, manufacturability and acceptance; and continuation of research efforts needed to produce full resolution 2D/3D products. A successful Phase II program will advance the technology to prototype and initiate market feedback in target applications. Phase II prototypes will embody the majority of the technology needed to produce the full resolution products and will serve to firm up manufacturing processes while establishing initial market demand in those segments where natural upgrades to full resolution will increase market penetration.

The direct commercial potential of the projects lies in autostereoscopic products that will be manufactured using the proposed technology. Such display products will find widespread use in scientific and medical visualization applications, CAD, industrial inspection, and remote vision applications. Consumer based applications may include electronic commerce and computer gaming.

Title: STTR Phase II: A New Device for Quantitative Determination of Trace Gas Species

Award Number: 0132112
Program Manager: Ritchie B. Coryell

Start Date: January 15, 2002
Expires: December 31, 2003
Total Amount: $500,000

Investigator: Wen-Bin Yan, wbyan@meeco.com
Company: Tiger Optics
250 Titus Avenue
Warrington, PA 18976-2426
Phone: (215)343-6600

Abstract:

This Small Business Technology Transfer (STTR) Phase II Project substantially furthers the development of a powerful means to simultaneously measure trace amounts of multiple species vital to environmental control, industrial process control, and human health and safety. A fast, flexible, accurate, and low power-consuming technique, prism Cavity Ring-Down Spectroscopy (CRDS) will measure trace species to levels as low as parts-per-trillion. The research completed in Phase I demonstrated that the technology requires prisms fabricated from high-purity, super polished materials of high optical homogeneity. Phase I served both to identify appropriate materials to construct a fully functional prism and to prove that the prism cavity operates from the near UV down to the near IR range, greatly enhancing the breadth of CRDS performance.

The commercial market for the prism cavity lends itself to a wide range of applications: manufacture of compound semiconductors for telecommunications; continuous emissions monitoring for environmental compliance and workplace safety; laser weapon development and performance verification; detection of explosives or chemical warfare agents; and chemical analysis of breath for medical diagnostics.

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: 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

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: 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: 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
Company: ISCA Tech
2060 Chicago Ave Suite C2
Riverside, CA 92507
Phone: (909)686-5008

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: 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
Company: Adelphi Technology, Inc
981B Industrial Rd
San Carlos, CA 94070
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: 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
Company: RadiaBeam
1600 Sawtelle Blvd
Los Angeles, CA 90025
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: Three-Dimensional Microscopy of Surfaces by Grazing Incidence Diffraction

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
237 LaFayette Street
New York, NY 10012
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: STTR Phase II: Novel Deposition Rate Sensors for Real-Time Thickness Control of Plasma Spray

Award Number: 0724382
Program Manager: Muralidharan S. Nair

Start Date: August 1, 2007
Expires: July 31, 2009
Total Amount: $499,983

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

Abstract:

This Small Business Technology Transfer (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

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
1995 University Avenue, Ste 375
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
Santa Barbara, CA 93117
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: Photon-Assisted Hydrogenation Process Technology for Manufacturability and Improved Operability of HgCdTe Infrared Detectors

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
Company: ARI
720 North Commerce
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: Structurally Integrated Organic Light Emitting Device-Based Sensors for Dissolved Oxygen in Water

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
Company: Integrated Sensor Technologies, Inc.
3138 Sycamore Rd
169, IA 50014
Phone: (515)292-4226

Abstract:

This Small Business Innovative Research (SBIR) 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: 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

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
Company: Southwest Sciences Inc
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: Atmospheric Pressure Microplasma Emission Spectrometer

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: RFID Tags for Cardiopulmonary Monitoring in Clinical Setting

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.

Geoscience Instrumentation

Title: STTR Phase II: A Rapid-deployment, Three-dimensional (3-D), Seismic Reflection

Award Number: 0239071
Program Manager: Muralidharan S. Nair

Start Date: May 15, 2003
Expires: April 30, 2005
Total Amount: $494,296

Investigator: Patrick F. Miller, pfm_mt@msn.com
Company: PFM Mfg. Inc.
108 North Spruce Street
Townsend, MT 59644
Phone: (406)266-5148

Abstract:

This Small Business Technology Transfer (STTR) Phase II project aims to build a prototype of a rapid-deployment, three-dimensional (3-D), seismic reflection system for near-surface exploration. Although the 3-D seismic reflection method enjoys tremendous commercial success in marine applications, 3-D seismic systems for land-based geophysical exploration have been limited because cost-effective and environmentally friendly deployment systems have not been developed. Such a system would be useful to build models of ground water flow, track pollutants, identify mineral-laden zones, and aid the sitting of large construction projects.

The next generation seismic system based on the land streamers concept using gimbal-mounted vertical geophones will be assembled. An industrial, low-impact All Terrain Vehicle (ATV) is a critical part of the system both to pull the land streamers and minimize environmental impact. The primary advantage of such a system is that fewer field personnel would be needed compared to conventional surveys and data can be collected more efficiently. The customer base for this seismic reflection system includes civil and environmental engineers and geophysical contractors.

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 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: Pipeline Integrity in Natural Gas Distribution and Transmission Systems

Award Number: 0422171
Program Manager: Muralidharan 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: Ultra-fast Broadband Imaging Spectroscopy for Geosciences Applications

Award Number: 0422094
Program Manager: Muralidharan 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 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: Remote Radio Frequency Measurements for Pipeline Monitoring - FloWatch911

Award Number: 0322092
Program Manager: Muralidharan S. Nair

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $493,680
Investigator: Mitchell Auerbach, mauerbach@cfl.rr.com
Company: Emergency Management Telecommunications
2496 Park Place Blvd
Melbourne, FL 32935
Phone: (321)259-8947

Abstract:

This Small Business Innovation Research (SBIR) Phase-II project will develop and test remote radio frequency measurements for integrity monitoring of gas fuel-pipelines. This novel application of RF measurements uses the pipe as a transmission line. Antennas launch pulses that travel inside the pipe, without disturbing the transported fluid. Pulses reflect-off obstructions/breaches in the pipe and are measured by distributed low-cost receivers to locate the fault. Phase-I research demonstrated the proof of concept for this automated monitoring system and defined interfaces with an emergency management telecommunications system that provides notification to the pipeline response team and warning to affected residents/businesses - all within minutes of the event. The objectives for Phase-II are to develop an engineering model FloWatch system, to install this system in an operating gas pipeline, and to perform end-to-end testing of the sensors and emergency notification system.

The outcome of this research will lead to a marketable product, which when implemented by pipeline operators, can save millions of dollars annually in pipeline spills and avert potential loss of life and property. Further benefits will result through improved pipeline operations that will result in lower-cost and reliable delivery of energy needs for businesses, industry and the general public.

Title: SBIR Phase II: Integrated Electric and Magnetic Free-Space Sensor for Geosciences

Award Number: 0349333
Program Manager: Muralidharan 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 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

Title: SBIR Phase II: Remotely Operated Vehicles (ROV) Mounted Sensor for Benthic Studies

Award Number: 9983306
Program Manager: Winslow L. Sargeant

Start Date: March 1, 2000
Expires: December 31, 2002
Total Amount: $400,000

Investigator: Salvador Fernandez, fernandez@ciencia.com
Company: Ciencia Inc
111 Roberts Street, Suite K
East Hartford, CT 06108
Phone: (860)528-9737

Abstract:

This Small Business Innovation Research Phase II Project will result in development of a novel oceanographic chlorophyll fluorescence sensor for the study of benthic microalgae. This sensor will be the first to incorporate fluorescence lifetime measurement capability, and the first to implement such capability for stand-off measurements from an ROV. This is of major significance, because it will permit, for the first time, direct in situ measurements of fluorescence quantum yield, and hence of photochemical efficiency, a feat that is not possible with simple amplitude-based fluorimeters. Continental shelf benthic ecosystems are of critical importance to marine biology and the viability of these ecosystems can be objectively assessed from the physiological status of the resident microalgae. The most important component of this status is the level of their photosynthetic performance, determined by the rates and efficiency of primary stages of light-driven photochemistry. Yet, knowledge about these processes, which control the health, long-term viability, productivity and dynamics of benthic microalgae is minimal because of the lack of suitable research tools for their study.

Potential commercial applications include oceanographic sensors, precision farming, photosynthesis analyzers for the laboratory research market, non-invasive brain oxymetry, product authentication, High Throughput Screening, clinical in vitro diagnostics and on-line process analysis.

Title: SBIR Phase II: Microminiature, High Resolution, Passive Peak Strain Detector for Smart Structures and Materials

Award Number: 0078617
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2000
Expires: July 31, 2003
Total Amount: $486,491

Investigator: Steven Arms, swarms@microstrain.com
Company: MicroStrain Inc
310 Hurricane Lane
Williston, VT 05495
Phone: (802)862-6629

Abstract:

This Small Business Innovation Research (SBIR) Phase II project combines hermetically packaged, differential variable reluctance transducers (DVRT) capable of peak strain detection (PD) with shape memory alloy (SMA) actuators to produce improved passive PDs. These detectors can withstand harsh environmental conditions, e.g., moisture, salt, vibration, and can be reset for repeated uses. Sensors in smart structures generally require system power in order to operate, but power outages may result in loss of key data. Therefore, sensors that can record peak information without power, i.e., passively, are needed in smart structures. Earlier passive PDs have relied on measuring the magnetic properties of transformation induced plasticity (TRIP) steels. However, these devices suffer from bulky size, low resolution, high nonlinearity, and a one time use limitation due to material yielding. This technology addresses these problems by using modified, microminiature DVRT-PDs. Phase I successfully designed, built, and tested hermetic packages, and SMAs were successfully employed for resetting of the devices. Techniques for remote interrogation using radio frequency identity tags were investigated, micropower prototypes were designed and built, and methods for wireless delivery of power to the SMA actuator were demonstrated. In Phase II, highly integrated microelectronics will be combined with the hermetic DVRT-PD packages to produce self-contained, remotely queried and remotely resettable PDs. Novel micropower sensor excitation circuits, capable of long range interrogation, will be built, tested, and packaged for independent laboratory evaluation and eventual field deployment. Field tests will include health monitoring of structural joints, repairs, and supporting members of civil structures, including bridges. The physical attachment of the DVRT-PDs to these structures will be designed for reliability, low cost, and ease of use. Applications include health monitoring of composite structures, aircraft, trains, bridges, dams, and buildings.

Military and commercial markets for these systems are significant. Health monitoring has the potential to enhance the safety and life of military, aerospace, and civil structures. Sensate structures equipped with passive networks of peak displacement or strain measurement devices could be interrogated for their response to test loads or potentially damaging events, and either replaced or their embedded sensors reset for future interrogation. Critical civil and military structures require 'smart' sensors in order to report their strain histories; this can help to insure safe operation after exposure to potentially damaging loads, e.g., earthquakes, hurricanes, military combat, etc.

Title: SBIR Phase II: A High Frequency Beam Steered Electromagnetic Impulse Radar to Locate Human Targets Through Opaque Media

Award Number: 0216574
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2002
Expires: September 30, 2004
Total Amount: $500,000

Investigator: Scott R. Thompson, scott@realtronics.com
Company: RealTronics
PO Box 228
Hermosa, SD 57744-0228
Phone: (605)255-4410

Abstract:

This SBIR Phase II project will develop a through material imaging system that will locate human targets through opaque media. The technology will also provide wide area subsurface sensing for ground probing applications. The phase I results demonstrated that the system has the capability of detecting human targets on the opposite of building walls and through walls of granite over 10m thick. The thrust of the phase II research lies in software development to classify targets in the downrange profile, track targets, and count targets; and hardware development to eliminate the need for an external off the shelf receiver. The latter effort will also require software development to process data for the classification algorithms. The unique innovation of this project is that it can conduct full area investigations and locate stationary targets from a fixed location.

There are two primary applications for this technology, situational awareness and subsurface investigation. The former, which is the most attractive for early market entry, comprises homeland security, police/fire/search and rescue, and military actions where the location of human subjects on the opposite side of walls, vegetation, snow, fire, or other opaque media is sought. The latter includes geophysical exploration, ore body investigation, utility detection and location, road-bed and bridge subsurface scans for cracks and voids, and unattended ground sensing from a fixed point to assess subsurface changes that can be used to predict earth or structural failure.

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

Award Number: 0522021
Program Manager: Muralidharan S. 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 - LaBr3, LaCl3 and CeBr3 - 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.

MEMS

Title: SBIR Phase II: Large Area Platform Technology for Small Diameter Silicon Carbide

Award Number: 0321616
Program Manager: Winslow L. Sargeant

Start Date: July 15, 2003
Expires: June 30, 2005
Total Amount: $499,999
Investigator: Lee O. Kareem, lee.kareem@zin-tech.com
Company: ZIN Technologies
3000 Aerospace Parkway
Brook Park, OH 44142-1001
Phone: (216)977-0631

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will optimize the key technologies for deployment of high-temperature pressure sensors from proven silicon carbide (SiC) sensor dies for harsh environment applications within aerospace and automotive markets. These include wafer bonding and planarization, electrical characterization, selection of integrated electronics manufacturing methods, and temperature compensation algorithms. The Discrete Wafer Array Process (DWAP) technique will be further developed to demonstrate fabrication of SiC pressure sensors. Prototype platforms for demonstration of low-cost and high volume manufacturability of single crystal SiC devices in conventional foundries will be provided and the semiconductor-on-insulator (SOI) technology provided by the DWAP concept will be leveraged to demonstrate superior device performance. This work will focus on developing and optimizing the necessary technical foundation of SiC sensor dies through electrical characterization and interface electronic development, and fabrication of SiC pressure sensor dies on 4-inch platform for testing by GE and Ford.

The increasing demand for miniaturization presents unique growth opportunities in the MEMS Market, which is estimated at $7Billion. Combined skills in MEMS manufacturing processes, electronics system design, algorithm development, and market access are required for success. The harsh environment market segment, estimated at $4.5Billion by 2005 is poised to be a major beneficiary of the technical and cost saving superiority of Silicon Carbide (SiC) over Silicon (Si) as the primary semi-conducting material. The pressure sensor sector of the market segment will grow from $3.5Billion by 2005 to $9.06Billion, with a Compounded Annual Growth Rate (CAGR) of 16.5%.

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.

Title: SBIR Phase II: Micromachined Vacuum Microelectronic Devices Using Nanoscale Self-Assembly

Award Number: 9983511
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $400,000
Investigator: Dmitri Routkevitch, droutkevitch@synkera.com
Company: Nanomaterials Research LLC
1831 Left Hand Circle
Longmont, CO 80501
Phone: (720)652-4001

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel low-cost microfabrication technology for vacuum microelectronics. Affordable and reliable microfabrication of refractory materials is needed, since these materials are able to withstand high temperature and severe electromagnetic radiation. Although several materials have been identified as candidates, they have both high cost and difficulties with high aspect ratio, high resolution bulk micromachining. An approach based on self-organized nanoporous anodic alumina with unique anisotropy morphology will allow high aspect ratio, high resolution micromachining. Phase I demonstrated that a vacuum microtriode with promising performance could be fabricated from micromachined alumina ceramic. This may be the only technology for making ceramic micro-electromechanical systems (MEMS) for vacuum microelectronics and other applications, that are stable in harsh environments, have mechanical durability, are compatible with mainstream microfabrication, cost less, and scale up suitably. Phase II will optimize the technology and design, fabricate prototypes of vacuum integrated circuits (logic and amplifier), and scale-up the processes of device batch production for evaluation.

Potential commercial applications include vacuum microelectronics and MEMS for the harsh environments of space, satelliate communicaitons, radars, deep drilling, nuclear reactors, as well as less strenuous environments that attend such uses as cellular phone networks, flat panel displays, and various sensors

Title: SBIR Phase II: Electrostatic Self-Assembly Processes for Fabrication of MEMS Materials and Devices

Award Number: 9983175
Program Manager: Winslow L. Sargeant

Start Date: May 15, 2000
Expires: April 30, 2004
Total Amount: $461,800
Investigator: Tingying zeng, tyzeng@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 sensor, actuator, and micro-electromechanical system (MEMS) products based on electrostatically self-assembled piezoelectric and electrostrictive polymer thin films. Phase I found that an electrostatic self-assembly (ESA) process may be used to synthesize piezoelectric and electrostrictive materials with large transduction coefficients from a variety of dipolar molecular materials. This indicates an ability to replace poled polymer and conventional ceramic transducer materials in numerous sensor and actuator devices and produce benefits in simplified processing, cost savings and improved performance. In addition, the ability to select patterns and release portions of ESA-processed multilayer films allows the formation of MEMS structures, and thereby a new approach to surface micromachining.

Phase II will optimize the ESA synthesis process in manufacture of sensors, actuators, and MEMS products and demonstrate ESA thin-film based devices, including polymer MEMS. New ESA-processed piezoelectric and electrostrictive thin film materials will have widespread potential commercial applications in sensor and actuator devices used for instrumentation and controls.

Title: SBIR Phase II: In-Situ, Real-Time Process Control for Micro-Electro-Mechanical System (MEMS) Applications

Award Number: 9983399
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: August 31, 2003
Total Amount: $399,983

Investigator: Sylvie Charpenay, Sylvie_bosch-charpenay@mksinst.com
Company: On-Line Technologies Incorporated
87 Church Street
East Hartford, CT 06108
Phone: (860)291-0719

Abstract:

This Small Business Innovation Research Phase II project will develop a multiple-applications, low-cost, real-time process monitoring and control tool for micro-electro-mechanical system (MEMS) deep-etch fabrication. Deep-etch processes are used to manufacture high aspect ratio structures up to several hundred microns thick, and promise to deliver new devices with increased performance and functionality at lower cost. A major difficulty in deep-etch technology is the control of the etch depth, which is currently measured post-etch using ex-situ destructive scanning electron microscopy. This is extremely inefficient, and is a major hurdle to be surmounted before extensive production takes place. During Phase I, an FTIR-based sensor was designed, constructed and installed on top of an etcher chamber. Etch depth and photoresist thickness measurements were obtained, for the first time ever, in-situ and in real-time on several MEMS structures. An excellent correlation between the FTIR measurements and SEM measurements was found. During Phase II, analysis models will be developed and implemented to measure the widest possible range of MEMS structures. These models will extract multiple parameters on any type of patterns, and will allow the use of the sensor for various applications, including deep trenches in silicon or SOI (silicon on insulator) wafers, membranes, thick photoresist, and mainstream silicon applications such as DRAM (Dynamic Random Access Memory) trenches. Hardware will be optimized for spot size, measurement spot range, compactness and, very importantly for the cost-sensitive MEMS industry, for cost.

The result of this project will be the development of a metrology tool with capabilities currently unavailable, and which are in high and increasing need. The specific anticipated results of the use of the proposed metrology are: (1) to reduce cost through the reduction of destructive measurements and the improvement in process control,(2) to increase the reproducibility of the MEMS structures through better process control (run to run accuracy is currently ~3 % and is expected to be lowered by the use of the sensor to <0.5 %), (3) to provide useful feed-back for process development, thus reducing development time. These results will have a great impact on the deep-etch MEMS market, as they willhelp future MEMS applications to mature and come to market at a faster pace through cheaper characterization and improved process control. In addition, this first-of-a-kind real-time wafer-state monitoring and control technology will lead to applications within mainstream semiconductor processing such as DRAM.

Title: SBIR Phase II: Photonic Networking of Micro-Electro-Mechanical Systems Arrays for Smart Structures

Award Number: 9986118
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2004
Total Amount: $797,292

Investigator: Behzad Moslehi, bm@ifos.com
Company: Intelligent Fiber Optic Systems Corporation
650 Vaqueros Avenue, A
Sunnyvale, CA 94085
Phone: (408)328-8610

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop novel photonic ModeRouting networks containing many nodes for monitoring and controlling the structural health and function of complex systems. Each node is, in general, a microsystem that combines sensing, computing, and actuating functions. The microsystems may contain many Micro-Electro-Mechanical Systems (MEMS) with aggregate data rates approaching gigabits-per-second. This research addresses the enormous challenge for interrogating, activating, and controlling all microdevices through a high-capacity interconnection system. Wire-based and wireless approaches cannot handle such data rates. Further problems include operation in electrically noisy and potentially explosive environments. The innovative IFOS solution offers high-efficiency, ultra-high capacity, electromagnetic-interference-immunity, electrical-passivity, and expendability. Phase II will optimize, fabricate, and test several MEMS array nodes, MEMS fiber interfacing, and PhotoPowering, as well as design and build an expandable, ModeRouting network of MEMS nodes.

Commercial applications of the IFOS photonically-interconnected MEMS array networks include civil, mechanical, aerospace, chemical, and marine engineering, particularly monitoring and control of programmable structures by microsensors and microactuators for mechanical systems, electrical power plants, automobiles, materials processing, and medicine.

Title: SBIR Phase II: Investigation of Charge Trapping in Plasma Enhanced Chemical Vapor Deposition (PECVD) Dielectrics Using Electrostatically Actuated Mechanical Resonators

Award Number: 0331436
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $499,882

Investigator: Igal Ladabaum, igal.ladabaum@sensant.com
Company: Sensant
14470 Doolittle Dr.
San Leandro, CA 94577-5546
Phone: (510)346-8166

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop high quality dielectric films and structures for a family of ultrasonic transducers for medical imaging applications. The technology and methods developed in Phase I to characterize charge-trapping behavior of dielectrics are the critical innovations required to take micro-fabricated ultrasonic transducers from their current state to a commercially viable state. Charge trapping created by the high electric fields in the device is detrimental to transducer performance. Charge trapping is dependent on field polarity and causes shifts in electromechanical conversion efficiency in time. Variations in charge trapping within a transducer array are even more disruptive. A process that removes the polarity dependence of charge trapping and thereby enables a new type of bipolar ultrasound imaging array that improves image quality will be developed. Since performance and reliability are critical to successful commercialization of these ultrasound probes, the issues of how dielectric charging causes time-dependent loss in performance and material degradation that could limit lifetime will be researched.

The development and commercialization of micro-fabricated ultrasound transducers (MUT) is targeted at the medical applications market. This work will also enable the development of ultrasound probes that can non-invasively provide more accurate diagnostic information for doctors, such as improved ability to distinguish between cancerous and benign tissue. The image quality to price ratio drives market share in the global $3Billion diagnostic ultrasound market. These novel ultrasonic transducers will significantly improve the image quality/price ratio, and thus realistically create market share swings of 5% upon product release. Specifically, in the $1Billion mid-to-premium segment of the radiology market most relevant to the proposed research, $50M of annual system sales would be generated by the introduction of MUT probes, of which approximately one third are direct probe sales.

Title: SBIR Phase II: An Innovative Normal Stress Sensor System for Complete Characterization of Polymer Shear Flow Properties

Award Number: 0318662
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $499,289

Investigator: Seong-Gi Baek, seonggibaek@rheosense.com
Company: Rheosense
2357 Ventura Drive, Suite 104
Woodbury, MN 55125
Phone: (651)714-3842

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will address several technical improvements needed for successful commercialization of a novel MEMS sensor plate containing monolithic miniature capacitive pressure sensors. As shown in Phase I, the sensor plate can be used to accurately measure the first (N1) and second (N2) normal stress differences, which are important nonlinear elastic flow properties of various classes of viscoelastic liquids. In Phase II, sensor packaging and lead transfer to the sensors will be made suitable for high volume, high quality manufacturing of sensor plates. One version will be optimized for measurements at lower pressures and another version optimized for measurements on molten commercial thermoplastics at higher temperatures and pressures. The latter version of the sensor plate will be smaller in diameter to make possible measurements on smaller samples at higher shear rates, and will contain miniature temperature sensors that will enable accurate compensation for changes in sensor calibration constant with temperature. Improvements will be tested with a wide variety of commercial polymer systems and other important classes of viscoelastic liquids.

This novel sensor plate will meet the critical market need for an inexpensive instrument for fully characterizing shear flow properties of molten thermoplastics. The competing alternative technology, the force rebalance transducer (FRT) is expensive and works best with large samples. It is simpler/less expensive to adapt a sensor plate rather than a transducer to existing rheometers. Hence the sensor plate has significant commercial potential to satisfy pent-up demand for an inexpensive way to upgrade rheometers to allow flow elasticity measurements.

Title: SBIR Phase II: Harsh Environment Fluid Viscosity-Density Sensor

Award Number: 0239151
Program Manager: Winslow L. Sargeant

Start Date: February 15, 2003
Expires: January 31, 2005
Total Amount: $500,000
Investigator: Richard Mlcak, mlcak@bostonms.com
Company: Boston MicroSystems, Inc.
30-H Sixth Road
Woburn, MA 01801-1758
Phone: (781)933-5100

Abstract:

This Small Business Innovation Research Phase II project is aimed at developing MEMS-based miniaturized fluid viscosity and density sensors that can operate within small confines provide electronic readout, and that are capable of surviving harsh environments (high temperature, high pressure, corrosive, abrasive) typical of many fluid sensor applications. The Harsh Environment Fluid Viscosity-Density Sensor consists of a packaged flexural plate wave (FPW) resonator instrumented with low cost, compact electronics for sensor read-out. In Phase I, the technical objectives were successfully accomplished by fabricating resonant FPW fluid sensors from harsh environment compatible single crystal SiC and epitaxial piezoelectric AlN materials, and demonstrated their ability to independently measure fluid viscosity and density. In Phase II, fully functional, packaged and electronically instrumented Harsh Environment Fluid Viscosity-Density Sensor prototypes will be developed and optimized for specific customer applications. The fluid sensors will be field tested in our customer's systems to demonstrate precise and accurate fluid viscosity and density measurements and stable operation in the customer's fluids and environmental conditions. After successful completion of Phase II, the Harsh Environment Fluid Viscosity-Density Sensor will be ready for scale-up manufacturing and commercialization in Phase III.

The Harsh Environment Fluid Viscosity-Density Sensor has commercial applications in 1) Condition-Based Maintenance of oils and other fluids in engines and industrial process equipment, 2) Process and Quality Control in manufacturing, chemical processing and water/waste treatment industries, and 3) down-hole sensors for Petrochemical Exploration and Extraction.

Title: SBIR Phase II: Novel Joining Method for Self-Assembly of Reliable Three Dimensional Micro-Electro-Mechanical Systems

Award Number: 0091582
Program Manager: Cheryl F. Albus

Start Date: June 1, 2001
Expires: May 31, 2003
Total Amount: $499,867

Investigator: Brian R. Schaible, brian@sporian.com
Company: Sporian Microsystems
4699 Nautilus Court South #201
Boulder, CO 80301
Phone: (303)516-9075

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will continue to develop a solder self-assembly process that was the concept explored in Phase I. It will build upon the successful Phase I results that demonstrated the use of solder to self-assemble two-dimensional surface micromachined Micro-Electro-Mechanical Systems (MEMS) into useful three-dimensional structures. This concept is a next step in the evolution of MEMS assembly. The overall objective of Phase II is to move the technology from the lab environment to a commercial production process that is well understood and has excellent yield. Research personnel from industry and education are involved and state-of-the-art equipment will be utilized.

A number of promising commercial applications have been identified and discussions with potential commercial partners suggest interest in commercializing this technology.

Title: SBIR Phase II: Microelectromechanical (MEMS) Mirror Arrays for Bioimaging Applications

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: 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

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.

Nanostructured Materials

Title: SBIR Phase II: A New Scale-Up Technology for Industrial Production of High Quality Semiconductor Nanocrystals

Award Number: 0321611
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $498,433

Investigator: Yongqiang A. Wang, awang@nn-labs.com
Company: NanoMF
3468. W. Yale St.
Fayetteville, AR 72704
Phone: (479)871-0707

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop the so-called Continuous Batch (CB) technology for the massive production of high quality semiconductor nanocrystals inexpensively. The CB technology has the following advantages over the most closely competitive technology, continuous flow production (CFP: It uses much less toxic and less expensive chemicals as reactants).

To date, production of high quality semiconductor nanocrystals can only be performed in well-equipped labs and in very small (dozens of milligram) quantities. The CB's potential for cost savings, improved qualities (i.e. size distribution, optical absorption, and photoluminescence emission) and the high productivity (thousand kilograms/year) makes it superior in comparison to the existing CFP technology.

Title: SBIR Phase II: Carbon-Coated Nano-Structured Electrodes for Next-Generation Lithium-Ion Batteries

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: 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 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

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

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: 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
Company: ITN Energy Systems Incorporated
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: STTR Phase II: Novel Nanocoated Ferromagnetic Materials

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.
11711 Chase Ct
Westminster, CO 80020
Phone: (303)460-9865

Abstract:

This Small Business Technology Transfer 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: 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
19 Thomas
Irvine, CA 92618
Phone: (949)829-5524

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: 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: SBIR Phase II: Next Generation Nano-Probes for Ultra-High Resolution Near Field Microscopy, Nanolithography, and High-Density Data Storage

Award Number: 0422018
Program Manager: T. James Rudd

Start Date: July 1, 2004
Expires: June 30, 2006
Total Amount: $498,094

Investigator: Ahmed Sharkawy, sharkawy@emphotonics.com
Company: EM Photonics, Inc.
51 E. Main Street
Newark, DE 19711
Phone: (302)456-9003

Abstract:

This Small Business Innovation Research Phase II project focuses on the development, demonstration, and commercialization of ultra-high resolution nano-probes for applications in near field scanning optical microscopy/spectroscopy (SNOM), nano-lithography and high-density optical data storage based on photonic band gap technology. In this Phase II project the planar, photonic crystal-based nano-probes analyzed and fabricated in Phase I will be optimized. In addition, the process for realizing full three-dimensional photonic crystal nano-probes will be developed. Tune-ability will be incorporated in the nano-probes by either varying the physical dimensions of an embedded nanocavity, within our probe, or by applying an external electric, or magnetic, field to modify the optical properties of a nanocavity and hence modulate its resonant frequency, or line width. By tuning the operational wavelength of the nano-probes, they can be used to image rather complex spatial features at various spectral wavelengths. The nano-probe will be combined with an integrated spectrometer for spectral filtering of various detected wavelengths. Both the nano-probe and the spectrometer are photonic crystal based and hence can be integrated on a single device. Recently developed technology, which is referred to as combinational lithography, will be used to realize a three-dimensional nano-probe. The advantage here is that by having full lateral confinement one can realize a nano-probe that can be scanned over a photoresist coated sample and used to expose it. The advantage the technique has over conventional SNOM exposure is that by using a photonic crystal nano-probe the lateral fields are localized to a much smaller region, which results in a much higher resolution exposure. To this end, the combinational lithography process is a technique for the fabrication of defects, such as tapered waveguides and resonators, embedded in a three-dimensional photonic crystal. The method is efficient, flexible and very economical for fabricating large-scale photonic crystals. As such, it allows for the arbitrary placement of defects within a high quality photonic crystal lattice of arbitrary symmetry, and achieves this in a minimum number of process steps.

Commercially the project will lead to multi-functional, high resolution photonic crystal based nanoprobes that will dramatically impact both the commercial and research fields of near-field optical microscopy, optical data storage, and nanolithography. The innovation has near term potential integration with current nano-photonic imaging and writing systems. In the future, these devices show potential for various systems requiring high resolution such as single molecule detection, which have generated significant interest in the physical and biological sciences and the study of small numbers of quantum dots, where probe requirements are far below that achievable by classical optics (~100nm) as is due in part to the high density of quantum dots which necessitate sub-micron optical resolution in order to isolate quantum dot structures.

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.

Title: SBIR Phase II: Reactive Mounting of Heat Sinks

Award Number: 0321500
Program Manager: Winslow L. Sargeant

Start Date: October 15, 2003
Expires: September 30, 2005
Total Amount: $500,000
Investigator: Timothy Weihs, tweihs@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 introduces a new reactive joining process for mounting heat sinks onto chips, chip packages and substrates. The process uses reactive multi-layer foils as local heat sources for melting solder layers, and consequently bonding the components. The foils are a new class of nano-engineered materials, in which self-propagating exothermic reactions can be ignited at room temperature with a spark. The work will focus on reactive mounting of heat sinks onto server chips, an application that is in critical need of performance improvements. Two alternatives will be considered - the reactive mounting of a copper heat sink onto a metallized heat spreader that surrounds the chip, and reactive mounting of the heat sink directly onto a metallized chip. Significant improvements in heat conduction in microelectronic devices are needed as existing approaches such as adhesives, greases and epoxies suffer a number of limitations such as poor thermal conductivity, low mechanical strength and/or susceptibility to degradation. With the decrease in the size and the increase in speed of microelectronic devices, poor heat dissipation has started to limit device performance and applications and thus has become a critical issue.

The worldwide market for thermal management in microelectronic devices is about $3.7 billion/year and high-end heat-sink mounting constitutes approximately 10% of this market

Title: SBIR Phase II: Aligned Carbon Nanotubes for Use as Atomic Force Microscope Tips

Award Number: 0078536
Program Manager: Winslow L. Sargeant

Start Date: September 15, 2000
Expires: August 31, 2002
Total Amount: $369,369

Investigator: Vladimir Mancevski, vam@xidex.com
Company: Xidex Corporation
8906 Wall Street, Suite 105
Austin, TX 78754
Phone: (512)339-0608

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to establishing the first-ever, large-scale production capability needed to manufacture carbon nanotube tips for scanning probe tools. To achieve this, the investigator must combine several fabrications technologies in a unique way. The investigator must also solve challenging problems related to the design, structural form and attachment of the tips themselves that will enable them, as the manufacturer, to guarantee that the products sold meets customers' performance specifications. It is believed, for example, that one of their proprietary technologies will enable them to produce carbon nanotube tips that meet the important requirement for adequate stiffness in lateral bending.

The core technology being commercialized stems from a new approach for growing a single, aligned carbon nanotube directly on a cantilever, originally identified by the PI. This approach is suitable for fabricating both the carbon nanotube tip and the cantilever in one continuous process, ideal for large-scale manufacturing. Xidex will develop, manufacture and sell carbon nanotube tips for use with critical dimension atomic force microscopes (CD-AFMs), scanning capacitance microscopes (SCMs), regular atomic force microscopes (AFMs) and scanning tunneling microscopes (STMs).

Title: SBIR Phase II: Development of High-Tc Superconducting Quantum Interference Device (SQUID) Magnetometers for Unshielded Operation

Award Number:	9983502
Program Manager:	Winslow L. Sargeant
Start Date:	April 1, 2000
Expires:	March 31, 2002
Total Amount:	$399,974

Investigator(s) Mark DiIorio, markd@magnes.com
Company: Magnesensors, Inc. (MSI)
9717-A Pacific Heights Boulevard
San Diego, CA 92121
Phone: (619)458-5752

Abstract:

This Small Business Innovation Research Phase II project is aimed at developing an ultra-sensitive magnetic sensor technology that is capable of operation in an unshielded environment. These compact sensors will be based on superconducting quantum interference devices (SQUIDs) that are fabricated from high temperature (high-Tc) superconducting materials. A collaborative effort between MagneSensors and U.C. Berkeley will employ novel design and materials processing solutions to produce high-Tc SQUIDs operating in ambient fields with an unprecedented level of sensitivity. The program will test the developed sensors on real-world applications at both low and high frequencies to demonstrate operation in the presence of large background magnetic field interference. This new enabling technology seeks to overcome the limitations in sensitivity, bandwidth, size, and spatial resolution, which restrict the more widespread application of present conventional magnetic field sensors. The eventual goal is the development of a low-cost, portable system with much greater sensitivity than is available with any other instrumentation.

This technology will enable the development of an entirely new generation of instrumentation that will find use in a wide variety of applications. Such applications include non-destructive evaluation of cracks and corrosion in aircraft, inspection of integrated circuits, homogeneous immunoassays and DNA probes using magnetic labels, geophysical surveying, environmental monitoring, detection of unexploded ordnance, diagnosis of intestinal ischemia, and screening for cardiac arrhythmias The potential market size for some of the applications reaches over $1 billion.

Title: SBIR Phase II: Characterization of Ceramic Particles Based on Elliptically Polarized Light

Award Number: 9983405
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2000
Expires: July 31, 2003
Total Amount: $761,977
Investigator: Sivakumar Manickavasagam, sivam@synergetic-tech.com
Company: Synergetic Technologies, Incorporated
One University Place Suite D-210
Rensselaer, NY 12144
Phone: (518)525-2650

Abstract:

This Small Business Innovation Research Phase II project is aimed at developing and demonstrating an innovative information-rich and real-time system for particle characterization. Encouraged by results from Phase I which established the feasibility of using polarized light scattering for characterization of micron, sub-micron and nano-sized ceramic particles, Synergetic Technologies proposes to develop an accurate and reliable on-line instrument. Phase I illustrated the high accuracy achievable, the ability to detect and quantify nano-size particles, and the capability of determining the size distribution of high aspect ratio whiskers and irregularly shaped particles. Project tasks include: system design, construction, calibration and testing; software development for more accurate shape determination and automized system use; study of different lasers; and testing and demonstration at three potential customer sites (a major ceramic research university, a large industrial research laboratory, and a small company at the leading edge of nanomaterials production). The University of Kentucky staff and students will assist in this project.

The ability to measure fine particle sizes and shapes on-line is necessary for controlling the quality of many high technology products, such as advanced ceramics and pharmaceuticals. In addition, monitoring and controlling particle size is fundamental to the manufacture of many consumer products, medical products, food processing and environmental monitoring.

Title: SBIR Phase II: Nanocrystalline Fe-Co For Electromagnetic Interference (EMI) Suppression

Award Number: 0239008
Program Manager: Winslow L. Sargeant

Start Date: January 1, 2003
Expires: December 31, 2004
Total Amount.: $500,000

Investigator: T. S. Sudarshan, sudarshan@matmod.com
Company: Materials Modification Inc
2721-D Merrilee Drive
Fairfax, VA 22031-0113
Phone: (703)560-1371

Abstract:

This Small Business Innovation Research Phase II project focuses on developing nanocrystalline soft ferromagnetic materials for various end use applications such as Electromagnetic Interference (EMI) suppression, magnetic bearings and inductors. Phase I clearly established the feasibility of producing these materials via a patented microwave plasma technique. In addition, these nanomaterials were consolidated to near theoretical densities using a patented plasma pressure compaction technique and the compacts exhibited high magnetic strength and low coercivity. During Phase II, the process will be to develop these materials for specific applications. Our Industrial partners will evaluate the produced materials to evaluate parameters, which are critical for transitioning the technology to an immediate useful product. In addition, an IP protection and various avenues to commercialize the technology will be sought.

There are numerous applications for nanocrystalline soft magnetic materials with superior magnetic and mechanical properties and low core loss. This includes EMI prevention components, generators, transformers, data communication interface component, magnetic bearings (commercial high-performance applications in the domain of rotating machinery), magnetic recording heads, motors, sensors, and reactors. MMI plans to focus on three market segments including (1) EMI suppression (2) Magnetic Bearings and (3) Inductors.

Title: SBIR Phase II: Nanoparticle Photostimulated Luminescence Based Optical Storage

Award Number: 0132030
Program Manager: Cheryl F. Albus

Start Date: February 1, 2002
Expires: January 31, 2004
Total Amount: $499,988
Investigator: Wei Chen, wchen@nomadics.com
Company: Nomadics Incorporated
1024 S. Innovation Way
Stillwater, OK 74074-1508
Phone: (405)372-9535

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will demonstrate the ability to generate photostimulated luminescence (PSL) in nanoparticles. The potential applications in digital imaging and storage offered by PSL phosphors, including X-ray imaging could be significant. PSL phosphors currently in use present several drawbacks including greater expense and poorer resolution as compared to conventional screen-film methods. The quantum confinement of nanoparticles offers solutions to many of the shortcomings of existing PSL phosphors. The project will characterize nanoparticles with a goal of optimizing these materials for use as phosphors in thin films. The project will also fabricate the required thin films and compare them to commercially available PSL phosphors for performance, longevity, and other factors of interest.

The commercial applications will be widely applicable to digital imaging, offering high resolution, low cost, easy storage, low complexity, easy portability, and other desirable features. Materials with efficient PSL have great potential for technical applications such as optical storage, X-ray imaging, radiation measurements and quality control, optical dosimeters and dating, infrared sensors, image intensifiers, near-infrared-to-visible light converters, and bio-molecular structure recording and probing.

Title: SBIR Phase II: Dissolution of Single-Walled Carbon Nanotubes

Award Number: 0110221
Program Manager: Cheryl F. Albus

Start Date: September 1, 2001
Expires: August 31, 2003
Total Amount: $499,938
Investigator: Mikhail E. Itkis, mitkis@engr.ucr.edu
Company: Carbon Solutions, Inc
5094 Victoria Hill Drive
Riverside, CA 92506-1450
Phone: (909)787-2229

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a cost-effective procedure for the production of soluble single-walled carbon nanotubes (SWNT) in commercial quantities. Phase I results demonstrated dissolution of full-length SWNTs in common organic solvents by exfoliation and covalent functionalization. It has been found that the purity of as-prepared SWNT (AP-SWNT) soot greatly influences both the cost and quality of the final product. The major emphasis for the project will be directed towards the synthesis of byproduct-free AP-SWNT soot, in purification of the SWNTs and in optimizing and scaling-up the dissolution step.

The dissolution of carbon nanotubes can greatly enhance the processability of this unique material and facilitate the entry of SWNTs into commercial applications requiring high strength lightweight materials, electromagnetic shielding materials, conductive composites and nanoelectronics. The development of the solution chemistry of SWNTs will facilitate applications in polymer science, and in medicine.

Title: SBIR Phase II: Nanomaterial for Microchip Chemical Sensors

Award Number: 0215819
Program Manager: T. James Rudd

Start Date: September 15, 2002
Expires: August 31, 2004
Total Amount: $499,994
Investigator: Stuart Farquharson, stu@rta.biz
Company: Real-Time Analyzers, Inc.
87 Church Street
East Hartford, CT 06108-3728
Phone: (860)528-9806

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project will develop a novel microchip chemical analyzer that incorporates a new nanomaterial that performs both separation and detection of small quantities of chemicals and biochemicals. Phase I demonstrated feasibility by incorporating a proprietary nanomaterial in 20- by 50-micron channels etched in a glass microchip and performing chemical separation and surface-enhanced Raman spectral analysis of several test chemicals. Phase II will complete development of the microchip chemical analyzer by designing reproducible plastic microchip cards that fit into an integrated micro-fluidics and Raman system. Development will include the following chemicals: p-aminobenzoic acid, phenyl acetylene, adenine, acetaminophen, secobarbitol, cocaine, and related metabolites.

The microchip analyzer will have broad commercial value to the agricultural, biotech, chemical agents, environmental, medical and pharmaceutical industries. Specifically, the microchip is being designed to measure drugs and metabolites in body fluids to aid clinical trials of new drugs, assist dosage control of chemotherapeutic drugs, and diagnose drug overdose.

Title: SBIR Phase II: Synthesis of High Capacity Sn/MOx Nano Composite Anode Materials for Lithium Rechargeable Batteries

Award Number: 0321628
Program Manager: T. James Rudd

Start Date: September 1, 2003
Expires: August 31, 2005
Total Amount: $500,000

Investigator: John M. Miller, jmiller@tjtechnologies.com
Company: T/J Technologies, Inc.
PO Box 2150
Ann Arbor, MI 48106-2150
Phone: (313)213-1637

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a metal-oxide tin-alloy nano-composite for use as an anode material in a new ultra-low cost lithium-ion battery. This new battery system could impact many applications and offer an environmentally benign alternative to lead acid batteries with significant performance enhancements. With the advent of ultra-low cost cathode materials, for example lithiated metal phosphates, the development of a complementary anode material is now the gating item for low-cost lithium-ion batteries. In Phase I, mixtures of transition metal oxides and tin alloy were successfully produced. The electrochemical and physical characteristics were evaluated and these materials showed excellent electrochemical performance but exhibited a high first cycle loss. Internal work on tin alloys mixed with transition metal carbides and nitrides suggests the first cycle loss could be improved through simple chemical modification of the oxide component. The Phase II work will involve development of these modified oxides to reduce first cycle loss. In addition low cost production methods will be developed for preparing the precursors and materials. Optimized electrodes for use in ultra-low cost battery prototypes will be produced and targeted for outside evaluation.

Commercially, this anode material will be combined with metal phosphate cathodes to make a new class of lithium-ion batteries that are cost competitive with lead-acid batteries and maintenance free. This higher energy lead acid replacement opens up opportunities in the growing UPS and HEV markets. There are also non-commercial impacts. Any reduced use of lead acid batteries, which creates toxic waste, is beneficial to the environment. This new class of batteries would lead to the reduction of the 50,000 tons of toxic lead released due to incomplete recycling of lead-acid batteries. The development of materials that enable lithium-ion batteries to be cost competitive with lead acid batteries could give US battery manufacturers a chance to compete against the Asian dominated rechargeable battery market.

Title: SBIR Phase II: Randomly Textured Nanoscale Surfaces for Silicon Solar Cells

Award Number: 0109098
Program Manager: Ritchie B. Coryell

Start Date: January 1, 2002
Expires: December 31, 2003
Total Amount: $472,584

Investigator: Saleem H. Zaidi, saleem@uswest.net
Company: Gratings, Incorporated
7104 Jefferson, N.E.
Albuquerque, NM 87109-4311
Phone: (505)889-4072

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will integrate random, reactive ion etching (RIE) texturing techniques into low-cost, multi-crystalline (mc) silicon (Si) solar cells. RIE texturing techniques, developed in Phase I, are distinguished by their low-reflection (1 percent), large area (200 square centimeters) application, and the ability to control etched profiles. This texture control has been employed to increase near infrared absorption in Si by enhanced oblique optical coupling into the substrate. RIE-texturing techniques have potential application in several fields including low-cost substrates for surface enhanced Raman scattering and field emission devices. Phase II will be concerned with conformal emitter formation techniques uniquely suited to RIE-textured surfaces. These methods will lead to solar cell manufacturing in a cluster environment with similar chambers for texturing, emitter formation, and nitride films for surface passivation.

Potential industrial applications are expected in high-efficiency, RIE-textured, mc-Si solar cells using processes suitable for their respective manufacturing environments.

Title: SBIR Phase II: Continuous Flow Reactor and Size-Selection Chromagraphic Scheme for Use in High Throughput Manufacture of Silicon Nanoparticles

Award Number: 0321688
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $499,903

Investigator: Fred V. Mikulec, fmikulec@innovalight.com
Company: InnovaLight
6801 N. 360 Hwy
Austin, TX 78731-1786
Phone: (512)795-5835

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is to continue the scale up of luminescent Si nanocrystal production using the continuous flow reactor developed during the Phase I period where the main objective of the Phase I proposal of converting a cumbersome batch process into an efficient continuous one was accomplished. This new continuous flow reactor will serve as an enabling technology because the system will be applicable to the high temperature synthesis of numerous nanoscale colloidal materials.

This technology could raise the average efficiency of conventional lighting from under 15% to more than 50%, potentially reducing the electricity consumed for illumination by a factor of 3X. The process can create particles that have many favorable attributes that lend themselves to other applications as well, many of which will be pursued for licensing. These include multi-level floating gate memory, optical interconnects, optical integrated circuits, electro-chemical products, fuel cells, bio-molecular recognition, battery electrodes, and displays.

Title: SBIR Phase II: Nanoparticle Te Inks for Spray Deposition of Submicron Te Contact Layers in CdTe Solar Cells

Award Number: 0216422
Program Manager: T. James Rudd

Start Date: September 1, 2002
Expires: August 31, 2004
Total Amount: $500,000

Investigator: Doug Schulz, schulz@ceramem.com
Company: CeraMem Corporation
12 Clematis Avenue
Waltham, MA 02453
Phone: (617)899-4495

Abstract:

This Small Business Innovation Research Phase II project is aimed at making Photovoltaic (PV) solar electric power more affordable to our nation and to the world. The technology in this program represents a new process for the manufacturing of cadmium Telluride (CdTe) solar cells. In this process the contact layers of copper-doped tellurium nanoparticles are sprayed on rather than sputtered, which promises to be a more efficient method of manufacturing. The successful CdTe solar cell prototype will be designed with input from potential end-users as a means of increasing the likelihood for commercialization.

It is anticipated that this process will result in solar cells with superior initial and long-term efficiencies. Such improvements in performance could result in reduced costs for solar cell manufacturing ($/W), higher power during operation (kW-h/yr), and an extension of the useful lifetime - three aspects that will allow solar energy to be more competitive with existing methods for electric power production.

Title: SBIR Phase II: High Performance Nano-Fe/SiO2 Soft Magnetic Cores Based on Exchange Coupling

Award Number: 0216929
Program Manager: T. James Rudd

Start Date: October 1, 2002
Expires: September 30, 2004
Total Amount: $499,997
Investigator: Yide Zhang, inframat@aol.com
Company: Inframat Corporation
74 Batterson Park Road
Farmington, CT 06032
Phone: (860)678-7561

Abstract:

This Small Business Innovation Phase II project is directed toward optimizing and scaling up fabrication of exchange coupled Fe/ceramic nanocomposites for high performance soft magnetic applications. In Phase I, Inframat Corporation took pioneering steps to develop Fe/ceramic magnetic nanocomposites, which resulted in significant improvements over microsized ferrites including higher saturation magnetization and lower power loss. The design of the Fe/ceramic nanocomposite is based on an exchange coupling effect between neighboring nanoparticles, where Fe nanoparticles are uniformly distributed within an insulating ceramic matrix. Successful Phase I efforts have provided the scientific and technological groundwork for further magnetic nanocomposite technology advancement in Phase II. The proposed Phase II program scales-up the Fe/ceramic nanocomposite technology performed in Phase I. Emphasis is on rapid commercialization of nanocomposite cores. Key Phase II milestones include (1) scale-up of the demonstrated chemical synthesis into pilot-scale production, (2) demonstration of prototype cores having desirable magnetic properties through exchange coupling, and (3) demonstration of high performance prototype DC-to-DC converters using the exchange coupled magnetic nanocomposite cores.

Phase II participants include Ceramic Magnetics, UConn, Villanova Univ., Georgia Tech, and a converter specialist, Colonel William McLyman. Ceramic Magnetics has pledged $75,000 cost share to the Phase II and will carry a $250,000 follow-on funding.

Title: SBIR Phase II: Fluorescent Polymeric Nanoparticles

Award Number: 0239285
Program Manager: T. James Rudd

Start Date: February 1, 2003
Expires: January 31, 2005
Total Amount: $499,998
Investigator: Lawrence F. Hancock, lhancock@nomadics.com
Company: Nomadics Incorporated
1024 S. Innovation Way
Stillwater, OK 74074-1508
Phone: (405)372-9535

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new generation of fluorescence amplifying reagents based on poly (phenylene ethynylene (PPE) nanoparticles. Because of the role of the amplifying polymer in the enhanced sensitivity of these compounds, these compounds are called Amplimer reagents. The project will develop and launch two types of Amplimer reagents: microarray and quantitative PCR reagents. The Amplimer reagents will improve the sensitivity and performance of fluorescence-based assays by providing brighter, more stable fluorescence signals and by improving sensitivity through fluorescence amplification effects.

The commercial and broader impacts of this technology are consumable fluorescent reagents that improve the sensitivity and reliability of two rapidly growing diagnostic platforms for genetic sequence analysis: microarray-based assays and quantitative PCR assays. Diagnostics based on genetic sequence information currently account for $1 billion of the $24 billion dollar diagnostics market. This figure is expected to grow significantly as the follow-on of the human genome project filters through drug discovery and medical science.

Title: SBIR Phase II: Advanced Light Weight Thermal and Electrical Insulation Using Fullerenes

Award Number: 0320618
Program Manager: T. James Rudd

Start Date: July 1, 2003
Expires: June 30, 2005
Total Amount: $500,000

Investigator: Eugene M. Wexler, eveksler@mercorp.com
Company: Materials & Elctrochem/MER
7960 South Kolb Road
Tucson, AZ 85706
Phone: (520)574-1980

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a technology to produce an advanced high efficiency multi-layer thermal and electrical insulation using fullerenes. The recently completed Phase I project has demonstrated absolute technical and economical feasibility of producing and utilizing such insulation systems resulting from the unique thermal properties of fullerenes. Fabricated samples of fullerene-based insulation were shown to possess R-values of 36 to 40 per inch of thickness, which considerably exceeds those of commonly available insulation materials (for example, polyurethane (R6.7), expanded polystyrene (R3.8), and even vacuum insulated panels (R9~24)). In addition, proposed fullerene-based insulation is very compact, lightweight and cost-effective. During the course of this Phase II project, the team will optimize fabrication technology, structure and properties of the proposed fullerene-based insulation as well as perform an extended prototype study by producing and fully characterizing various insulation systems. At the completion of this effort, an optimized fabrication technology for producing advanced thermal and electrical insulation systems will be demonstrated, commercial application identified and extensive testing at a potential customer site initiated in order to start the product certification process.

Commercially, the proposed high efficiency thermal and electrical insulation system will have numerous applications, especially in the area of cryogenic temperatures. Based on high performance, ultimate compactness, flexibility and lightweight, the premier field of application will include miniature cryogenic storage and shipping containers utilized in pharmaceutical industry, neuro- and bio-storage, assisted reproduction, oncology research, immunology, gene therapy, tissue banking, food industry, micro-refrigerators and mechanical freezers, etc.

Title: STTR Phase II: Vertical-Cavity Surface-Emitting Laser Based on Nanostructured Active Material

Award Number: 0321699
Program Manager: T. James Rudd

Start Date: July 1, 2003
Expires: June 30, 2005
Total Amount: $500,000
Investigator: Matt Kim, mkmicrolink@aol.com
Company: MicroLink
6457 Howard Street
Niles, IL 60714-3301
Phone: (847)588-3001

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will develop a vertical cavity surface emitting laser (VCSEL) that operates at 1.3 micron wavelength based on incorporating a quantum dot active region of GaAs-based InAs and GaAsSb. It is based on recent research developments within the university laboratory in developing novel 1.3 micron laser and VCSEL sources, and the commercial epitaxial growth capability of the company. In the project the tasks involved include growing GaAsSb quantum dots and quantum well structures, fabricating VCSELs using the InGaAs and GaAsSb based quantum dot and GaAsSb quantum well active regions, and development, demonstration and evaluation of manufacturable, high Q cavity suitable for commercial 1.3 micron VCSELs.

Commercially the project will lead to important new products for an emerging fiber optic market. The low cost 1.3 micron wavelength VCSEL is viewed by industry analysts as a key enabling device for high volume production of fiber optic transceivers for the metro and metro access markets.

Title: STTR Phase II: Benign Thin Film Composite Particles for Protection from UVA/UVB - Rays

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: 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: SBIR Phase II: Commercial Scale Production of High Quality and Affordable Fe3O4 Nanocrystals for Nano-Biomedicine

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: 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: Nanomaterial Innovation Ltd.
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: 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: Integration of Nanostructured Electrodes with Organosilicon Electrolytes for High Energy-Density Supercapacitors

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: 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 Technologies, Inc.
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: Nanostructured Materials and Process for Improved Electrochromic Device Performance

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: Supercritical Fluid Processing of Polymer/Clay Nanocomposites

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: nanoScienceEngineering Corporation
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: 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.

Photonics

Title: SBIR Phase II: Phase Locking of High Power Fiber Laser Arrays

Award Number: 0091378
Program Manager: Winslow L. Sargeant

Start Date: January 15, 2001
Expires: December 31, 2003
Total Amount: $499,987
Investigator: Peter K. Cheo, p.cheo@att.net
Company: PC Photonics Corporation
64 Windward Way
Waterford, CT 06385
Phone: (203)443-4356

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is aimed at achieving the first ever 350W (cw) output power in a high brightness and diffraction-limited laser beam from a multicore phase-locked fiber laser array. Under Phase I, the feasibility of the unique power combining concept has been demonstrated by phase-locking a group of 7 Yb-doped single mode fiber lasers, embedded in a common cladding. In addition, a theoretical model has been developed, providing a deeper understanding of physical mechanisms responsible for phase locking of a multicore fiber laser array. These results clearly indicate that this extremely challenging goal for Phase II can be accomplished. Nevertheless, there remain several obstacles that need to be removed before embarking on commercialization. First, a significant improvement of the laser performance must be made. This can be accomplished by exploring various parameters, which include fiber length, cavity finesse, gain saturation, temperature and stress distributions, as well as fiber structural parameters, such as core separation and the V-value. In addition, an order of magnitude improvement for efficient coupling of pump power into the clad must be made. To advance this technology, various pumping techniques will be explored, in particular the side pumping of the fiber laser from the cladding walls, instead of the fiber end facets. If successfully developed, this could be the most viable way to obtain the maximum output power without causing catastrophic damage. Finally, the reliability of the device when operating at very high power level must be established by raising the power-damaging threshold.

High power diode-pumped multicore fiber lasers can be very competitive in the market place as compared to high power diode-pumped solid-state lasers and C02 lasers presently employed by automotive, aerospace and ship-building industries for precision drilling, high-speed cutting and welding of metals and composition materials.

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
Company: Boston Applied Technologies, Incorporated
6F Gill Street
Woburn MA, 01801
Phone: (781)935-2800

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
Investigator: Hisham Menkara, hisham@phosphortech.com
Company: PhosphorTech Corporation
#154
Atlanta GA, 30318
Phone: (404)664-5008

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
Company: United Silicon Carbide, Inc
100 Jersey Ave
New Brunswick NJ, 8901
Phone: (732)565-9500

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

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
Company: OEPIC Semiconductors, Inc
1231 Bordeaux Dr
Sunnyvale CA, 94089
Phone: (408)752-9139

Abstract:

This 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: Ultimate Sensitivity Photodetector

Award Number: 0450605
Program Manager: Juan E. Figueroa

Start Date: February 1, 2007
Expires: January 31, 2007
Total Amount: $355,974
Investigator: Eric Harmon, harmon@lightspintech.com
Company: Lightspin Technologies, Inc
4407 Elm Street, Suite 300
Bethesda MD, 20815
Phone: (301)656-7600

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: 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
Company: Photodigm, Inc
1155 E Collins Blvd 200
Richardon TX, 75081
Phone: (972)235-7584

Abstract:

This Small Business Innovation Research 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: 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
Company: Chiral Photonics, Inc
115 Industrial East
Clifton NJ, 7012
Phone: (973)594-8888

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: 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
Company: ONDAX Inc
850 E Duarte Rd
Monrovia CA, 91016
Phone: (626)357-9600

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: Liquid-Crystal Waveguides for Optical Integrated Circuits

Award Number: 0450463
Program Manager: Juan E. Figueroa

Start Date: February 1, 2007
Expires: January 31, 2007
Total Amount: $499,565

Investigator: Mike Anderson, anderson@vescentphotonics.com
Company: Vescent Photonics Inc
2927 Welton St
Denver CO, 80205
Phone: (303)296-6766

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: Photonic Crystal Coherent Thermal Emission for Sensors

Award Number: 0450397
Program Manager: Juan E. Figueroa

Start Date: February 1, 2007
Expires: January 31, 2007
Total Amount: $495,949

Investigator: Irina Puscasu, ipuscasu@ion-optics.com
Company: Ion Optics Inc
411 Waverley Oaks Rd Ste 144
Waltham MA, 02452
Phone: (617)788-8777

Abstract:

This 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: Integrated Dense Wavelength Division Multiplexing (DWDM) 3D Micro-Opto-Electro-Mechanical Systems (MOEMS) Optical Switch for Dynamically Reconfigurable Network

Award Number: 0422155
Program Manager: Muralidharan S. Nair

Start Date: September 1, 2004
Expires: August 31, 2006
Total Amount: $499,925

Investigator: Roger Helkey, helkey@calient.net
Company: Calient Networks
25 Castilian Drive
Goleta, CA 93117
Phone: (805)562-5501

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: Muralidharan S. Nair

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $499,954

Investigator: Evgueni Slobodtchikov, slobodtchikov@qpeak.com
Company: Q Peak, Inc.
135 South Rd
Bedford, MA 01730
Phone: (781)275-9535

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: Compact, High-Power, Terahertz (THz) Radiation Source

Award Number: 0422057
Program Manager: Muralidharan S. Nair

Start Date: September 15, 2004
Expires: August 31, 2006
Total Amount: $500,000
Investigator: Hans Bluem, hans_bluem@mail.aesys.net
Company: Advanced Energy Systems
27 Industrial Blvd, Unit E
Medford, NY 11763
Phone: (609)514-0316

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: All-Optical Method to Detect and Diagnose Optical Faults in Advanced Optical Networks

Award Number: 0419104
Program Manager: Muralidharan S. Nair

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $499,226

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

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: Muralidharan S. Nair

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $500,000
Investigator: Stephen Senturia, sds@polychromix.com
Company: Polychromix, Inc.
10 State Street
Woburn, MA 01801
Phone: (781)569-6199

Abstract:

This Small Business Innovation Research 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: Muralidharan 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 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.

Title: SBIR Phase II: Fiber Optics Confocal Module for Biomedical Application

Award Number: 9983313
Program Manager: Om P. Sahai

Start Date: April 1, 2000
Expires: September 30, 2002
Total Amount: $399,996
Investigator: Indu Saxena, sbirproposals@intopsys.com
Company: Intelligent Optical Systems Inc
2520 W. 237th Street
Torrance, CA 90505
Phone: (310)530-7130

Abstract:

This Small Business Innovation Research Phase II project is to develop a highly versatile fiber optics-based confocal system for biomedical applications. The proposed confocal fiber optics systems utilizes optical fiber technology to offer extreme compactness, multiple wavelength light excitation/detection (N X N coupling) minimal adjustment, and very low cost. One of the unique advantages of using optical fiber for confocal microscopy is that both the entrance and exit pinholes are, in fact, the endface of the core of an optical fiber, which guarantees that the system will always remain in alignment. During Phase I of the project, we designed and developed two laboratory optical configurations: one for retrofitting regular upright microscopes, and one for high density microarray scanners, we then successfully demonstrated the feasibility of these optical fiber confocal systems.

In Phase II, we will expand the fiber and wavelength multiplexity, maximize photon efficiency, optimize the confocal fiber optical module, develop a biochip-based confocal fiber probe array, and characterize and test the systems by performing bioassays. IOS's fiber optics-based will provide confocal microscopes with a capability that will significantly reduce the cost of the system, increase the versatility of the wavelength selection, and increase the popularity of using the confocal effect for many different important applications

Title: SBIR Phase II: Enhanced Organic Electroluminescent Display

Award Number: 9983435
Program Manager: Winslow L. Sargeant

Start Date: June 15, 2000
Expires: August 31, 2003
Total Amount: $392,272
Investigator: Shujun Wang, shujunw@reveo.com
Company: Reveo Incorporated
3 Westchester Plaza
Elmsford, NY 10523
Phone: (914)345-9555

Abstract:

This Small Business Innovation Research Phase II project continues Reveo's successful development of unprecedented high-brightness, polarized-light-emitting electroluminescent devices (ELD's) for the immediate applications of energy-efficient liquid crystal display (LCD) and dashboard backlights, as well as the longer-term applications of glare-free general room lighting and automobile headlights. Polarized light is essential to reduce distracting glare from indoor lights for LCD backlights. However, all current methods of producing polarized light rely on a bulky polarizing panel placed in front of an unpolarized light source. Some have the serious disadvantage of wasting half the energy by absorbing one polarization state, but even reflective panels that polarize the light without waste suffer from the intrinsic disadvantages of high cost, complicated manufacturing, and inconvenient packaging. Reveo's ELD promises to be the first commercially viable polarized light source, bypassing all the disadvantages of present reflective polarizing panels while offering dramatic energy savings of a factor of two in LCD and dashboard backlights by eliminating the need for a polarizer altogether. In Phase II, we will construct prototype demonstration backlights to attract funding commitments from strategic partners, placing this revolutionary technology firmly on the path to fruition for the benefit of the environment and humanity. The polarization properties of light are used ubiquitously in modern technology, as both enabling concepts for other technologies and as direct, important improvements in people's lives.

Reveo's polarized-light-emitting electroluminescent device has immediate applications as an LCD backlight, allowing energy savings of a factor of two without being significantly more expensive than current backlights. With further development, this technology offers the potential of functioning as a polarized "light bulb" for room light, reducing eyestrain and other health consequences of glare for millions of office workers. The advent of a low-cost, high-brightness polarized light source has far-reaching positive impact on the environment, the economy, and indeed American health.

Title: SBIR Phase II: Development of a Compact, Lightweight Millimeter-Wave Source

Award Number: 9983471
Program Manager: Winslow L. Sargeant

Start Date: May 1, 2000
Expires: July 31, 2002
Total Amount: $400,000
Investigator: Jose Velazco, jvelazco@microwavetech.com
Company: Microwave Technologies Inc
5716 Edgewater Oak Court
Burke, VA 22015
Phone: (703)250-1440

Abstract:

This Small Business Innovation Research Phase II project will involve the experimental study of a novel millimeter-wave source (MWS) that will provide short-wavelength radiation for numerous civilian and military applications. The MWS is based on novel synchronous interactions between a pencil electron beam and rotating wave fields. Our Phase I studies confirm that the MWS will offer order of magnitude improvements in the overall size and weight when compared to conventional millimeter-wave sources which will make these new devices less complex, more affordable, and readily available for a diversity of applications. Some of the applications for these devices include high-resolution radar, satellite telecommunications systems, power beaming, and electron cyclotron resonance heating of fusion plasmas. Also, due to the fact that the MWS does not require a focusing magnetic field, it should be suitable for airborne and mobile applications, as well as other commercial applications where size, weight, and efficiency are critical. Detailed experimental analysis of this concept is proposed during Phase II in order to evaluate key issues such as beam transport, maximum output power, efficiency and gain.

Once successfully developed, the MWS will be the basis for a new generation of millimeter-wave sources capable of producing high-power ultrahigh frequency radiation with high efficiency in a very compact and lightweight package.

Title: SBIR Phase II: Fiber-Optic Magnetic-Field Sensor System Employing Highly-Efficient Photonic Signal Processing

Award Number: 9986120
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2004
Total Amount< $771,893

Investigator: Behzad Moslehi, bm@ifos.com
Company: Intelligent Fiber Optic Systems Corporation
650 Vaqueros Avenue, A
Sunnyvale, CA 94085
Phone: (408)328-8610

Abstract:

This Small Business Innovation Research Phase II project expands the magnetic-field sensor system developed in Phase I into an optimized system containing an array of multiplexed two-dimensional sensors using mode-routing architecture for industrial process control systems, including physical-vapor-deposition (PVD) reactors containing magnetic orientation devices which are used in the manufacture of magnetic storage disks and recording heads. The uniformity and orientation of these magnetic fields need to be measured and controlled with high accuracy. In Phase I, IFOS demonstrated devices that virtually eliminate power losses that are characteristic of other known fiber-optic magnetic sensor arrays. IFOS has fabricated novel photonic mode-routing components, built a feasibility system prototype with new sensing materials and ultra-high-resolution demultiplexing, and conducted preliminary tests. IFOS, in collaboration with a federal laboratory, identified another appllication involving cryogenic systems to avoid thermal-leakage problems of electronic sensors. The IFOS solution enables achievement of the necessary accuracy and cost goals. The Phase II objective is to design and construct an optimized 5-point vectorial magnetic-field-sensor system for PVD reactor installation, as well as a 2-sensor system for cryogenic applications. IFOS' strategic partners will provide Phase-II and Phase-III-kind and cash contributions. Commercial applications include measurement of magnetic orientation and confinement fields for PVD systems, cryogenic systems, electric power utilities, hydrogen fusion chambers and linear acccelerators. Improving PVD industrial process control, will yield higher sensitivity and reliability. It will enable storage densities exceeding 60 Gbit/inch2 on rigid media.

This is a significant market opportunity identified by IFOS and its strategic partner, the market leader for data-storage PVD systems. Other applications exist in the measurement of leakage current and line sag in high-voltage transmission towers, and complex stresses in automotive, aerospace, and civil structures. The technology will have an impact in a wide variety of optical fiber sensor systems and optical components and subsystems, such as magnetically-actuated tunable optical filters and switches, add-drop multiplexers as well as mode-routing components. IFOS magnetic sensor systems are immune to electromagnetic interference, elecrically and chemically passive, compact, light weight and suitable for use in explosive environments

Title: SBIR Phase II: Ultra-Compact Driver Technology for Extending the Lifetime of High Power Laser Diode Arrays

Award Number: 0109913
Program Manager: Winslow L. Sargeant

Start Date: September 15, 2001
Expires: August 31, 2003
Total Amount: $499,960

Investigator: Rodney A. Petr, rpetr@srl.com
Company: Science Research Lab Inc
15 Ward Street
Somerville, MA 02143
Phone: (617)547-1122

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop compact, all-solid-state, pulsed drivers coupled with solid-state protection circuitry for powering laser diodes/diode arrays and increasing their reliability and lifetime. New high-current semiconductor switch technology will be coupled with proprietary new diode protection circuits featuring fault-mode detection and high-speed current limiting to extend laser diode lifetime tenfold. This leads directly to a tenfold reduction in annual laser operating cost. Recent breakthroughs in high power semiconductor technology, namely the Gate Commutated Thyristor (GCT) switch, also offer significant improvement in speed, power, and compact size over existing commercial devices. Phase II will develop advanced, compact pulsed power modules based on these technologies.

GCT technology, coupled with a proprietary fast protection circuitry, offers a significant decrease in diode laser system size and weight and a tenfold decrease in laser cost-of-ownership made possible by increased diode lifetime. New commercial applications for the diode-pumped solid-state lasers are expected to include powering diodes for optical telecommunications and ultraviolet and X-ray point sources for Next Generation Lithography in the semiconductor industry, as well as in laser cutting and welding. Medical uses for this new fault-protected, solid-state driver technology will include oncology and gene therapy.

Title: SBIR Phase II: Material Processing for Optimizing the Performance of an Embedded Bragg Grating

Award Number:	0110490
Program Manager:	Winslow L. Sargeant
Start Date:	September 1, 2001
Expires:	August 31, 2004
Total Amount:	$499,540

Investigator: Philip R. Battle, battle@advr-inc.com
Company: AdvR
910 Technology Blvd Suite K
Bozeman, MT 59718
Phone: (406)522-0388

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will enable the fabrication of waveguides in potassium titanyl phosphate (KTP) containing Bragg gratings with specified spectral and electro-optic characteristics. These characteristics include selectivity, bandwidth, central wavelength, and electro-optic tuning range. To achieve this goal, the relationship between the processing steps used to form the Bragg grating and its resulting spectral and electro-optic properties will be fully quantified. The ability to control the spectral characteristics and electro-optically tune these gratings will enable a broad range of new and commercially useful devices. Using the processing steps developed, an array of Bragg gratings will be fabricated with each grating optimized for stabilizing the wavelength of a laser diode. Translating the waveguide array with respect to the laser diode will tune its wavelength. This novel tuning technique will have significant technical and cost advantages over other tuning techniques.

Potential commercial applications include tunable filters for active dispersion compensation, high-speed add/drop filters for wavelength division multiplexing (WDM), and a broadly tunable source for test and evaluation of network components. Other applications include stabilizing laser diodes for spectroscopy, seeding high power lasers, and frequency doubled diode-based replacement lasers for low power Argon-Ion and helium cadmium (HeCd) lasers.

Title: SBIR Phase II: Novel Multi-Wavelength Time-Resolved Laser Induced Fluorescence Detector

Award Number: 0091507
Program Manager: Winslow L. Sargeant

Start Date: May 1, 2001
Expires: June 30, 2003
Total Amount: $500,000

Investigator: Daniel Engebretson, dengebretson@dakotatechnologies.com
Company: Dakota Technologies, Inc.
2201A 12th Street North
Fargo, ND 58102-1808
Phone: (701)237-4908

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will lead to a breakthrough in the use of laser-induced fluorescence (LIF) for chromatographic detection. Commercial standalone LIF detectors are based on CW lasers and collect data at a fixed wavelength. Consequently, they add minimal capability for resolving complex mixtures beyond that inherent in the chromatographic separation itself. On-the-fly fluorescence lifetime measurements at a single emission wavelength have been proposed as a better way to resolve the signals of co-eluting species. Our approach is far more powerful because it provides lifetimes on-the-fly and at several wavelengths simultaneously. A new prism flow cell fiber optically coupled to the emission spectrograph was introduced in Phase I. In addition, two different algorithms strategies for analyzing the multi-dimensional fluorescence data were developed and demonstrated. In Phase II a diode-pumped laser will replace the flashlamp pumped excitation laser, thereby providing 100 times higher pulse repetition frequency, 10 times shorter pulse duration, and 10 times better shot-to-shot stability. New digitizer technology will be incorporated to accommodate the laser's high repetition frequency. Important Phase II activities include fluorescence methods development to extend the range of applications to drugs and drug metabolites and elaboration of the chemometric algorithms.

The instrumental approach to be realized through the Phase II research will have a profound impact on QA/QC assessments of drug purity, bioequivalence and pharmacokinetic studies, and research investigations in humans and animals. Sales of several hundred units per year to pharmaceutical manufacturers, contract research organizations, and universities are anticipated. The technology will later be adapted for faster and more accurate DNA sequencing.

Title: SBIR Phase II: Multi-Channel Fluorescence Lifetime Measuring Instrument Using a Novel Low-Cost Digitizer

Award Number: 0321573
Program Manager: Winslow L. Sargeant

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $500,000

Investigator: Mark J. Pavicic, mpavicic@dakotatechnologies.com
Company: Dakota Technologies, Inc.
2201A 12th Street North
Fargo, ND 58102-1808
Phone: (701)237-4908

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will deliver a low-cost, multi-channel digitizer that can revolutionize applications of fluorescence sensing with its ability to accurately capture over 10,000 complete fluorescence decay curves (waveforms) per second per channel. This novel low-cost digitizer exploits a unique 'flash capture' approach to analog-to-digital (A/D) conversion to achieve an exceptional combination of speed (>1GS/s), resolution (10 bits), and low power. Fluorescence sensing measurement underlies an immense array of cutting-edge applications because it provides a sensitive and versatile probe into nano-scale behavior and properties. The project will develop a full-featured instrument-grade engineering prototype of the digitizer and integrate it into a portable demonstration instrument to showcase capabilities such as distinguishing biological or chemical agents by their spectral and temporal signatures.

This custom digitizer will match the capabilities of laser-induced fluorescence (LIF) to deliver accurate, cost effective, and complete data collection. The digitizer will be the first low-cost compact digitizer suitable for the specific front-end LIF analysis of biological agents. Among the weapons of mass destruction that threaten people around the world, biological agents are perceived to be the main hazard facing us today. The system's ability to capture more information, faster and more accurately will reduce the high occurrence of false alarms suffered by today's systems, resulting in a more reliable system with the potential to save lives. When integrated with biomedical instrumentation, the digitizer will have scientific and educational benefits through the use at academic institutions for research and discovery.

Title: SBIR Phase II: Laser Direct-Writing Technique to Produce Integrated Optical Amplifier/Splitter

Award Number: 0216288
Program Manager: Winslow L. Sargeant

Start Date: July 15, 2002
Expires: June 30, 2004
Total Amount: $499,998

Investigator: Douglas J. Taylor, djtaylor@tplinc.com
Company: TPL, Inc.
3921 Academy Parkway North, NE
Albuquerque, NM 87109-4416
Phone: (505)342-4471

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will continue the successful work from the Phase I project and develop integrated amplifier/splitters through laser direct writing of wet-chemically derived, erbium-doped coatings. Precursor solutions will be mixed on the molecular level to produce pure and homogeneous materials. Waveguide structures will be written into the erbium-doped fluoride coatings with a laser, which raises its index of refraction to confine light. The erbium-doped channel waveguides will be pumped with a 980 nm source to amplify 1550 nm signals.

Markets in which integrated optical devices, such as amplified splitters, can be used total several $100 million. This device will expedite bringing fiber the last mile because it will replace the current serial arrangement of discrete splitters and amplifiers, which is bulky and expensive due to the number of components and interconnects. The proposed integration techniques will also enable optical integrated circuits and next-generation computing. Prototypes will be fabricated during Phase II. TPL has extensive experience in wet-chemical processing and demonstrated ability to commercialize its technologies. The PI is a pioneering researcher of laser-fired, sol-gel derived films. LightPath Technologies will assist TPL with device and marketing development.

Title: SBIR Phase II: Microsphere-Based Optical Spectrum Analyzer

Award Number: 0091557
Program Manager: Winslow L. Sargeant

Start Date: April 15, 2001
Expires: March 31, 2003
Total Amount: $499,409
Investigator: Joel Roark, jroark@nomadics.com
Company: Nomadics Incorporated
1024 S. Innovation Way
Stillwater, OK 74074-1508
Phone: (405)372-9535

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will build upon the exciting results of Phase I, which demonstrated that whispering gallery mode (WGM) resonances of a microsphere can be tuned over a significant range by sweeping the microsphere's temperature. It is intended to employ this effect to produce a temperature-tunable optical filter suitable for development of a next-generation optical spectrum analyzer (OSA) for remotely monitoring dense wavelength division multiplexed (DWDM) networks. Such a device will greatly benefit the telecommunications industry by providing a means of embedded real-time monitoring of system operation and signal quality. This capability has the potential to virtually eliminate costly system failures. The plan for reaching the project goal is to develop a first-generation prototype and use this prototype to demonstrate the expected capabilities of a next-generation OSA.

The initial application for the technology is as an embedded test and monitoring system for telecommunications fiber networks. The major customers are optical network installers and service providers.

Title: SBIR Phase II: Ultraviolet-Polarizing Chiral Film

Award Number: 0091551
Program Manager: Winslow L. Sargeant

Start Date: February 15, 2001
Expires: January 31, 2003
Total Amount: $499,939
Investigator: Bunsen Fan, fan@reveo.com
Company: Reveo Inc
3 Westchester Plaza
Elmsford, NY 10523-1609
Phone: (914)345-9556

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is designed to develop and commercialize high-durability UV polarizer optics with unprecedented performance. The breakthrough polarizers are made from stacks of oriented, birefringent thin film layers, which are obtained by vacuum deposition at an oblique angle. The film material itself is optically isotropic, but the birefringence arises from the nanostructure of the layers in the film stack. Films can be constructed from a single material, relieving the conventional constraints on material transparency and enabling a wider operating wavelength range. Using LiF as the film material, for example, could extend the operating range down to 110 nm. Extension to the far UV and extreme UV appears possible with materials such as silicon carbide or boron carbide. The deposition technique thus offers an exciting opportunity to engineer unique film properties. In Phase II, the investigator proposes to enlarge the database of film materials for UV chiral film polarizers and design, fabricate (using a customized deposition system), and characterize UV chiral film polarizers for practical applications. The investigator will then develop high-speed deposition techniques to ensure the polarizers are low-cost. Commercialization activities will accelerate in Phase III.

The inorganic UV polarizer films may have several advantages over conventional polarizer components, and become key devices in many important industrial-manufacturing processes, including systems for chemical synthesis, drug development, and liquid crystal alignment for LCDs.

Title: STTR Phase II: High Twisting Power Chiral Materials for Nanostructured Bragg Reflective Displays

Award Number: 0091522
Program Manager: Winslow L. Sargeant

Start Date: February 1, 2001
Expires: January 31, 2003
Total Amount: $497,063

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 (STTR) Phase II Project develops a new class of chiral materials, the dioxolanes, which provide unprecedented helical twisting power. When added to a nematic liquid crystal, a concentration of only a few percent is required to twist the nematic phase into a tight helix with a periodicity of the wavelength of light. Because of the low concentration, the chiral additive does not dilute important physical properties of the nematic material required to optimize Cholesteric displays for brightness, contrast, speed and low operating voltages. Being simple molecular structures, dioxolane derivatives can be synthesized in both left and right hand moieties to enable, for the first time, Cholesteric displays that nearly double the reflective brightness to where it approaches that which we are used to seeing from paper. Phase II research has both a basic and an applied component. The basic component studies the helical twisting power and its relationship to the molecular structure of the chiral compounds and host mixtures. The applied component uses this information to design and develop chiral additives for advanced Cholesteric displays for use in electronic books and other handheld devices.

The chiral materials will be used in display products primarily used in handheld devices whee low power, sunlight readability, and wide-angle viewing of high resolution, full color images are important. Devices targeted are electronic book, cell phones, pagers, etc.

Title: SBIR Phase II: Rare Earth-Aluminum Oxide Glass Photonic Devices

Award Number: 0216324
Program Manager: Winslow L. Sargeant

Start Date: September 15, 2002
Expires: August 31, 2004
Total Amount: $499,997

Investigator: J.K. Richard Weber, weber@containerless.com
Company: Containerless Research Inc.
910 University Place
Evanston, IL 60201-3149
Phone: (847)467-2678

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop photonic devices based on a new and proprietary family of rare earth oxide - aluminum oxide glasses, the real glasses, doped with Yb, Tm, and Er oxides. Phase I research showed exceptionally broad emission from Yb 3+, efficient energy transfer in co-doped glasses, and fluorescence lifetimes and spectra of Tm and Er that meet device requirements at high dopant concentrations. Feasibility of scaled-up production of the glasses was demonstrated. The Phase II activities include: collaboration with firms engaged in the glass and optical device business; scaled-up glass synthesis; optimization of dopant concentration and optical properties for devices; and construction and characterization of prototype laser devices.

Markets for optical device products are extremely large, multinational, and growing though expanded applications and displaced technologies. The Phase II R&D is focused on lasers, amplifiers, and optical devices for communications, laser surgery, and emerging military applications. The patent position and the absence of complex proprietary interests in the technology place this work in a strong commercial position.

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
Company: Phoenix Science & Tech Inc
27 Industrial Ave
Chelmsford, MA 01824
Phone: (978)367-0232

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: Voltage Tunable Micro-Ring Resonators: Low-Cost, Reconfigurable Optical Add-Drops

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: 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
Atlanta, GA 30339
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: 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: Novel Monolithically Integrated Wavelength-Range-Selectable and Widely-Wavelength-Tunable Semiconductor Lasers with High Functionalities

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.

Title: SBIR Phase II: A New Class of Complex Ferroelectric Liquid Crystal Mesogens for Advanced Electro-Optic Devices

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
Longmont, CO 80503
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: New Ceramic Sub-Microchannel Plates

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
2021 Miller Dr Unit B
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.

Robotics

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 research 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: SBIR Phase II: Flexible and Transparent Coating Polymers for Flat Panel Displays

Award Number: 0110105
Program Manager: Winslow L. Sargeant

Start Date: September 1, 2001
Expires: August 31, 2004
Total Amount: $500,000
Investigator: Silvia D. Luebben, silvia@tda.com
Company: TDA Research, Inc
12345 West 52nd Avenue
Wheat Ridge, CO 80033-1917
Phone: (303)940-2301

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new optically transparent intrinsically conducting polymer (ICP) that can be processed from organic solutions. Despite much information on ICPs in the technical literature, the number of commercial applications of ICPs is still very small because of their intrinsically poor stability and the lack of reasonable processing methods. Phase II will address the problem of processability. Phase I successfully prepared ICPs that are soluble up to 15% weight in alcohols. Cast films are optically transparent, have conductivity of 1-100 Siemens per centimeter, and maintain constant conductivity when elongated up to 30%. ICPs were made from commercially available monomers. Phase II will bring the polymers developed in Phase I from a feasibility stage to commercial products by optimizing their composition and synthesis and scaling up production and purification.

These materials could be used to replace indium tin oxide in flat panel displays and other electronic applications. ICPs are expected to find application in the manufacture of electronic components, inks, biomedical materials, electronic devices, and specialty coatings.

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
Company: Arkansas Power Electronics International, Inc.
700 W Research Center Blvd
Fayetteville AR, 72701
Phone: (479)799-6578

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: High Surface Area Tantalum Powder for Capacitor Applications

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
Company: AP Materials, Inc.
4041 Forest Park Ave
Saint Louis MO, 63108
Phone: (314)633-1806

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 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: 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
1024 S Innovation Way
Stillwater OK, 74074
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: 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: 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: Microdisplays Based on III-Nitride Wide Band Gap Semiconductors

Award Number: 0450314
Program Manager: T. James Rudd

Start Date: February 1, 2007
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:

The goal of this SBIR Phase II project 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/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, 2007
Expires: January 31, 2007
Total Amount: $510,050
Investigator: Larry Gadeken, larrygad@betabatt.com
Company: BetaBatt, Inc.
12819 Westleigh Drive
Houston TX, 77077
Phone: (281)450-5449

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, 2007
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 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: 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
1024 S Innovation Way
Stillwater OK, 74074
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

Award Number: 0422110
Program Manager: Muralidharan 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 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: 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 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.

Title: SBIR Phase II: High Performance Lead-Free Piezoelectric Ceramics

Award Number: 0349673
Program Manager: Cheryl F. Albus

Start Date: December 1, 2003
Expires: November 30, 2005
Total Amount: $500,000
Investigator: Edward Sabolsky, sabolsky@nextechmaterials.com
Company: NexTech Materials Ltd
404 Enterprise Dr
Lewis Center, OH 43035
Phone: (614)842-6606

Abstract:

This Small Business Innovation Research Phase II project proposes to focus on the formation of grain-oriented (textured) lead-free piezoelectric and dielectric ceramics for various electroceramic and transducer applications. The overall objective of this project will be to produce lead-free ceramics with high piezoelectric performance, and demonstrate that these materials can be used in existing actuator/transducer designs, especially for applications currently using lead-based ceramics. The broader impacts will be the elimination of lead-based compositions, such as lead zirconate titanate (PZT), there are no commercially available lead-free compositions that possess comparable properties to PZT.

Beyond the commercial effect, lead is known to be toxic, so commercial products containing lead present serious health and environmental hazards at both a local and global level. Therefore, there is a substantial need for a high performance, lead-free piezoelectric ceramic with properties comparable to lead-based compositions in order to sustain the growth of piezoelectric transducers and sensor market, while meeting the many environmental and health needs.

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 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 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: Investigation of Ferroelectric Materials with Properties Optimized for Electron Emission

Award Number: 0078556
Program Manager: Winslow L. Sargeant

Start Date: September 1, 2000
Expires: August 31, 2003
Total Amount: $399,880
Investigator: Lek Len, lklen@fm-technologies.com
Company: FM Technologies Inc
4431-H Brookfield Corporate Driv
Chantilly, VA 20151
Phone: (703)818-9400

Abstract:

This Small Business Innovation Research Phase II project was motivated by recent research demonstrating that ferroelectric cathodes using commercial ferroelectric materials that were optimized for transducer applications can produce current densities in excess of 30 Amperes per square centimeter at 500,000 Volts, and can sustain an emission pulse (at 50,000 Volts) for a time in excess of 2 microseconds. Under the Phase I project ferroelectric materials optimized for use as cathodes were fabricated and tested, and promising materials were identified for further testing and optimization. The objective of the Phase II project will be to demonstrate a ferroelectric material with emission characteristics and lifetime meeting industry-defined requirements for application as a cathode in a commercial electron tube. Phase II research will include cathode testing at 20,000 volts, 1 microsecond with hundreds of pulses per second, characterization of the electron beam produced by the ferroelectric cathode according to size, energy and emittance, and validation testing of the cathode at an electron tube manufacturer's facility under commercial operating conditions.

It is anticipated that these tests will demonstrate the efficacy of the ferroelectric cathode materials developed under this project for use in commercial electron tubes. Cathodes are used in a wide variety of microwave tubes. Applications include radar, communications, radio and TV transmission, accelerators for medical, waste treatment, environmental and research applications

Title: SBIR Phase II: Development of AlGaN Field Emission Cathodes

Award Number: 0078637
Program Manager: Winslow L. Sargeant

Start Date: September 1, 2000
Expires: August 31, 2002
Total Amount: $399,995
Investigator: Nalin Kumar, kumarmaple@aol.com
Company: UHV Technologies Inc
113B West Park Drive
Mount Laurel, NJ 08054
Phone: (609)608-0977

Abstract:

This Small Business Innovation Research Phase II project focuses on optimization and scale-up of an aluminum gallium nitride (AlGaN) field emitter technology that could be used for practical applications. Materials have been identified that are very promising to deal with the wide-band-gap for field-emission applications. These materials have low to negative electron affinity. The Phase I project demonstrated various AlGaN compositions that possessed different doping levels for field emission properties. The Phase II project will carry out a detailed and systematic parametric optimization using closely-coupled theoretical modeling and experimentation to produce rugged, low-voltage III-V nitride field emitters. The project will utilize the company's deposition chamber and will demonstrate the effects of composition, doping, ion implantation, substrate temperature and other parameters. Effects of microstructure and conductivity of grain boundaries will also be investigated to develop better understanding of the AlGaN cold cathode technology.

The commerical potential for this technology is a compact addressable X-ray source. Additional applications will include electronic coolers, electron guns, solar-blind UV detectors, large-area lighting and flat-panel displays.

Title: SBIR Phase II: Thresholdless Ferroelectric Liquid Crystals

Award Number: 0078722
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2000
Expires: March 31, 2003
Total Amount: $328,372
Investigator: William Thurmes, thurmes@displaytech.com
Company: Displaytech Incorporated
2602 Clover Basin Drive
Longmont, CO 80503
Phone: (303)772-2191

Abstract:

This Small Business Innovation Research Phase II project's goal is a commercial quality liquid crystal exhibiting V-shaped switching with no hysteresis. This LC will be used in gray-scale displays and telecommunications optical switches. Ferroelectric liquid crystals (FLCs), due to their fast switching speed and wide viewing angle, have inherent advantages over the more commonly used nematic liquid crystals. However, when used in displays, they have a disadvantage - they generally can be driven to only two states, on and off. Since displays require intermediate gray states, FLCs currently attain gray scale by rapidly switching on and off. This project uses a new type of FLC which, in addition to its speed and viewing angle advantage, also shows analog switching. This type of material, previously known as a "thresholdless antiferroelectric", is now known to be an FLC with a linear optical response to applied field (also known as "V-shaped switching"). This project's objective is to make new liquid crystal compounds and mixtures that exhibit V-shaped switching. Towards that end, a variety of cores, chiral tails, and achiral tails, all of which are either known or suspected to promote a de Vries-type smectic A, have been proposed. About 50 - 100 liquid crystals will be synthesized by combining these various components. These new LCs will be combined with LCs made in the Phase I or earlier, giving mixtures that ideally will have not only a de Vries smectic A phase, but also a wide room-temperature smectic C phase, good low-voltage analog electrooptic response, good alignability, and fast hysteresis-free switching. An optimal alignment layer configuration will be determined. The newly formulated mixtures will be placed in cells containing this alignment layer to give V-shaped switching displays.

This project could be instrumental in advancing our knowledge of the root causes of V-shaped switching in FLC and, by extension, add insight into the responses of self-assembling molecules to applied forces. In addition, since the interaction of the alignment layer with the liquid crystal is crucial for V-shaped switching, much more so than for typical FLCs, this project will provide a better understanding of the alignment layer-LC interactions.

Title: SBIR Phase II: High Performance Vertical Heterojunction Bipolar Transistor (HBT) on SiC Using Novel III-Nitride Technology

Award Number: 9983390
Program Manager: Rosemarie D. Wesson

Start Date: April 1, 2000
Expires: March 31, 2002
Total Amount: $399,737

Investigator: Peter Norris, peternorris@compuserve.com
Company: Corning Applied Technologies Corporation
8A Gill Street
Woburn, MA 01801
Phone: (617)935-2030

Abstract:

This Small Business Innovative Research Phase II Project is aimed to develop a novel vertical geometry Heterojunction Bipolar Transistor (HBT) based on III-nitride heterostructures grown on SiC (silicon carbide). There is a strong need for high power HBTs for highly linear, high power microwave amplifiers. The innovation of this proposal is to demonstrate WBG (wide band gap) HBTs on SiC that will take advantage of the vertical geometry, and high thermal conductivity of SiC through the use of highly conductive novel nitride buffer and base structure to enhance p-type lateral conductivity with improved vertical transport properties through the base.

The proposed vertical WBG HBT device is a critical component for a new generation of satellite and base stations for wireless communication networks. Another application area is DC switch components for high power electronics.

Title: SBIR Phase II: Gas-Cluster Ion Source for Mass Spectrometer and Microelectronic Applications

Award Number:	0078580
Program Manager:	Winslow L. Sargeant
Start Date:	September 15, 2000
Expires:	August 31, 2002
Total Amount:	$398,416

Investigator: David Fenner, dbfenner@fastdial.net
Company: Epion Corporation
37 Manning Road
Billerica, MA 01821
Phone: (978)670-1910

Abstract:

This Small Business Innovation Research Phase II project will design, fabricate and test a prototype gas-cluster ion-beam (GCIB) sputtering tool for depth profiles with monolayer-specific surface analysis of thin films. Applications will be to multilayer thin films of key importance in the microelectronics industries including semiconductors, metals in magnetic sensors, and dielectrics in photonic and micro-optical devices. The sputtering tool is expected to meet aggressive performance specifications including depth resolution of less than 1 nm in conjunction with mass spectrometry. This GCIB tool will be designed particularly for in-situ sputtering with surface-analytical instruments including the secondary-ion mass spectrometer (SIMS), the Auger electron spectrometer (AES) and the x-ray photoelectron spectrometer (XPS). The overriding motivation is the critical need in microelectronics for techniques to obtain accurate sputter depth measurements. The Phase-I effort demonstrated those GCIB methods with argon clusters sputter with near-atomic smoothness, high depth resolution and high secondary-ion yields. Minor instrumental design issues limited the cluster beam exposure uniformity and this artificially limited the average depth resolution measured. Straightforward engineering solutions are well known and are expected to yield improvements in Phase II that will provide depth resolution of well below 1 nm.

The proposed technology will enable analysis of next-generation microelectronics devices having much thinner films. Epion is the first and only to manufacture GCIB systems. The tool to be prototyped will enable and have a wide applicability to many areas of the electronic materials processing and manufacturing industry.

Title: STTR Phase II: Electrochromic Devices Fabricated from Self-Assembled Polyelectrolytes for Flat Panel Displays

Award Number: 0110370
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2001
Expires: October 31, 2003
Total Amount: $499,913
Investigator: Janice Stevenson, stevensonp@lunainnovations.com
Company: Luna Innovations, Inc.
PO Box 11704
Blacksburg, VA 24062-1704
Phone: (540)953-4267

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will continue development of a new electrochromic device based on self-assembly of organic nanomaterials. Phase I used these materials to create laboratory scale devices. Precise control of the material composition at the nanometer (nm) scale, combined with the thin layers deposited (40 nm thick), allowed switching speeds of 25-50 milliseconds for the first time, which are nearly fast enough for display applications. Further, it was found that these materials, fabricated in the solid state, could be switched by applying only 1.0 volt. Phase II will focus on optimizing device performance, developing tri-state and multi-color devices, and evaluating performance under environmental conditions necessary for commercial product development.

Markets for the technology are very large and range from automotive self-dimming rear-view mirrors to smart windows for residential and commercial buildings, smart glasses, and display products. Phase III is planned for manufacturing scale-up and will be conducted in an industrial partnership.

Title: SBIR Phase II: Novel Use of Microspheres In Plasma Display Device

Award Number: 0216106
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $499,330
Investigator: Timothy M. Henderson, hendersonmsi@earthlink.net
Company: Imaging Systems Technology, Inc.
329 N. 14th
Toledo, OH 43624-1454
Phone: (419)536-5741

Abstract:

This Small Business Innovation Research Phase II project continue the development and commercialization of novel plasma display panels which utilize gas filled microspheres (Plasma-spheres) as the pixel elements. The project has six objectives: (a) improve process control of the Plasma-sphere production system, (b) produce Plasma-spheres with optimum properties and characteristics, (d) develop reliable microsphere-electrode configurations, (e) develop a semi-automated process for fabricating Plasma-sphere panels, (f) construct and evaluate prototype plasma-sphere panels, and (g) determine techniques for a fully automated production process. The Plasma-spheres will be produced with a prototype production system built in Phase I. The Plasma-sphere panels will be characterized for operating voltages, current and brightness. As part of the prototype panel construction a reliable method of applying the Plasma-spheres to substrates will be developed.

The use of Plasma-spheres will dramatically increase manufacturing throughput, reduce materials cost by half, and eliminate many process steps and expensive specialized machinery which are part of the current plasma panel technology. These cost reductions along with new applications which will result from the availability of an open flexible substrate (e.g., large conformal and panoramic displays), will provide Plasma-sphere panels with a significant competitive edge.

Title: SBIR Phase II: Electrochemical Method to Fabricate Flexible Solar Cells

Award Number: 0321736
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $500,000
Investigator: Shalini Menezes, interphases@att.net
Company: Interphases Rsch Co
166 N. Moorpark Rd, Suite 204
Thousand Oaks, CA 91360-4420
Phone: (805)497-2677

Abstract:

This Small Business Innovation Research Phase II project is developing an innovative flexible photovoltaic technology based on n-copper indium diselenide (n-CIS). Phase I research devised a new approach to synthesize large-grained films, and a new device configuration with only 3 layers on a metal foil. The research also devised a simple 4-step fabrication method for the n-CIS photovoltaic cell. This process uses high throughput, high yield roll-to-roll electrodeposition on a continuous metal foil. The n-CIS photovoltaic technology will evolve into a stable and efficient flexible prototype device in Phase II, with pilot line production in Phase III.

The research will lead to an affordable, non-polluting, renewable n-CIS PV technology to meet the growing demand in the global energy market. Its applications include: remote industrial and recreational power, off-grid and grid-tied residential and commercial power, generation systems, central power plants, spacecraft and satellites. Technology commercialization will make a tangible contribution to the nation's energy supply, the environment and the welfare of the society.

Title: SBIR/STTR Phase II: A Low Cost Semiconductor Metallization-Planarization Process

Award Number: 0131791
Program Manager: Rosemarie D. Wesson

Start Date: March 15, 2002
Expires: February 29, 2004
Total Amount: $500,000
Investigator: E. Jennings Taylor, jenningstaylor@faradaytechnology.com
Company: Faraday Technology Inc
315 Huls Drive
Clayton, OH 45315-8983
Phone: (937)836-7749

Abstract:

This Small Business Innovation Research Phase II Project will establish market demand for a novel electrically mediated leveling technology and position the technology for market launch via a joint venture. The specific Phase II objectives are: 1. Scale-up and demonstration of the electrically mediated process on eight-inch wafers, 2. Development of a process library for feature sizes 1-5 down to 0.17 microns, and lower, and 3. Design of a "proof of concept" plating tool. Preliminary concept design of a plating tool incorporating the electrically mediated process will be performed by an outside firm.

The sustainable competitive advantage associated with the project for leveling is cost. Minimal overplate will eliminate or minimize the need for chemical/mechanical planarization (CMP) by reducing the copper waste slurry compared to the state-of-the-art copper metallization processes. This in turn would eliminate the associated control, environmental, and cost issues.

Title: SBIR Phase II: A Source for High Rate Growth of Gallium Nitride Films
Award Number: 0132055
Program Manager: Rosemarie D. Wesson

Start Date: March 1, 2002
Expires: February 29, 2004
Total Amount: $493,649

Investigator: Michael E. Read, read@psicorp.com
Company: Physical Sciences Inc
20 New England Business Center
Andover, MA 01810-1077
Phone: (508)689-0003

Abstract:

This Small Business Innovation Research Phase II Project will develop a neutral, high flux/fluence nitrogen atom beam source for application to the high rate growth of III-V nitride semi-conducting materials over large areas. The proposed source is based on proprietary MID-JET technology. This technology employs an electrode-less discharge contained by vortex flow, rather than a dielectric tube commonly used in traditional sources. MIDJET technology utilizing a temperature of 5000 C to produce1021 nitrogen atoms has been demonstrated. This is 2-3 orders of magnitude higher than that generated by currently available sources. It is particularly applicable to Metal Organic Chemical Vapor Deposition (MOCVD) systems, where it will allow both high growth rate and the elimination of the use of ammonia. The MIDJET will be adapted for use in a MOCVD reactor and a demonstration made of the system's ability to grow gallium nitride at a rate of at least 10 microns per hour.

This project will develop a charge-free, high flux/fluence nitrogen atom beam for the growth of III-V nitride materials, which can replace existing plasma-based tools. With higher growth rates of high quality material over larger areas, systems based on the MIDJET will have with application to the fabrication of high power/high temperature semiconductor devices and blue illumination sources (including those for flat panel displays).

Title: SBIR Phase II: Advanced Carbon Electrodes to Reduce Ultracapacitor Size and Cost

Award Number: 0132078
Program Manager: Cheryl F. Albus

Start Date: March 1, 2002
Expires: February 29, 2004
Total Amount: $500,000

Investigator: Michael R. Wixom, tjultracap@aol.com
Company: T/J Technologies, Inc
PO Box 2150
Ann Arbor, MI 48106-2150
Phone: (313)213-1637

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop advanced carbon electrode materials for ultracapacitors. Presently, ultracapacitor voltages are limited to 2.3 - 2.7 V/cell. New carbonaceous electrode materials are expected to increase cell potential limits to >3.6 V. Given the quadratic dependence of energy density on cell potential, these materials will increase ultracapacitor energy storage by >100%. The increased cell potential will reduce device size and cost by reducing the number of cells required to attain a given voltage rating. Phase II will demonstrate that these materials can withstand extended charge/discharge cycling to high voltage. A scalable process will be developed to produce the new carbon electrode materials. Prototype ultracapacitors will be produced to support customer demonstrations.

The commercial potential of this project is for ultracapacitors that are used in portable electronic devices, power conditioning (UPS), and electromechanical actuators. Additional applications include hybrid electric and conventional vehicles to service intermittent high power loads (e.g. regenerative braking, engine start, electromechanical valves, and electric power steering).

Title: SBIR Phase II: Germanium Liquid Crystals for Perfect Displays

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
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 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: 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: LT Technologies
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.

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: Thick Film Garnet Materials for In-Plane Propagation Magnetooptic Devices

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: Integrated Photonics Inc.
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: SBIR Phase II: New N-Type Polymers for Organic Photovoltaics and other Electronic Devices

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: 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: Ultra Low Cost, p-i-n OLED Lamps for Specialty Lighting

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: STTR Phase II: Improved Boron Nitride Materials for Enhanced Thermal Management

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 (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

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.

Spintronics

Title: SBIR Phase II: Sub-Nanosecond Spin Dependent Tunneling Devices

Award Number: 0091564
Program Manager: Winslow L. Sargeant

Start Date: February 15, 2001
Expires: January 31, 2004
Total Amount: $499,993
Investigator: Dexin Wang, dexinw@nve.com
Company: NVE Corporation
11409 Valley View Road
Eden Prairie, MN 553443617

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop prototype Spin Dependent Tunneling (SDT) devices by combining high-speed magnetic thin films and low-RC SDT structures achieved in Phase I. These devices will be fabricated using standard microelectronic photolithography and packaging techniques, suitable for volume production. Sub-nanosecond switching will be demonstrated with these devices, which are integrated with integrated circuit (IC) electronics. Fast IC electronics will be implemented using low voltage differential signaling (LVDS). SDT devices exhibit large signal, low switching field, and high resistance, which lead to high sensitivity, low power consumption, and small size and weight, when compared with giant magnetoresistive (GMR) devices. Fast SDT devices will require improvements in both magnetic speed and electronic speed, while existing attractive static properties need to be maintained. Phase II is expected to produce integrated SDT devices with state-of-the-art properties and switching time less than one nanosecond.

Potential commercial applications for this research are expected in high-speed isolators, high-speed magnetic field and current sensing devices, fast magnetic random access memories (MRAM), reconfigurable magnetic logic, read heads, and gigahertz (GHz) inductor/transformers, as well as their derivative products.

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: Flux-Gated Spin-Dependent-Tunneling Sensors

Award Number: 0321554
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $499,973
Investigator: Catherine Nordman, cathyn@nve.com
Company: NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344

Abstract:

This Small Business Innovation Research Phase II project seeks to fabricate a novel nanotechnology spin-dependent tunneling (SDT) magnetic field sensor device with increased signal-to-noise performance at low frequencies. The increased resolution at low frequencies is greatly desired in a large number of application markets. The proposed device is based on innovative methods of modulating the permeability of, and/or the flux through, integrated flux concentrators. These methods of "flux gating" (chopping or sweeping the magnetic field which is sensed by the SDT transducers) are employed using on-chip, microfabricated coil structures. The project explores the nature of frequency-dependent (or 1/f) noise that is intrinsic to SDT devices, and offers an integrated low-power method of noise reduction. SDT technology is at the leading edge of magnetoresistive transducer development due, in part, to the fact that its magnetoresistance can be more than 3 times that of the best giant magnetoresistive devices, and more than 15 times that of the anisotropic magnetoresistive sensors on the market today. The devices for this Phase II is based on novel and proprietary concepts for the advancement of small, solid-state, low-cost, low-power magnetic field sensors. The primary need is for high-resolution magnetic field sensors that are more fieldable and cost effective. SDT technology offers this high-resolution potential as well as the low-cost advantages of silicon fabrication methods used for SDT micro-sensors.

Applications for these sensors include non-destructive testing, security and surveillance, and magnetic media validation. Each of these very diverse applications share a common need for the small, highly sensitive, low power magnetic field sensing devices being proposed. The new devices will enable each of these areas to expand into small portable applications and into areas where cost effective low-field sensing has not been possible.

Title: SBIR Phase II: Ultra Low Hysteresis Giant-Magnetoresistive (GMR) Bridge Sensor

Award Number: 0091563
Program Manager: Winslow L. Sargeant

Start Date: February 15, 2001
Expires: January 31, 2004
Total Amount: $399,983
Investigator: John Anderson, johna@nve.com
Company: NVE Corporation
11409 Valley View Road
Eden Prairie, MN 55344-3617

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop giant-magnetoresistive (GMR) sensing devices that yield superior hysteresis performance over existing bridge sensors and GMR signal isolators and provide intrinsic self-biasing without using affixed magnets or power consuming coils. Phase I demonstrated that edge pinning techniques can be used to fabricate low hysteresis push-pull and shielded bridge sensors with designed bias points. Before the technology can be commercialized, Phase II research must: (1) develop hard edge resistor elements that minimize hysteresis and maximize signal; (2) optimize hard edge processing and implementation; (3) determine the viability of alternate pinning strategies; (4) develop specification, architecture, and physical designs for prototype sensor or isolator products; (5) fabricate target devices; and (6) characterize devices for magnetic and electrical responses. A fully developed magnetic field sensor and/or signal isolator is expected, one that is ready for commercialization.

Potential commercial applications are discrete low hysteresis bridge sensors and isolators, improved digital magnetic switches, and ultra-low field sensors employing integrated circuit (IC) based feedback amplifiers.

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: Monochromatic Micro X-ray Fluorescence Analysis Using Toroidal Crystal Optics

Award Number: 0091570
Program Manager: Winslow L. Sargeant

Start Date: March 15, 2001
Expires: February 28, 2003
Total Amount: $498,565
Investigator: Zewu Chen, zchen@xos.com
Company: X-Ray Optical Systems, Inc
15 Tech Valley Drive
East Greenbush, NY 12061
Phone: (518)880-1500

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will meet the demand from the microelectronics industry for an improved micro x-ray fluorescence instrument for thin film measurements. A new technique, monochromatic micro x-ray fluorescence (MMXRF) analysis using doubly curved crystal optics can meet this significant market need. A toroidal crystal can focus characteristic x-rays from a microfocus x-ray source based upon diffraction. The focused beam is monochromatic and the beam size is expected to be significantly smaller than that of current MXRF systems. This technique will provide high sensitivity and enhance excitation of low Z elements with the selection of beam energy. In addition, this technique will significantly increase the speed of high-energy x-ray measurements. A prototype MMXRF system will be developed that incorporates a modular dual beam system to probe samples with two energies simultaneously.

The initial application of the technology is in the area of semiconductor manufacturing. As semiconductor manufacturing moves to larger wafers and higher levels of integration, a single wafer may require hundreds of steps. These wafers are expensive to produce and very difficult to repair. The instrument under development would provide elemental and thickness analysis to identify defective thin film deposition at the earliest opportunity, avoiding the considerable loss associated with rejections at the end of the production line.

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
Company: Phifer Smith Corporation
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
Company: UES, Inc.
4401 Dayton Xenia Rd
Dayton OH, 45432
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: High-resolution, high-precision 193-nm photomask phase metrology system

Award Number: 0450620
Program Manager: T. James Rudd

Start Date: February 1, 2007
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: 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
Company: Bellwether Instruments, LLC.
1214 Sherwood Road
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: Advanced Detectors for X-Ray Diagnosis

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
Watertown MA, 02472
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: 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: 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: Non-Contact/Zero-Stress Surface Polishing Process for Copper/Low Dielectric Constant Semiconductors

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: 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: MatchBox Display Systems

Award Number: 0422099
Program Manager: Muralidharan S. Nair

Start Date: October 1, 2004
Expires: September 30, 2006
Total Amount: $499,935
Investigator: Chongchang Mao, cmao@setechinv.com
Company: Southeast TechInventures
PO Box 13714
Durham, NC 27709
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: Ge-Free Strained Silicon Via dTCE Bonding (Differential Thermal Coefficient of Expansion Bonding)

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 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 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: Millimeter Wave Transceivers on Large Metamorphic Wafers

Award Number: 0321728
Program Manager: Winslow L. Sargeant

Start Date: November 15, 2003
Expires: October 31, 2005
Total Amount: $511,971

Investigator: Timothy Childs, tim@tlcprecision.com
Company: TLC Precision Wafer Technology
1411 W. River Road N
Minneapolis, MN 55411
Phone: (612)341-2795

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an innovative low-cost W-band (70-80 GHz) single chip transceiver using the metamorphic wafer technology developed in Phase I, and efficiently integrating the various MMIC components. The low cost non-electronic beam FET processes, MM HEMTs, and initial chip designs developed in Phase I will be used for the development of the fully integrated transceiver in Phase II. The resulting new technology will enable the MMW industry to be cost effective to expand the commercial market to achieve the low cost and high performance required in the industry.

This project will enable enhanced performance and low cost consumer compatible volume production of automotive collusion avoidance radar systems, MMW tracking systems, and security radar and detection systems.

Title: SBIR Phase II: Vacuum Ultraviolet Spectroscopic Ellipsometer for Semiconductor Lithography

Award Number: 0321715
Program Manager: Winslow L. Sargeant

Start Date: December 1, 2003
Expires: November 30, 2005
Total Amount: $500,000

Investigator: Daniel Hampton, hampton@containerless.com
Company: Containerless Research, Inc.
910 University Place
Evanston, IL 60201
Phone: (847)467-2678

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will provide a novel, patented sensor of the polarization properties of light for operation in the vacuum ultraviolet spectral range, from ~ 120 to 200 nm. The instrument is a complete polarimeter that measures all four of the Stokes parameters of polarized light. It enables new semiconductor metrology applications and measurements with high precision and accuracy that are not achievable by rotating analyzer ellipsometry. The $30B semiconductor equipment market is continuously challenged to meet changing requirements with decreasing dimensions and thickness of structures on chips.

The G-DOAP instrument meets key requirements of the industry for vacuum ultraviolet metrology tools. It also brings new capabilities to surface science investigations in many fields through the product for this market that we will offer. This technology can accelerate progress along the International Roadmap for Semiconductors, which cites VUV tools as a key need.

Title: SBIR Phase II: Liquid Phase Epitaxy of Potassium Tantalum Niobate on Low Dielectric Constant Substrates

Award Number: 0321608
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $500,000

Investigator: Vincent Fratello, vjfratello@integratedphotonics.com
Company: Integrated Photonics, Inc.
1110 Commerce Drive
Richardson, TX 75081
Phone: (972)690-0099

Abstract:

This SBIR Phase II project proposes to develop the Liquid Phase Epitaxy (LPE) of potassium tantalum niobate (KTN) on a cubic perovskite substrate. In this manner both components of the film/substrate composite may be optimized for device performance. KTN has almost two orders of magnitude higher electrooptic coefficients than current generation lithium niobate waveguides, which would permit shorter path lengths, lower bias voltages or some combination of the two. The new, low dielectric constant substrate material developed in Phase I will enable better matching of the effective microwave dielectric constant to the optical dielectric constant of the film material and achieve lower bias fields. In Phase II, the researchers will develop the new substrate material to commercial quality and size. LPE of KTN will be developed from a new innovative flux system that allows excellent control of growth and superior film properties. Both film and substrate will be fully characterized and optimized as a composite. The process and product will be scaled up to full commercial size. IPI will interact with strategic partner device manufacturers to optimize the material and realize device applications. Electrooptic devices are used in any photonics application where an electrical signal can be used to change the state of a beam of light. While the best-known applications for electrooptic devices are in telecommunications, customers can be found wherever light is used to move information including optical computing, analog and digital signal processing, information processing and sensing. Devices include phase and amplitude modulators, Q-switches, multiplexers, switch arrays, couplers, polarization controllers, deflectors, correlators, sensors, potential transformers and optical parametric oscillators.

Potential customers are noticeably found in both the electric power industry and the military. Initial applications in sensors will have an immediate potential for impact in reliability of electric power distribution through failure anticipation and prevention and conservation of electric power through monitoring and control. The proposed work will enable electrooptic modulators, switches and innovative new photonic device applications with lower costs, smaller footprints and lower power budgets. All this contributes to improvements of the infrastructure of the Internet and more rapid, lower cost deployment, especially in the local loop.

Title: SBIR Phase II: Low Cost Visible Blind Ultra Violet Photodetectors on Glass and Polyimide

Award Number: 0321465
Program Manager: Winslow L. Sargeant

Start Date: November 1, 2003
Expires: October 31, 2005
Total Amount: $500,000

Investigator: Ratnakar Vispute, rd@bluewavesemi.com
Company: Blue Wave Semiconductors Inc.
6208 Three Apple Downs
Columbia, MD 21045
Phone: (410)312-2999

Abstract:

This Small Business Innovation Research project proposes commercialization of innovative oxide based visible and solar blind ultra-violet light detectors successfully fabricated and tested. The studies clearly indicate the possibility of growing good quality wide band gap tunable oxide thin films on low cost substrates such as glass, quartz, silicon, and polyimide for photoconductive and Schottky UV photodiodes. The detectors fabricated on these substrates show comparable performance to those of AlGaN on sapphire, and SiC with a high responsivity and UV to visible rejection ratio of more than three orders of magnitude. The feasibility of tuning the detector performance at selective UV regions is also successful which is achieved through innovation of the composition control in the wide band gap oxide layer.

The company will extend this technology to commercialize the low cost UV detectors and large format detector arrays for UV radiation monitoring systems for personal safety and consumable products, and exploit additional capabilities beyond the scope of the existing Si, GaAs, and AlGaN technologies.

Title: SBIR Phase II: An Optical Sensor for Semiconductor Back-End Processes

Award Number: 0320062
Program Manager: Winslow L. Sargeant

Start Date: November 15, 2003
Expires: October 31, 2005
Total Amount: $500,000

Investigator: Jim Hang, jimhang@newdri.com
Company: New Dimension Research
400 West Cummings Park
Woburn, MA 01801
Phone: (781)933-1165

Abstract:

This Small Business Innovation Research (SBIR) project is to develop innovative miniature con-focal laser scanning sensors for semiconductor packaging processes by using diode laser detector array chips. There are no moving parts in this sensor for scanning, unlike other con-focal devices. This sensor with a fast imaging rate will be integrated with chip IC placement robot machines, to inspect solder bump co-planarity of Flip Chip Bonding (FCB) and the ball of Ball Grid Arrays (BGA) before packaging. BGA and FCB are used in mission critical devices in airplanes and medical devices. To ensure quality of the packaging, semiconductor-packaging companies demand lower cost, smaller, fast imaging optical sensors in the automatic optical co-planarity inspection instruments to ensure the reliability and quality of package assembly.

The electronics industry's demands for increasing circuit density, higher levels of integration and improved cost/performance capabilities have led to the proliferation of the use of BGA and FCB. This will reduce chip failures and system failures. These high reliability devices may eventually save lives and improve the quality of life.

Title: SBIR Phase II: Acoustic Microcavitation Assisted Fine Cleaning of Post-Chemical Mechanical Planarizing (CMP) Wafers

Award Number: 9983485
Program Manager: Rosemarie D. Wesson

Start Date: May 1, 2000
Expires: April 30, 2003
Total Amount: $750,000
Investigator: Mark McKenna, mark@ritecinc.com
Company: RITEC Inc
60 Alhambra Road, Suite 5
Warwick, RI 02886
Phone: (401)738-3660

Abstract:

This SBIR Phase II project is to continue the investigation in the removal of particulates from silicon wafers. It is a problem which can only become more important as the evolving circuit complexity demands greater miniaturization and multi-storied 'architectural' chip designs. Miniaturization poses a increasing challenge because any particulate which is one-third to one-half the size of the smallest chip circuit feature (i.e. the line width) is deemed a killer defect. As the line width gets thinner, the particle-intolerance because correspondingly greater. Up to 40% of all silicon wafer rejections are due to unremoved particulates. The challenge of maintaining ultra-clean wafer surfaces is further exacerbated by the more complex, multi-storied chip designs. Each new 'floor' of circuitry requires that a high degree of wafer flatness and smoothness be restored using the chemical mechanical planarizing or polishing (CMP) process. Each CMP procedure involves a fine, fumed silica slurry and therefore introduces new particulates. Several CMP operations are typically necessary in wafer processing and each wafer must be perfectly cleaned after each operation.

This project is to develop a precision cleaning unit to rapidly clean post-CMP silicon wafers using only 'Silent Sound and Clean Water'. Based on Acoustic Coaxing Induced Microcavitation (ACIM), the process requires no chemicals--only silent sound and clean water. The Silent Sound and Clean Water (SSCW) wafer cleaner to be developed through this SBIR Phase-II grant will face none of the conventional limitations with regard to particle size and it will be wholly environmentally friendly.

Title: SBIR Phase II: Whole Wafer Thermal Imaging for Real-Time Process Monitoring and Control

Award Number: 0078444
Program Manager: Winslow L. Sargeant

Start Date: December 15, 2000
Expires: May 31, 2003
Total Amount $399,991

Investigator: Joseph Cosgrove, cosgrove@afrinc.com
Company: Advanced Fuel Research, Inc.
87 Church Street
East Hartford, CT 06108
Phone: (860)528-9806

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a real-time, whole wafer sensor for process monitoring and fault detection in advanced semiconductor and thin film fabrication processes. The production of future semiconductor and optoelectronic devices will depend critically on continued advances in process sensing and control. In present-day manufacturing, process yield and productivity are limited by the high sensitivity of layer properties to process conditions, and by an inability to control process conditions adequately throughout the process sequence. Current technology relies primarily on open-loop control using indirect sensor signals; a costly practice resulting in significant scrap and equipment downtime for preventative maintenance. To address this problem through improved closed loop control, this project will develop a high performance imaging radiometer with advanced thermographic and wafer mapping algorithms. Phase II includes hardware, software, and applications development that addresses important components of the sensor technology for monitoring blanket and patterned substrates. The sensor will provide near video-rate, spatially resolved whole wafer measurements of temperature and film properties from a model-based analysis of thermal radiance images. In-house testing on a rapid thermal processing tool and field testing on a MOCVD reactor will be performed. Potential commercial applications are anticipated in optimization and control of many advanced semiconductor fabrication processes such as rapid thermal processing (RTP), molecular beam epitaxy (MBE), and metal-organic chemical vapor deposition (MOCVD). Improved whole wafer sensors have potential for significant increase in the number of process steps performed by RTP and thus increase the RTP as a generic process method.

The commercial benefits of an in-situ wafer state sensor include reduced scrap, reduced equipment preventative maintenance, improved process efficiency, and improved device uniformity and performance.

Title: SBIR Phase II: Material for Efficient Laser Diode-Pumped Laser and Upconversion Phosphor Technology

Award Number: 0078551
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2000
Expires: December 31, 2002
Total Amount: $398,330

Investigator: Arlete Cassanho, acm4@earthlink.net
Company: AC Materials Incorporated
2721 Forsyth Road
Winter Park, FL 32792
Phone: (407)679-3395

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will focus on improving solution growth of Nd and Yb,Pr-doped NaYF4 single crystals. Two alternate techniques are proposed: top seeded solution growth and traveling solvent zone. Phase I results indicate that spectroscopically Nd:NYF is superior to YAG and YLF and as good or better than YVO4 as a laser diode-pumped laser; and that Yb,Pr:NaYF4 is a 1.3 micron emitter with favorable properties for use in telecommunications. In a parallel effort to crystal growth, laser evaluation of NYF will continue through laser tests and by measurements of NYF's thermo-optic properties. In Phase I a very efficient single phase green emitter Yb,Er :NYF phosphor was demonstrated. A second thrust of this Phase II effort will then be to develop synthesis processes of granular doped NYF materials for their use in 2-D and 3-D displays.

Combinations of Yb,RE-doped NYF will be prepared to extend the range of colors to red and blue. Nd:NYF is seen as a superior material to YLF and YAG for compact diode pumped lasers and an economical alternative to Nd:YVO4 currently used. Yb, Pr: NYF can be used as amplifiers for telecommunications in the important 1.3 micron wavelength range. NYF phosphors, dispersed in plastic hosts can be used in 2 and 3-D transparent displays for head mounted applications such as air traffic control, medicine, autos and aircraft.

Title: SBIR Phase II: X-ray Microscope

Ward Number: 0091519
Program Manager: Winslow L. Sargeant

Start Date: March 15, 2001
Expires: February 28, 2003
Total Amount: $500,000
Investigator: Steven W. Smith, steve@spectrumsdi.com
Company: Spectrum San Diego, Inc.
15950 Bernardo Center Dr. Ste
San Diego, CA 92127
Phone: (619)676-5382

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is directed at improving the capabilities of high-resolution x-ray imaging systems. The enabling technology in this approach is a novel x-ray detector formed from transparent scintillation crystals. A prototype developed in Phase I demonstrates a spatial resolution of six microns. This surpasses the resolution of commercial systems based on microfocus x-ray sources, and is 4-6 times better than current x-ray detectors. Based on these results it is anticipated that a resolution of 1-2 microns can be achieved in Phase II. If fully successful, the end result of Phase II will be a commercialized x-ray microscope with five to ten times the resolution of existing products.

High-resolution x-ray imaging is used in many fields, including manufacturing, medicine, and scientific research. The product developed in Phase II will have better technical performance and be lower in cost that presently available systems.

Title: STTR Phase II: Nanostructure Fabrication Using Near-Field Scanning Optical Microscopy

Award Number: 0110486
Program Manager: Cheryl F. Albus

Start Date: September 1, 2001
Expires: August 31, 2003
Total Amount: $500,000

Investigator: Russell E. Hollingsworth, rhollingsworth@itnes.com
Company: ITN Energy Systems Inc
8130 Shaffer Parkway
Littleton, CO 80127-4107
Phone: (303)420-1141

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will further develop a revolutionary approach to nanostructure fabrication. This Near-Field Scanning Optical Nanolithographic approach, which we have already shown to be capable of writing 100nm width lines, utilizes a direct, optical write technology in conjunction with optical photoresists. The direct optical writing is performed with a customized Near-Field Scanning Optical Microscope (NSOM) tool. The major goal of the proposed work is to design and construct a commercially viable NSOM lithography tool and demonstrate processes for flexible pattern generation on 4" wafers. Phase I work demonstrated the preliminary design of the NSOM lithography tool and photoresist processes using a novel inorganic hydrogenated amorphous silicon resist, as well as conventional polymer resists. Best line widths of approximately 100nm, comparable to the probe diameter, were obtained.

The commercial benefits from this project will be the construction and demonstration of the NSOM lithography tool for rapid prototyping of nanostructures in university and corporate research labs.

Title: SBIR Phase II: Mechanism of the Layer Transfer Process for Silicon-on-Insulator

Award Number: 0216676
Program Manager: Winslow L. Sargeant

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $500,000
Investigator: Alex Usenko, usenko@si-sandwich.com
Company: Silicon Water Tech., Inc.
240 King Blvd
Newark, NJ 07102-2100
Phone: (973)297-1410

Abstract:

This Small Business Innovations Research (SBIR) Phase II project builds on demonstrated and patented new hydrogenation-based processes for producing silicon-on-insulator (SOI) wafers for the semiconductor manufacturing industry. It has been demonstrated that this new techniques can be bonded for improved activation of the surfaces of silicon wafers. The innovation also serves to suppress layer transfer faults. The improvement in yield and the reduction in cost in the SOI production process have also been achieved. The process is expected to scale down to the formation of SOI surface films of thickness well below 0.1 micron. During Phase I, an RF plasma treatment was developed which optimizes the amount of adsorbed activating species on surfaces resulting in an improved layer transfer yield over previous wet chemical activation techniques. The process optimization was based on molecular dynamics simulation of the sub-monolayer hydroxylized surface. In Phase II the simulation-based process design continues with experimental characterization of the resulting probability of the layer transfer faults. The Phase II work plan includes more detailed process design and optimization leading to a characterization of best effort SOI wafers by the venture partners.

The impact of the proposed commercialization activity on the existing $10B worldwide silicon starting-wafer industry is potentially huge. The increasing usage of SOI by the leading semiconductor manufacturers is optimistically projected to grow from 1% to 10% of the worldwide silicon market. If successful, a ramp up to commercialization SOI pilot production will begin immediately upon the completion of this Phase II contract.

Title: SBIR Phase II: Silicon Chip Antenna for Radio Frequency Identification Devices

Award Number: 0109003
Program Manager: Winslow L. Sargeant

Start Date: September 1, 2001
Expires: August 31, 2003
Total Amount: $499,752

Investigator: Klaus Dimmler, klaus@hi-point.com
Company: HiPoint
19 Leaming Rd.
Colorado Springs, CO 80906
Phone: (719)540-8504

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will build a small form factor silicon chip antenna for radio frequency identification (RFID) applications in smart tags. A new high-performance, low cost, small size silicon chip antenna, fabricated by wafer batch processing, will be combined with a standard, passive (no battery) RFID chip to form a low cost, high-performance RFID tag of small dimensions. The antenna and the RFID chip are stacked directly on top of each other. Phase I used a simplified process and scaled up structures. In Phase II the process will be optimized, devices with the intended dimensions will be used, and the antenna chip and the RFID chip will be stacked.

Passive RFID systems are used in applications such as object tagging, asset management, hazardous materials tracking, and tracking of important documents. Existing RFID technology is limited by the need for large transponder antennas (~ 1 inch by 2 inch minimum) and costly multi-component assembly. The silicon wafer batch processed antenna chip technology will produce millimeter-scale smart tags (programmable replacement for bar codes), enabling products for large commercial markets.

Title: SBIR Phase II: Integrated Reactor Scale and Topography Feature Scale Simulator for Plasma Enhanced Semiconductor Processes

Award Number: 0091528
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2001
Expires: September 30, 2003
Total Amount: $499,965
Investigator: James Cole, jvc@cfdrc.com
Company: CFD Research Corporation
215 Wynn Drive, 5th Floor
Huntsville, AL 35805
Phone: (256)726-4800

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will provide a commercial software tool that integrates reactor scale, (pre) sheath transport, and feature scale models for comprehensive analysis of thermal chemical vapor deposition and low-pressure plasma processes in integrated circuit fabrication. Phase II will focus on development of (pre) sheath models, a feature scale simulation tool, a charging model, and the supporting infrastructure in proprietary software, called CFD-ACE+, to integrate these models. (Pre) sheath models from Phase I will be enhanced to address additional common plasma reactor operating conditions. A feature scale simulator, based on the multi-physics models of the existing proprietary software and embedded in the reactor model, will be developed. The model for surface charging will be integrated with the (pre) sheath and sheath models for ion transport and the feature scale models. The software infrastructure will be extended to simplify the model definition steps common to all feature scale simulators.

This tool will provide engineers in the semiconductor industry with a means to predict the effect of both reactor designs and process conditions on the size, shape, and quality of the device components they are producing. It will extend the CFD-ACE+ commercial reactor scale modeling software to interface properly with feature scale simulators.

Title: SBIR Phase II: Planar Magnetic Levitation Technology for Precision Microelectronics Manufacturing Equipment

Award Number: 0078419
Program Manager: Winslow L. Sargeant

Start Date: February 1, 2001
Expires: January 31, 2003
Total Amount: $397,820
Investigator: Edward C. Lovelace, lovelace@satc.com
Company: SatCon Technology Corp
161 First Street
Cambridge, MA 02142-1221
Phone: (617)349-0861

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a planar magnetic levitator/positioner for precision microelectronics manufacturing equipment. Based on feasibility proven in Phase I, Phase II will design, construct, and test a minimum-actuator maglev stage that can be readily integrated in a process tool. A single-moving maglev platen will be driven in all six degrees of freedom with three levitation motors. The platen will generate large two-dimensional motions for transportation with small four-axis motions for alignment and small adjustments. It will lead to a clean-room compatible, lightweight, compact, inexpensive structure that can meet demanding dynamic performance requirements in next-generation precision microelectronics manufacturing.

Magnetic levitation has many potential applications in microelectronics manufacturing equipment that require precise planar position control, such as wafer steppers, wafer handlers, wire bonders, surface profilometers, scanned probe microscopes, and precision inspection machines. This technology is expected to figure prominently in the highly competitive microelectronics manufacturing capital equipment 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
Company: BridgeWave
3350 Thomas Rd
Santa Clara, CA 95054
Phone: (408)567-6900

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
2153 SE Hawthorne Rd Ste 129
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: 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
Company: LumArray
15 Ward St
Somerville, MA 02143
Phone: (617)253 6865

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: 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
Company: ALCES
4750 Cortland Dr.
Jackson, WY 83001
Phone: (307)732-1994

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: 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: 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: Novel Hybrid Rapid Thermal Processing (HRTP) Systems for Annealing of Advanced Silicon Devices

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

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: 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: SBIR Phase II: R-CEL for DUV Lithography

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: 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: 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 (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: 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 research 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: Gentle Atomic Level Chemical Mechanical Smoothening (CMS) of Gallium Nitride Substrates

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
Phone: (352)334-7237

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: 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: 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: Trapping Particle Detector for On-Line Monitoring

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.

Wireless Networks

Title: SBIR Phase II: Fabrication of Photonic Band Gap Structures Embedded in Low Temperature Co-fired Ceramic for Millimeter Wave Applications

Award Number: 0110399
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2001
Expires: September 30, 2004
Total Amount: $499,867

Investigator: Vladimir Manasson, vmanasson@waveband.com
Company: WaveBand Corporation
375 Van Ness Avenue, Suite 1105
Torrance, CA 90501
Phone: (310)212-7808

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop new materials engineered for microwave electronics. As microwave applications expand, including portable wireless devices, and as digital integrated circuit speeds and clock rates increase to the millimeter wave (MMW) range, the need arises for low-loss elements of microwave/MMW interconnects (EMIs) with properties uniform over a broad range of frequencies and environmental conditions. A new technique is now sought to embed EMIs based on Photonic Band Gap Structures (PBSs) in ceramic substrates at an early stage of fabrication. PBSs will reduce radiative losses in devices fabricated using the Low Temperature Co-fired Ceramic On Metal technique by preventing radiation leakage and by minimizing undesired scattering. The result will be improved performance, without increasing manufacturing costs. Phase I designed, fabricated, and tested PBS-based EMIs, wherein, cross waveguides with low cross talk were successfully tested. Phase II will automate the design and production of devices that include PBS EMIs. The technology will be demonstrated through the design and fabrication of a MMW antenna based on PBS.

A PBS will lead to quite new applications: frequency-band controlled filters, perfect channel-drop filters, point-defect resonant cavities, line-defect ninety-degree waveguide bends, waveguide intersections with low crosstalk, and others. The new technique will be employed in high-volume production items for applications such as automotive radars, avionics, as well as in a variety of broadband wireless communication devices.

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)
20 New England Bus Ctr Dr
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 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.

Title: SBIR Phase II: Innovative Software Definable Radio and Network Architecture for Low-Cost Commercial Application

Award Number: 9983341
Program Manager: Juan E. Figueroa

Start Date: April 1, 2000
Expires: November 30, 2002
Total Amount: $749,587
Investigator: Richard Bergfeld, rbergfeld@aol.com
Company: Ameranth Wireless, Inc.
12230 El Camino Real
San Diego, CA 92130
Phone: (717)897-0103

Abstract:

This Small Business Innovation Research Phase II project follows a successful Phase I technology demonstration and will establish the feasibility of a multimode (IEEE 802.11 and Bluetooth) data communications system using a single-chip radio modem and a single-chip baseband processor, both software configurable. The program objectives are, (1) Quantify key system design parameters, (2) Determine the best suited radio and baseband processor architectures, (3) Identify critical system features and interfaces needed to assure system applicability to existing and anticipated commercial applications.systems, (4) Specify a radio and baseband system to be simulated with the Ameranth 21st Century Restaurant(TM) commercial design software, (5) Design a prototype radio, (6) Construct a prototype transceiver module using selected Ameranth terminals, (7)Demonstrate the operation of the system using the Ameranth terminals/system application(s), and (8) Prepare for initial production and commercialization. The technology is a Bluetooth chipset implementation using silicon-on-insulator wafer structure and BiCMOS transistor structure.

The market for wireless computing devices is enormous. Ameranth products have applicationacross a wide range of industries, including the hospitality, retail, transportation, law enforcement, health care, finance, telecommunications and defense industries. Ameranth has more than 2,300 customers that have expressed interest in these products.

Title: SBIR Phase II: Parallel Hardware Implementation of the Split and Merge Discrete Wavelet Transform for Wireless Communication

Award Number: 0239330
Program Manager: Winslow L. Sargeant

Start Date: March 15, 2003
Expires: February 28, 2005
Total Amount: $500,000
Investigator: Alexander W. Moopenn, amoopenn@mosaixtech.com
Company: Mosaix, LLC
176 Melrose Avenue
Monrovia, CA 91016
Phone: (626)305-5550

Abstract:

This Small Business Innovative Research (SBIR) Phase II project proposes to develop the Intellectual Property (IP) core of novel image compression / signal decomposition algorithm based on the discrete wavelet transform (DWT). This is a fully parallel, scalable, multi-resolution, and low power implementation of the JPEG2000 DWT engine and is particularly well suited for use in both consumer applications at one end of the spectrum (as in reduced bit-rate web browsing over wireless communications channels as found in the next generation of web enabled cell phones) as well as in high-end commercial applications at the other end of the spectrum (as in non-linear video editing accelerators for the movie industry). This particular implementation is a highly efficient implementation of the DWT transform and makes use of a novel Overlap-State wavelet decomposition algorithm that minimizes memory, I/O and computational requirements. Over the next decade, spiraling consumer demand for fast mobile communication of voice and IP over increasingly integrated terrestrial and satellite based systems plagued by a limited electro-magnetic spectrum allocation necessitates the pursuit and development of better compression algorithms that a visually pleasing at low bit rates. As a consequence of extensive research, transform coding techniques now dominate every single image and video-coding scheme proposed to-date. Consequently, efficient software and hardware based transform coding system designs and implementations have become a high priority objective.

In fact, it is widely accepted that JPEG2000 will become the universally accepted format for digital images and high quality video - whether on the web, cable, over wireless systems, in digital cameras, printers, faxes or remote sensors. With its wavelet based image-coding technology, it offers features previously impossible in JPEG. Compared with the old baseline JPEG, the new JPEG2000 spec poses formidable technology challenges for the myriad of developers and OEM's planning on using it. The new standard uses coding algorithms based on the discrete wavelet transform (DWT) which is fundamentally different from the discrete cosine transform (DCT) JPEG spec. In JPEG2000, the importance of computational and especially memory bottlenecks has clearly increased several fold over the old specification. In fact, various implementations of computationally efficientCE wavelet transforms have been reported in recent years.

Title: SBIR Phase II: Wireless Firefighters Lifeline

Award Number: 0216076
Program Manager: Winslow L. Sargeant

Start Date: October 1, 2002
Expires: September 30, 2004
Total Amount: $499,975

Investigator: James D. Halsey, halsey@islinc.com
Company: Info Sys Lab Inc
8130 Boone Blvd Suite 500
Vienna, VA 22182-2640
Phone: (703)448-1116

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will demonstrate a capability for locating imperiled firefighters in buildings using wireless technology based on long wavelength signals that penetrate buildings with lower perturbation than observed at higher frequencies. The system is being developed for firefighters (estimated 5 year market of over $150 million) but is useful for any application requiring geolocation in buildings where GPS cannot work. Such applications include tracking personnel and equipment in crisis situations, military combat, inventory management and police and military training. This concept has significant advantages over competing technologies; ultra-wideband solutions pose frequency-licensing problems, and man-portable inertial units are bulky, costly and have significant time-dependent errors.

The Wireless Firefighter Lifeline (WFL) system is completely mobile and supports multiple firefighters. It complies with Part 15 rules and will not require FCC licenses. Phase II will demonstrate the underlying technology over a wide range of conditions and will produce a prototype system that will serve as the baseline for future system development. It provides extensive commercial and societal benefit, offers performance superior to that of other potential technologies, and is well positioned to attract further funding.

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
Phone: (310)738-1787

Abstract:

This Small Business Innovation Research 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: 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.