Environmentally Benign Technology

Title: SBIR Phase II: High Efficiency Low Cost Nitrogen Fertilizer Production from Fly Ash

Award Number:	0822738
Program Manager:	Cheryl F. Albus
Start Date:	August 1, 2008
Expires:	July 31, 2010
Total Amount:	$500,000

Investigator: Peng Zhang, info@unitedee.com
Company: United Environment & Energy, LLC
111 Ridge Road
horseheads, ny 14845
Phone: (607) 796-0830

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop innovative high efficiency, low cost nitrogen fertilizer manufacturing technology from fly ash. Fly ash is a recycled material from coal power plants that may contain high concentrations of mercury and carbon. Traditional nitrogen fertilizer production uses natural gas as the primary feedstock and is very costly. The traditional fertilizers are water-soluble compounds, resulting in significant loss of fertilizer which in turn pollutes streams and ground water. America's coal power plants produce more than 71.1 million tons of fly ash per year, and most of it is disposed in landfills. The high mercury content in the fly ash makes the disposal more difficult and costly. The Phase II project will bring the viable fly ash nitrogen fertilizer production technology from a laboratory scale to a pilot scale, and will determine the optimal pilot plant operation conditions, produce fertilizer for farmland field testing, and demonstrate its commercial viability. The pilot plant data will be used to understand the importance of design parameters and operating conditions on plant performance, refine the manufacturing plant design, and reduce the risk associated with construction of manufacturing plants. The broader impacts (commercial significance) if this project is successful will be a high volume and highly technical application for fly ash and a value-added high efficiency low cost nitrogen fertilizer. The production of this fertilizer will not be affected by the availability of natural gas. Moreover, the projected production cost of this nitrogen fertilizer is much lower than that of the traditional nitrogen fertilizer. The use of this new nitrogen fertilizer on farms will increase crop production profitability and prevent fertilizer loss and water pollution. By avoiding the landfill disposal of the fly ash, the coal power plants will save millions of dollars. If all the fly ash produced at coal power plants in the US were used to produce nitrogen fertilizer, the amount of nitrogen fertilizer produced could meet the entire US market demand. The success of this new technology will bring a revolutionary change to the traditional nitrogen fertilizer production process and will have substantial environmental, economic, and technical benefits.

Title: SBIR Phase II: Recycling Advanced Batteries

Award Number: 0750552
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $512,000

Investigator: Steven Sloop, ssloop@onto-technology.com
Company: OnTo Technologies
63221 Service Road Suite 6/F
Bend, OR 97701
Phone: (541) 389-7897

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop process conditions, recycled materials, and recycling of new battery technologies. Phase I demonstrated that the innovative recycling process can produce materials for new batteries from spent batteries. The Phase II recycling research objectives will (1) Survey advanced battery technologies (2) Improve process efficiency and (3) Recondition used materials. Starting with spent batteries, the project recovers materials, examines utility, and develops methods for recondition based upon physical or chemical limiting issues. The anticipated result of this development is establishment of the most efficient process to recycle high performance battery materials. The proposed project establishes the most environmentally friendly advanced battery recycling technology as the solution to the next generation's significant environmental challenge. Today's battery recycling options inefficiently bury, burn, or melt spent batteries. This project addresses needs from battery-reliant industries for low-cost recycling with minimal environmental impact; the developed recycling process is the basis for jobs fundamental to the future portable electronics and electrified vehicle markets. The innovation is based upon knowledge from battery life-limiting mechanisms coupled with green-chemical processing techniques. The research actively involves undergraduate researchers at Willamette University in the development and commercialization of energy efficient technologies.

Title: STTR Phase II: Ultraviolet Activated Chelation (UVAC) for the Recovery of Hg from Industrial Wastewater

Award Number: 0750442
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $502,423

Investigator: Anna Casasus, aicasasus@MazTechSolutions.com
Company: Sol-Gel Solutions, LLC
4110 SW 34th Street
Gainesville, FL 32608
Phone: (352) 378-4950

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II aims to further develop and optimize an advanced oxidation technology called Ultraviolet Activated Chelation (UVAC), which utilizes low-energy ultraviolet (UV) light for the removal of mercury (Hg) from industrial wastewaters. The Phase I project achieved Hg concentrations as low as 11 ppt (which is lower than the Hg levels commonly found in rainwater) via this process. The technology has been proven in the bench- and pilot-scales, but further work is required to consistently achieve Hg concentrations below 12 ppt and to obtain the most economical commercial design. The Phase II objectives will include the optimization of design parameters such as filtration, pH, residence time, and UV light characteristics. The effect of various water chemical characteristics on Hg removal will also be studied. It is anticipated that Phase II efforts will result in a robust and economical commercial system employing the UVAC technology for industries to comply with current and pending environmental regulations. The broader impact/commercial potential from this technology will be a process for Hg removal from water to trace levels, this technology is contributing to the protection of human health, wildlife, and the environment. Exposure to Hg, which can occur by consumption of contaminated fish, can affect cognitive thinking, memory, attention, language, and fine motor and visual spatial skills. Additionally some researchers have proposed a link between Hg and autism. A commercially viable solution for Hg removal from water to levels below 12 ppt is lacking. Development of the UVAC technology for the chlor-alkali industry may lead to the commercialization of the technology for other industries, such as coal-fired power plants and dental offices, among others. Further understanding of the UVAC process will enhance the scientific community's knowledge about Hg in the environment, particularly in relation to UV light.

Title: SBIR Phase II: An Innovative Method for Removing Resist from Wafers

Award Number: 0750623
Program Manager: Cheryl F. Albus

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $500,000

Investigator: Hang Ji, hji@uncopiers.com
Company: Uncopiers, Inc.
6923 Redbud Drive
Manhattan, KS 66503
Phone: (785)293-4917

Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop an innovative, environment friendly method for removing resist from semiconductor wafers. After every lithography step, and the following processing step, e.g., etching or ion implantation, the process-hardened resist must be stripped away and the wafer cleaned. Existing photoresist removal methods (plasma ashing and wet chemical stripping) are proving too aggressive for current state-of-the-art interconnect materials-they tend to degrade and damage low-k dielectrics and corrode copper; they are also detrimental to the delicate device structures. In this project the resist stripping and wafer cleaning are accomplished in a single process step through controlled microcavitation in ultrapure water with no damage to the underlying layers and features. Resist stripping is a growing $2.64B market. The proposed resist remover and wafer cleaner successfully overcome a critical technological barrier facing the IC manufacturing industry today. Beyond the IC manufacturing industry, the microcavitation based layer removal will find applications in all areas requiring controlled thin film removal,e.g., MEMS, PCB, optics, automotive (paint removal), and aerospace. This will be an enabling technology useful in thin film processing. Microcavitation is a chemical free, environmentally friendly technology.

Title: SBIR Phase II: Control and Optimization of Combustion Based on Multispectral Emission Tomography

Award Number:	0724385
Program Manager:	Rathindra DasGupta
Start Date:	August 15, 2007
Expires:	July 31, 2009
Total Amount:	$499,201

Investigator: Xuemin Jin, xjin@spectral.com
Company: Spectral Sciences Inc
4 Fourth Avenue
Burlington, MA 01803
Phone: (781)273-4770

Abstract:

The Small Business Innovation Research (SBIR) Phase II project investigates a novel approach for directly measuring critical combustion flow-field information required for active control to increase combustion efficiency and reduce harmful emissions. Combustion control systems can be based on non-intrusive in-situ measurement using passive optical probes that measure spectrally-resolved radiation from specific molecular products (H2O, CO, and CO2) in the hot flow field. Concentrations and temperatures can be directly determined from the observed spectral structure. The critical innovation in this proposal is the experimental determination of the functional relationship using spectral sensor technology and tomographic reconstruction techniques. Flow field characterization is achieved using a large number of measurements over multiple lines of sight through the flow.

The proposed Phase II research lays the scientific ground work for active control systems for a range of multi-burner combustors, including turbine engines, boilers, and process burners. These applications represent more than 50% of the global fossil energy usage; thus improvements in efficiency can have a major economic and societal impact. The proposed innovation is just one of the component technologies required for the development of active control systems, but it is an enabling component, with potential application in all industrial combustion markets.

Title: SBIR Phase II: One-Step Environmentally-Friendly Synthesis of Novel Organic/Inorganic Hybrid Pigments

Award Number:	0724210
Program Manager:	Rathindra DasGupta
Start Date:	August 1, 2007
Expires:	July 31, 2009
Total Amount:	$500,000

Investigator: Lori Polette-Niewold, lpolette@utep.edu
Company: Mayan Pigments
500 W. University Ave.
El Paso, TX 79968
Phone: (915)747-6122

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will support the commercialization of a novel line of high-performance Mayacrom pigments using a lower cost, solid-state, environmentally friendly one-step manufacturing process. The Mayacrom pigments exhibit superior properties compared with many commercially available pigments and may replace environmentally detrimental pigments such as cobalt and cadmium based colorants. The intellectual merit of the proposed work includes the advancement of knowledge of solid-state reactions in the fields of materials science and engineering. Environmentally, aspects of the proposal include creating a production process that is solvent free, consumes only a modest amount of energy, and releases only water during manufacturing, resulting in no negative ecological impacts.

Broader effects include the fundamental understanding of the solid-state thermodynamics and reaction kinetics that affect the physical and chemical properties of the pigments. Results of the influence of mixing intensity on reaction kinetics will also expand the knowledge for other industrial processes. Other broader impacts include continued collaborative research activities at the minority-based University of Texas at El Paso (UTEP) to expand the scientific understanding of these hybrid pigments and publish significant findings. If successfully commercialized, the one-step manufacturing process will create jobs in the United States and in the under-utilized El Paso, Texas border region.

Title: SBIR Phase II: Improved Methods to Manufacture Brominated-Carbon Adsorbents for Power-Plant Mercury-Emission Control

Award Number: 0620518
Program Manager: Rosemarie Wesson

Start Date: July 26, 2006
Expires: July 31, 2008
Total Amount: $499,714

Investigator: Yinzhi Zhang, YZhang@SorbentTechnologies.com
Company: Sorbent Technologies Corp
1664 Highland
Twinsburg, OH 44087
Phone: (330)425-2354

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to further develop an advanced manufacturing method to both lower the cost and increase the performance of brominated carbon sorbents for power plant mercury emission control. Fine brominated carbon, a newly-commercial material, has been demonstrating a superior affinity in full-scale sorbent-injection trials for scavenging toxic mercury from power plant flue gases. In the Phase I project various production parameters were experimentally examined and the feasibility of an improved manufacturing process was preliminarily established. The Phase II project will concentrate on further developing and testing the innovative manufacturing technique.

Coal-fired power-plant mercury emissions are increasingly recognized as injurious to the environment and, ultimately, to human health. A leading retrofit technology for this application is the injection of a new material, brominated carbon, ahead of existing plant particulate controls. Consequently, successful efforts to lower the production cost and to increase the performance of these new materials will have high economic returns, potentially saving the nation tens or hundreds of millions of dollars each year.

Title: STTR Phase II: Formulation of Environmentaly Friendly Lubricants Based on Polymeric Materials for Cold Forging Process

Award Number: 0620290
Program Manager: Joseph Raksis

Start Date: July 5, 2006
Expires: June 30, 2008
Total Amount: $487,141

Investigator: David Stark, tdstark@mindspring.com
Company: Sisu
840 Main Campus Drive,Suite 3580
Raleigh, NC 27606
Phone: (919)831-2246

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project proposes to develop a polymeric lubricant that is environmentally friendly for cold forging of metals, by using proprietary emulsion polymerication technology to synthesize polymers containing both polar functional groups that adhere to the metal surface, and hydrophobic groups to provide lubricity, and by replacing zinc phosphate typically used as a corrosion inhibitor, with a more benign material.

This technology could lead to new lubricants for metal forging processes that are more environmentally benign, thereby reducing a potential health and environmental threat, and enhancing the competitive manufacturing position of the US.

Title: SBIR Phase II: Novel Sensor for Control of Cleaning Processes During the Fabrication of Microstructures

Award Number: 0548743
Program Manager: Murali Nair

Start Date: January 23, 2006
Expires: January 31, 2008
Total Amount: $470,050

Investigator: Bert Vermeire, bert@env-metrology.com
Company: EMC
6595 N Oracle Rd Ste 153B
Tucson, AR 85704
Phone: (520)742-3300

Abstract:

This Small Business Innovation Research (SBIR) Phase II project provides a unique and robust in-situ sensor for detection and control of impurities in microstructures and porous layers associated with manufacturing of semiconductor, MEMS, and emerging nanodevices. Use of impedance as a measure of contamination in bulk fluids is well established. However, applying it in micro-scale features is novel and has many promising applications. The proposed Electro-Chemical Residue Sensor (ECSR) technology is not aimed at developing yet another sensor to measure contaminants in fluids. It is rather aimed at the in-situ, real-time, and low-cost measurement of residual contamination inside and on the sidewalls of micro- and nano- features (the bottlenecks of cleaning, rinsing, and drying). The Phase II proposed plan is to design, fabricate, and test a prototype sensor assembly and develop its interface with process tools for cleaning, rinsing, and drying of micro-features.

The first planned application, amounting to annual commercial market revenue of $9M to $30M, will be in rinsing and drying of patterned wafers and porous films in micro-electronics manufacturing. Currently, these operations are often run with no adequate real-time control. Insufficient cleaning and drying have significant negative impact on manufacturing yields and device performance. On the other hand, excessive cleaning and drying results in damage to the micro-structures, increase in cost, and wasting of chemicals, water, and energy. The application of the ECRS technology to wafer rinsing alone is expected to reduce water usage by 40-60%.

Title: SBIR Phase II: Compacting Fly Ash to Make Bricks

Award Number: 0548719
Program Manager: George Vermont

Start Date: January 23, 2006
Expires: January 31, 2008
Total Amount: $497,506

Investigator: Henry Liu, fpc_liuh@yahoo.com
Company: FPC
2601 Maguire Blvd
Columbia, MO 62501
Phone: (573)442-0080

Abstract:

This Small Business Innovation Research (SBIR) Phase II project has the objective of conducting R&D needed for commercialization of new technology to make bricks using fly ash, which is a byproduct or waste material generated at coal-fired power plants. Research conducted under Phase I demonstrated that the known freeze/thaw problem of fly ash bricks can be solved using air entrainment. This process converts a high volume waste material into a useful product using a room temperature process, with cost, air pollution nd energy savings, compared to traditional processes.

The Phase II work will test key fly ash brick properties not tested in Phase I, investigate ways to vary the brick's color and shape, and study key steps in scaling up the process.

Title: SBIR Phase II: Neutralizing Utility Mercury Control Sorbents for Fly Ash Use in Concrete

Award Number: 0349752
Program Manager: Cheryl F. Albus

Start Date : January 1, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Qunhui Zhou, QZhou@sorbenttechnologies.com
Company: Sorbent Technologies Corporation
1664 East Highland Road
Twinsburg, OH 44087
Phone: (330)425-2354

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to optimize and commercially apply a newly discovered carbon material that simultaneously exhibits high gas-phase adsorption of mercury and low wet-concrete adsorption of organic surfactants. Such a material is necessary if coal-fired power plants are to inexpensively retrofit sorbent-injection technology to comply with new limits on mercury emissions while continuing to sell their fly ash wastes as substitutes for cement in concrete construction applications. The material will be tested at both the pilot and full scales, paving the way for product commercialization.

The broader impact that could be achieved from this project will be a solution a serious pending economic and environment problem. The substitution of power-plant fly ash for manufactured Portland cement in construction applications is one of America's biggest recycling successes. Fly ash could lower the construction-industry concrete costs, increase the technical performance of the concretes, and preserve the environment by conserving energy and reducing both waste disposal and CO2 emissions.

Polymer, Powder, & Composite Systems

Title: SBIR Phase II: Compact membrane reactors for high-purity hydrogen

Award Number: 0750325
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December, 31, 2009
Total Amount: $490,317

Investigator: Subra Iyer, siyer@nrgtix.com
Company: Eneregtics Incorporated
P.O. Box 1745
Brea, CA 92886
Phone: (714) 993-9081

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop mini-channel membrane reformers to produce pure hydrogen from gaseous and liquid fuels. Fuel reforming of hydrocarbon fuels to yield high purity hydrogen is, at present, the only means for overcoming the lack of an established infrastructure for hydrogen. Fuel processors must be able to start up quickly, follow demand rapidly, be tolerant to sulfur, and operate efficiently over a wide range of conversion rates. The use of mini-channel reformers, with selective membrane removal of hydrogen at the site of production within the individual reformer stages, will lead to improved efficiency, thermodynamics and kinetics of reforming reactions. If successful, the proposed membrane reformer system will decrease system complexity, reduce costs, and allow ease of control, monitoring and transient response. The proposed technology has significant business opportunities in the business sector for high-purity merchant hydrogen, and in the civilian and military sectors for hydrogen fuel cells, used in portable power and distributed generation. Valuable scientific and technological understanding will also be gained about the behavior of hydrogen-permeable membranes and their use in high-temperature, sulfur-resistant, compact fuel reformers to produce high-purity hydrogen.

Title: STTR Phase II: Durable Functional Coloring of Fiber Reinforced Thermoplastic Structural Composites for High Strength Material Applications

Award Number: 0750194
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $500,000

Investigator: James White, jwhite@shepherdcolor.com
Company: The Shepherd Color Company
4539 Dues Drive
Cincinnati, OH 45246
Phone: (513) 454-1231

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will demonstrate the ability to color structural composite parts made of thermoplastic polymers reinforced with long (3 mm to 25 mm in length) glass fibers. Today the options are black or natural resin color which limits their design appeal. Colorants are not used in thermoplastic composites for structural applications because they historically caused significant loss in key properties. This breakthrough of successfully using durable, high performance energy managing colorants in long glass fiber reinforced thermoplastic structural materials will open options for a wide range of products in construction, safety, sporting goods, furniture, industrial, transportation and recreational markets. Application prototypes for the transportation and industrial markets will be created in this project.   By integrating durable color within structural composite parts, the speed of displacing traditional materials will increase. Thermoplastic composite materials provide clear advantages relative to metals of reduced weight in the part with equal or superior properties, corrosion resistance, and design flexibility, all resulting in significant cost savings. Painting processes can be eliminated with the incorporation of color. The structural long glass fiber reinforced thermoplastics are more durable and result in less waste over time and therefore are better for the environment.

Title: SBIR Phase II: Anti-Microbial Vinyl Nanocomposites

Award Number:	0646481
Program Manager:	William Haines
Start Date:	April 15, 2007
Expires:	March 31, 2009
Total Amount:	$500,000

Investigator: Andrew Myers, amyers@tda.com
Company: TDA Research, Inc
12345 W 52nd Ave
Wheat Ridge, CO 80033
Phone: (303)940-2301

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop biocidal nanocomposites to protect plastics such as polyvinyl chloride (PVC). Biocides can now be added as a component during the plastic manufacturing process to make it inherently resistant to microbial attack. PVC is a widely used plastic that requires antimicrobial protection in many applications, as it is often used near water (swimming pool liners and shower curtains) or in areas where sterile or clean surfaces are critical (flooring for hospitals or kitchens and bathrooms). PVC is currently protected from microbial attack by arsenic compounds or organic biocides that migrate slowly out of the protected material. Arsenic-based biocides are under increasing regulatory pressure, and an alternative would be welcomed by the industry. Unfortunately, current non-arsenic (organic) biocides leach out of PVC, contaminating the environment and allowing fungi to attack the PVC. TDA Research, (TDA) proposes to increase the permanence of biocides designed to disperse in PVC. Nanoparticle-based biocides would not migrate out of the thermoplastics, prolonging product lifetimes. The project will start by examining several active organic biocides that have been approved and regulated as biocides for thermoplastics. Following this will be tasks related to nanoparticle synthesis; formulation and testing of the nanocomposite; nanoparticle manufacturing scale-up; and performance and economic evaluation. The plan is to develop nonarsenic, non-migratory biocides for PVC.

Commercially, the proposed project will improve help eliminate the use of arsenic containing biocides; biocides which are particularly harmful because they persist in the environment. Despite their known dangers and the desire of manufacturers to discontinue their use, arsenic containing formulations continue to be used in several applications where the alternative organic biocides do not provide the needed long term protection. Further, the use of our technology will decrease the release of the organic biocides into the environment as well, keeping them in the polymer where they are needed.

Title: STTR Phase II: Formulation of Environmentaly Friendly Lubricants Based on Polymeric Materials for Cold Forging Process

Award Number:	0620290
Program Manager:	Joseph Raksis
Start Date:	July 5, 2006
Expires:	June 30, 2008
Total Amount:	$487,141

Investigator: David Stark, tdstark@mindspring.com
Company: Sisu
840 Main Campus Drive,Suite 3580
Raleigh, NC 27606
Phone: (919)831-2246

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project proposes to develop a polymeric lubricant that is environmentally friendly for cold forging of metals, by using proprietary emulsion polymerication technology to synthesize polymers containing both polar functional groups that adhere to the metal surface, and hydrophobic groups to provide lubricity, and by replacing zinc phosphate typically used as a corrosion inhibitor, with a more benign material.

This technology could lead to new lubricants for metal forging processes that are more environmentally benign, thereby reducing a potential health and environmental threat, and enhancing the competitive manufacturing position of the US.

Title: SBIR Phase II: Highly Efficient Exhaust Cleanup Technology for Environmentally Benign Processing

Award Number: 0548440
Program Manager: George Vermont

Start Date: January 10, 2006
Expires: December 31, 2007
Total Amount: $500,000

Investigator: Ofer Sneh, ofer@sundewtech.com
Company: Sundew Technologies
1619 Garnet St
Broomfield, CO 80020
Phone: (720)887-8166

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel, integrated reactive abatement model (IRAM) that effectively removes solidifying chemicals from the exhaust effluent of atomic layer deposition (ALD) manufacturing processes. ALD and related manufacturing technologies are widely used in the electronics industry and will be critical for emerging nanotechnology applications. However, a key issue is the emission of reactive, toxic and solidfying chemicals that clog and destroy equipment, requiring frequent cleanup and replacement, and create worker safety and environmental concerns.

Objectives of this project include developing suitable abatement chemistries and systems for several important generic ALD processes and deriving generalized IRAM methodology that can be used to produce a module that can be integrated into ALD equipment.

Title: SBIR Phase II: Development of Smart Material Using Natural Fiber Reinforced Composite

Award Number:	0521905
Program Manager:	Joseph E. Hennessey
Start Date:	August 1, 2005
Expires:	July 31, 2007
Total Amount:	$439,726

Investigator: Christopher Whitmer, cwhitmer@vibroacoustics-solutions.com
Company: Vibroacoustics Solutions Inc
2205 229th Place
Boone IA, 50036
Phone: (515)450-8997

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a suitable prototype based on the Active-Passive Natural Fiber Composite (APNFC0), the technical feasibility of which was demonstrated in the Phase I program. This innovative composite material concept is bio-based and hence environmentally friendly. The APNFC has excellent vibration and noise mitigation properties and can be used to control acoustic noise and structural vibrations in a wide variety of noisy environments. The unique design of this composite material will reduce noise transmission over a broad band of frequencies through a combination of absorption and dissipation phenomena. The prototype to be built during Phase II will consist of a thermoformed sandwiched material configuration where a polymer-based piezoelectric layer (PVdF) is formed between two passive layers composed of variable density natural fiber composite (VDNFC). This material will have an embedded control system with amplifiers and power supplies.

The commercial applications of the new technology include: home appliances, soundproof architectural doors, office furniture, operator cabins for agricultural and construction machinery, building materials, automobiles, and aircraft cabins. Collectively, these represent a multi-billion dollar market for parts and products to which the present core technology can be applied. The company has a focus commercialization plan with strategic partner support in the appliance application and the office and construction applications.

Title: SBIR Phase II: High Performance Transparent AlON via Novel Powder Synthesis

Award Number: 0349022
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: George Hida, Ghida@mercorp.com
Company: Materials and Electrochemical Research Corporation (MER)
7960 South Kolb Road
Tucson, AZ 85706
Phone: (520)574-1980

Abstract:

This Small Business Innovative Research (SBIR) Phase II project proposes to develop a high performance transparent aluminum oxynitride (AlON) material, with improved mechanical properties and low cost, via an innovative powder synthesis method. Using nanoparticle sintering, an IR transmission of 80% can be achieved. The smaller grain size leads to a MOR of 400 MPa.

The Phase II program proposes to extend the applications of AlON for wide spread commercial applications. Several major forming methods will be developed in this Phase II program so that the forming capability can be established to fulfill all of the different parts for different markets. These products include high intensity discharge lamps, security windows, semiconductor substrates, laser windows, consumer optic windows, orthodontic brackets, etc.

Title: SBIR Phase II: Commercialization of Perfluorocyclobutyl Polymers for Integrated Optics and Other High Performance Applications

Award Number: 0349519
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $499,983

Investigator: Earl Wagener, ewagener@bellsouth.net
Company: Tetramer Technologies, L.L.c
501-8 Old Greenville Hwy, #325
Clemson, SC 29631
Phone: (864)653-4339

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to pursue commercialization of perfluorocyclobutyl (PFCB) polymer products successfully developed during Phase I. High performance fluoropolymers, whose structure can be readily adjusted to achieve performance targets and which can be easily processed are in demand for next generation technologies including integrated optics, fuel cell membranes, gas separation membranes, and deep UV lithography. Tetramer's patented PFCB polymers exhibit superior processing and performance advantages including excellent molding and extrusion capability, unmatched thermal stability, zero by-products during polymerization and fabrication, and the ability to tune properties for these large market applications that promise significant growth from to their global economic attractiveness and strategic military importance to the United States.

This distinctive activity will enhance scientific and technological knowledge in both academia and industry for such diverse technically driven fields as lower cost higher data rate integrated optics, fuel cell membranes, white light LEDs, and gas separation membranes and particularly the discipline of polymer chemistry due to its structural versatility. After protecting intellectual property, Tetramer plans to share the results through published papers, and university and industrial seminars. This project will also contribute to US global leadership in the above fields of strategic commercial and military interest.

Surface Treatments/Coatings

Title: STTR Phase II: A New Process for Boride Coatings for Manufacturing Applications

Award Number: 0822598
Program Manager: Cheryl F. Albus

Start Date: July 7, 2008
Expires: June 30, 2010
Total Amount: $499,858

Investigator: Rabi Bhattacharya, rbhattacharya@ues.com
Company: UES, Inc.
4401 Dayton Xenia Rd
Dayton, OH 45432
Phone: (937) 426-6900

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project is seeking the transfer and further development and commercialization of a new low temperature metal-organic chemical vapor deposition (LT-MOCVD) technology for boride coatings. The project will work to develop coatings for characterizations of adhesion, microstructure, morphology, composition and hardness. Selected coatings will be tested for friction and wear and corrosion resistance under laboratory test conditions on various common engineering substrate materials. The precursor preparation process will be scaled up and deposition will be done in an industrial scale deposition system. The coating process will be optimized for high hardness and good adhesion. Optimized coatings will be applied to components for testing at end users' facilities under production conditions. The broader impact/commercial potential of wear and corrosion resistant coatings are very attractive for their high hardness and good chemical stability, and have potential for many applications in the manufacturing sector in United States. The process developed in this project, of deposition of borides, will enable a wide spectrum of applications including cutting tools, die casting dies and inserts, transfer rolls for flat glass, components for chemical processes, armament industries, automotive and aerospace industries.

Title: SBIR Phase II: Nanostructured WC/Co Coatings for Enhanced Wear Resistance Applications

Award Number:	0646485
Program Manager:	Deepak Bhat
Start Date:	April 1, 2007
Expires:	March 31, 2009
Total Amount:	$499,972

Investigator: Ralph Tapphorn, rtapphorn@inovati.com
Company: Innovative Technology Inc
Cabrillo Business Park
Goleta, CA 93117
Phone: (805)571-8384

Abstract:

This Small Business Innovation Research (SBIR) Phase II project continued development of nano-crystalline tungsten carbide-cobalt coatings by integrating two novel processes: i) a low temperature spray deposition process (kinetic metallization), and ii) a nano-crystalline powder deposition process. The results of Phase I research demonstrated that the two proposed methods can be synergistically combined to synthesize unique new compositions of powders for thermal spray coating process. The Phase II work is focused on the scaling and optimization of the powder manufacture and deposition techniques.

If successful, the process and material system can provide an environmentally acceptable replacement for chromium-based coatings. A nc-WC-Co coating system with good fatigue properties will certainly provide an alternative to hard Chrome coatings, if it can be fabricated cost effectively. The environmental benefit resulting from this will be significant. The proposed technique is also claimed to result in a deposition equipment at a lower cost of ownership as compared to curently available equipment. The technique has significant broad applications in a number of key industries, including aerospace, power generation, oil and gas drilling, defense and medical industries.

Title: SBIR Phase II: Nanoparticulate Based Coating Approach for Making Thin Film Batteries

Award Number: 0620596
Program Manager: Rosemarie Wesson

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Suvankar Sengupta, ssengupta@aol.com
Company: MetaMateria
1275 Kinnear Rd
Columbus, OH 43212
Phone: (614)340-1690

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop unique materials demonstrated with potential to provide higher performance nanostructured cathodes for a solid state lithium ion thin film battery using a lower cost, nanoparticulate based deposition approach. A unique nanocomposite anode consisting Sn nanoparticles deposited onto CNT has been developed, with capacities higher than typically found in conventional Li ion batteries The cathode work will be directed toward development of improved cathode coatings.

The potential to cost-effectively eliminate the primary limitation to portable electronic advances will have a significant impact on industry and society. Lighter weight, more powerful and permanently rechargeable solid state devices that enable a new portable power "platform" will be an outcome of this endeavor. In addition, the nature of the solid-state design and materials is inherently disposable and environmentally friendly.

Title: SBIR Phase II: Nanocomposite Coating on Coronary Stents

Award Number:	0620563
Program Manager:	James Rudd
Start Date:	August 23, 2006
Expires:	August 31, 2008
Total Amount:	$490,533

Investigator: Robert Hoerr, bobhoerr@comcast.net
Company: Nanocopoeia
1479 Gortner Avenue, Suite 240
St. Paul, MN 55108
Phone: (651)624-3060

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is focused on designing, prototyping, and fully qualifying a proprietary manufacturing apparatus capable of applying a range of next-generation coronary stent coatings. First generation drug-eluting coronary stents have significantly improved clinical outcomes for heart patients, while concurrently highlighting the potential for substantial improvements. Next-generation methods are needed for improving the way drugs and other biologics are applied to the stent, as well as for active-agent release from the stent. The company successfully demonstrated in Phase I that its proprietary ElectroNanospray process could reproducibly apply nanocomposite drug/polymer coatings onto the intricate architecture of a coronary stent and could consistently meet preliminary specifications provided by a potential commercial partner. This Phase II project will extend that R&D by producing a manufacturing. Apparatus designed to significantly improve process control features and throughput. Rigorous step-wise hardware-qualification experiments will generate test lots of coated stents for further characterization and validation by the same partner. Feedback will guide design iterations needed to optimize this unique manufacturing capability, with the goal of producing an apparatus that coats stents with a broad range of novel nanocomposite coatings and drug-release properties for preclinical testing and meets the stringent performance requirements for commercial manufacturing in a regulated environment.

Commercially, sales of drug-eluting coronary stents will exceed $6 billion in 2006. With the first products entering the market in 2003, this represents the fastest market introduction in medical device history. The drug-eluting stent showed that the body's inflammatory and scarring response to the implanted bare metal stent, which resulted in re-blockage of the artery, could be overcome by applying thin layers of drug-releasing polymers to the stent surface. The broader implications are that coatings that enable site-specific delivery of biologically active compounds could improve the clinical performance of a wide variety of medical device implants, not only for cardiovascular indications, but also for use in orthopedic, neurology and tissue engineering applications. In addition, using the drug-eluting stent as an example, they offer the possibility of bringing about the same or improved clinical outcomes as existing therapies, while reducing cost, hospital length of stay, and loss of productivity by the patient. The novel manufacturing apparatus proposed in this research will have the ability to create and apply engineered nanocomposite coatings to device implants that incorporate novel active agents and controlled-release properties not possible with today's conventional coating processes, thereby offering the possibility of improved clinical outcomes for a wide variety of diseases.

Title: SBIR Phase II: Environmentally Benign Antifouling Coatings From Dendritic Nanotechnology

Award Number: 0522183
Program Manager: Joseph E. Hennessey

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $498,473

Investigator: Petar Dvornic, dvornic@dendritech.com
Company: Dendritech, Inc
3110 Schuette Rd
Midland MI, 48642
Phone: (989)496-2016

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to further the development of the technology to manufacture the first environmentally safe polymer coating that can successfully prevent aquatic biofouling on submerged man-made surfaces. The Phase I study clearly showed that the unique honeycomb-like structure of these novel nano-structured dendritic polymer coatings not only delivers very efficient anti-fouling protection, but also prevents environmental pollution.

The broader impact (commercial significance) of the program is the immediate application of this technology to coatings for ship/boat hulls used in marine and fresh water environments. These unique nano-structured antifouling coatings are also expected to have a very broad impact and large commercial effect in a variety of other water-based industries, ranging from shipping, fishing, tourism and defense, to production of energy in hydroelectric plants, protection of shorelines, production of potable water by desalination of sea water or from biofoulant-infested fresh-water sources.

Title: SBIR Phase II: Ultrananocrystalline Diamond as Wear Resistant and Protective Coating for Mechanical Shaft Seal Applications

Award Number: 0521596
Program Manager: Joseph E. Hennessey

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $511,530

Investigator: James Netzel, netzel@thindiamond.com
Company: Advanced Diamond Technologies
2001 S. First Street
Champaign IL, 61820
Phone: (217)239-1963

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new class of mechanical shaft seals based on the benefits of a novel material called Ultrananocrystalline (tm) diamond (UNCDtm) that will result in seals that last longer, save energy and reduce environmental emissions associated with industrial pumping and turbo-machinery applications. Mechanical shaft seals are used in almost every industry. The main functions of these seals are to ensure that the pumping fluid does not escape the system and to protect the fluids from contaminants. This program will build upon earlier results that showed that UNCD could reduce seal wear by orders of magnitude over SiC seals.

The project will include customer trials, securing industry standard qualification and developing manufacturing capabilities. New UNCD seal products will be developed for chemical, refinery, pharmaceutical, mining, and other demanding industrial applications. Several features of UNCD, including its fine grain size, high quality surface and its ability to be processed at reasonable temperatures, make it an ideal material to be leveraged other friction and wear
materials.

Title: SBIR Phase II: Temperature-Adaptive Nano-Crystalline Combinatorial Self-Lubricating Coating

Award Number:	0422080
Program Manager:	Errol B. Arkilic
Start Date:	September 15, 2004
Expires:	August 31, 2006
Total Amount:	$471,482

Investigator: Wenping Jiang, wjiang@virtual-incubation.com
Company: NanoMech Corporation
21 West Mountain
Fayetteville, AR 72701
Phone: (479)571-2592

Abstract:

This Small Business Innovation Research (SBIR) Phase II research project develops a temperature-adaptive nanoparticles-based solid lubricant coating (ZnO and MoS2 and their metastable forms) on textured cBN/TiN for hard turning and dry machining applications. The uniquely coated tool inserts are able to constantly release the lubricants out of reservoirs on the textured cBN/TiN surface. Currently available solid lubricant coatings do not offer temperature-adaptive properties and are NOT suitable for hard turning applications. Hard turning can offer manufacturers large cost savings compared to grinding. However, the achievable surface finish is critical. The preliminary results indicate that the proposed solid lubricant coating will enhance hard turning surface finish and provide greater consistency. In addition, both environmental and competitive cost issues are causing manufacturers to migrate toward dry machining. Solid lubricant coatings can both improve surface finish and extend the tool life in dry machining applications by lowering the friction at the interface between the tool and the workpiece. Commercially available solid lubricants are primarily configured in layered structures. As wear progresses, the lubrication layer wears away and leaves the hard layer behind. Thus, the proposed novel configuration that provides temperature adaptability while also offering continuous long lasting lubrication has great potential. The proposed research is an excellent example of adding value to industrial products from the investment in nano science and engineering. The project will provide improved understanding of how the tribo-chemistry of nanoparticle coatings can offer temperature adaptive properties and affect machining performance. Also, it will provide insights regarding the micro tribology along the boundary of the particles and binder(s).

The primary application of the coating will be for cutting tools in hard turning and dry machining. These are very important and growing commercial markets. Additional markets could be for rotating machinery, dies and molds, and other wear parts. The successful development of the proposed coating will help reduce environmental waste and contaminants from the usage of coolants. The disposal of both the used cutting fluid and the contaminated metal chips that were removed during the cutting process is becoming harder and more costly. The cost of the coolant has been widely estimated as contributing over 15% of a typical part.s machining costs. The project will help facilitate the adoption of high speed machining techniques, which is considered a key factor for the United States maintaining its manufacturing base in the face of strong competition from low labor rate countries.

Title: SBIR Phase II: ACIM deBonder: Thin Film Integrity Testing Using Controlled Microcavitation

Award Number: 0422191
Program Manager: Cheryl F. Albus

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

Investigator: Sameer Madanshetty, sameer@ksu.edu
Company: Uncopiers, Inc.
6923 Redbud Drive
Manhattan, KS 66503
Phone: (785)293-4917

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new method of determining how strong a thin film anchors to a substrate. The ACIM deBonder(trade mark)uses controlled microcavitation to directly reveal a thin film's adhesion strength by subjecting it to controlled erosion. ACIM is a means of constructively controlling acoustic microcavitation. Substrates are not harmed. The ACIM deBonder(trade mark) will be applicable to any type of film or coating that can be eroded in a controlled manner by cavitation. It is essentially a nondestructive method that only uses small areas of films. No special sample preparation is needed and the method is capable of in situ inspection. The ACIM deBonder tool will be developed for use in microelectronic manufacture. Semiconductor chips rely on the various film layers of their constitution to bond reliably. Beyond semiconductors the deBonder could be useful in optical coatings, and all contexts involving surface modification involving films.

The broader impacts of this project will be a new method of determining the adhesion strength of thin films; it is expected to advance the science of thin film engineering. The controlled erosion of ACIM can itself be used to create nascent surfaces in preparation for thin film deposition. Ultimately, the principle of ACIM deBonder (trade mark) relies controlled caviational erosion, in fact it relies on controlling the very fundamental process of phase change, the control of nucleation--the ability to convert a liquid into a gas in the vicinity of a solid phase. This should have much wider applications in a variety of chemical processing, e.g. in the control of the boiling processes in chemical and nuclear reactors. The study of this acoustically mediated nucleation control could form an active field/area of research and education

Title: SBIR Phase II: Cubic Phase-Stabilized Zirconia Thermal Barrier Coatings Applied via a Novel Chemical Vapor Deposition Route

Award Number: 0422242
Program Manager: Rosemarie D. Wesson

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $427,752

Investigator: Jason Babcock, jason.babcock@ultramet.com
Company: Ultramet
12173 Montague Street
Pacoima, CA 91331
Phone: (818)899-0236

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will seek to develop a novel technique for applying thermal barrier coatings (TBCs) to turbine (jet) engine components. The use of low thermal conductivity TBCs has enabled higher temperatures and longer component life to be achieved, along with more efficient engine operation. Application of the state-of-the-art coating compositions via chemical vapor deposition (CVD) has the potential for an order-of-magnitude reduction in processing cost over the conventional technique employed. In addition, CVD is a non-line-of-sight technique capable of coating components and/or regions of components not possible by any other means

The next-generation TBC system to be developed in this project will provide superior reduction in actual part temperature and oxidation resistance compared with state-of-the-art coatings. In addition to the increased engine efficiency realized from the higher temperature operation these coatings will allow, this application method has the potential for an 80-90% reduction in cost. Improved TBCs will have wide application to commercial and military propulsion and power generation systems, including turbine and reciprocating engines.

Title: SBIR Phase II: Nanocrystalline Diamond Coated Cutting Tools

Award Number: 0349769
Program Manager: T. James Rudd

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount $509,999

Investigator: Raymond Thompson, rthompson@VistaEng.com
Company: Vista Engineering Inc.
2800 Milan Ct
Birmingham, AL 35211
Phone: (205)943-6720

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop nanocrystalline diamond coatings on tungsten-carbide cutting tools with technical attributes that surpass the current generation of chemical vapor deposited (CVD) diamond coatings as well as tools made from polycrystalline diamond (PCD) wafers. The problem with CVD diamond coatings for cutting tools is poor surface finish and weak adhesion. Nanocrystalline CVD diamond deposited using microwave plasma (MP) techniques overcomes these problems with a smooth finish that is well adhered. This makes the nanocrystalline diamond a potential competitor to PCD diamond by lowering the price and increasing productivity. The research proposed for Phase II will use a 30kW MP-CVD reactor to investigate the relationships between nanocrystalline structure and technical performance. The structure will be controlled by process variables. Technical performance will be measured by mechanical testing and field testing on the proposed target application of machining cast aluminum-silicon alloy. The anticipated technical result will be direct correlations between structure, properties and performance that can be used to optimize nanocrystalline diamond coatings for machining automotive drive-train components.

Commercial applications of nanocrystalline diamond coatings are far reaching due to applications in the cutting tool industry that promote the use of hard-to-finish advanced materials; applications in pulp and paper for cutting and guides, applications in textiles for guides and applications in various bearing surface applications such as deep-well oil drill-head bearings. The National Institute of Health is also sponsoring research on nanocrystalline diamond applications in biomedical hardware surfaces subject to wear. Additionally, environmental impact of cutting fluid and related waste from machining processes are driving manufacturers to implement dry machining processes. MP-CVD nanocrystalline diamond tooling is the ideal tool for dry machining nonferrous materials.

Structural, Engineered, and High Temperature Materials

Title: STTR Phase II: Multi-Wall Carbon Nanotubes Inclusion for Thermal Conductivity Enhancement of Microencapsulated Phase Change Material Slurry

Award Number: 0823115
Program Manager: Cheryl F. Albus

Start Date: July 15, 2008
Expires: June 30, 2010
Total Amount: $499,783

Investigator: Curt Thies, Thiesman@aol.com
Company: Thies Technology
921 American Pacific Dr.
Henderson, NV 89014
Phone: (702) 567-8206

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project seeks to investigate the commercial feasibility of new processes capable of incorporating phase change materials (PCMs) and multi-wall carbon nanotubes (MWCNT) into micro- and nano-capsules thereby producing particles with novel thermal and fluid properties. The primary objective is to take advantage of MWCNT exceptional thermal properties to enhance the thermal performance nano/microencapsulated phase change material (N/MPCM) slurry. Thermally enhanced N/MPCM slurries can provide palpable benefits in the thermal management of commercial and industrial processes and products, from microelectronics devices to large industrial facilities, by providing considerable additional heat capacity and better heat transfer performance. The combined effect of nano/microencapsulated MWCNTs and phase change materials present a unique opportunity to improve the performance of heat transfer fluids beyond current levels. A series of experiments will be carried out to quantify the degree durability, heat transfer enhancements in laminar and turbulent conditions, and in typical heat exchangers. The broader impact/commercial potential of this project will have a lasting impact on the entire heat transfer industry. Direct impacts include lower flow rates, lower pressure drop, smaller heat transfer area and improved heat transfer effectiveness. The project will also elucidate how the new fluid performs in commercially available heat exchangers. The project will also provide unique educational opportunities to undergraduate and graduate students. The success of the project will broaden scientific and technological understanding of enhanced heat transfer fluids in industry as well as in academia. Indirect impacts include enhanced living standard and improved competitiveness. Successful commercialization of the proposed concept will find applications in biomedical, aerospace, homeland security, and energy generation.

Title: SBIR Phase II: Low-Cost Hot Press Die Casting of Graphite-Metal Materials

Award Number: 0823012
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $499,734

Investigator: James Connell, jconnell@charter.net
Company: Advanced Thermal Technologies
91 S. Street
Upton, MA 1568
Phone: (508) 529-4413

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to develop an unique hot press die casting technology to be used to produce graphite-metal materials. These materials will be used to produce packaging components for use in high power electronics packaging. There is a critical need for advanced materials with improved thermal properties capable of meeting the thermal management requirements of current and future high power electronic systems. The heat dissipation rate of electronic systems has increased dramatically, as a result of ongoing advances in semiconductor materials, compression of circuit physical architecture, size reduction of packaging envelops and faster switching speed. The technology developed in this project will enable the manufacture of cost effective graphite-metal packaging that offers improved thermal properties critical to thermal management solutions for next generation power electronics. The broader impact/commercial potential of this project will be the development of the hot press die casting technology for use in producing graphite-metal billet materials. The adoption and wide-spread use of the graphite-metal packaging products for electronic systems will enable commercial electronic devices based upon more efficient higher power semiconductor materials that will provide benefit to society in the form of more efficient, longer life electronics; reduced energy consumption; and improved environmental quality.

Title: STTR Phase II: Low-Cost Processing of Nanoporous, Super-Hydrophilic, Multifunctional Coatings for Glass and Plastic Surfaces

Award Number: 0823108
Program Manager: Cheryl F. Albus

Start Date: July 1, 2008
Expires: June 30, 2010
Total Amount: $499,999

Investigator: Uma Sampathkumaran, uma.sampathkumaran-1@innosense.us
Company: InnoSense LLC
2531 West 237Th St, Ste 127
Torrance, CA 90505
Phone: (310) 530-2011

Abstract:

This Small Business Technology Transfer Research (STTR) seeks to develop three significant permanent, self-cleaning, anti-fog coatings for plastic and glass surfaces. Fogging of the windows of a car is a hazard most drivers have experienced at one time or another. Fogging results in poor visibility, and unsafe driving or flying conditions. Durable, anti-fog coatings that provide a permanent solution to the problem have potential to satisfy critical needs, especially for the growing number of aging baby boomers. The broader impact/commercial potential of the coatings has been tested independently; these coatings will be fine-tuned for applications in aircraft cockpit windows, motorcycle helmet visors, and in related personal protective gear. These multifunctional hard coatings can be used as abrasion resistant, anti-fog and anti-reflection coatings on both glass and plastic surfaces. The coatings are made from inexpensive raw materials and simple processing techniques like dip or spray coating suited to forming conformal coatings.

Title: SBIR Phase II: Innovative Two-Phase High-Heat-Flux Heat Exchanger

Award Number: 0750416
Program Manager: Cheryl F. Albus

Start Date: March 1, 2008
Expires: February 28, 2010
Total Amount: $469,109

Investigator: Gregory Cole, gsc@mainstream-engr.com
Company: Mainstream Engineering Corporation
200 Yellow Place
Rockledge, FL 32955
Phone: (321) 631-3550

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to demonstrate an innovative multi-phase-fluid heat exchanger capable of revolutionizing heat transfer for high-heat-flux cooling applications. Initial experiments confirmed that metastable two-phase fluids can produce heat transfer coefficients 40% greater than single-phase fluids at the same flow rate and they have the potential to dissipate heat flux values. The broader impact/commercial potential from the technology will be result in a standardized family of two-phase cold plates that can be used by designers of electronics devices for a wide variety of applications. The new family of two-phase cold plates will be sold in sizes and configurations similar to existing air-cooled devices, but will have significantly increased heat flux dissipation rates and reduced thermal resistances. This project will also provide supporting design information and an Interactive Design Tool for use by the electrical packaging designer. The designer will then be free to package the remainder of the thermal management system based on basic vapor-compression design principals or purchase a system. Additionally, for applications where standard thermal components will not work, this project will provide custom solutions.

Title: SBIR Phase II: Innovative Isotropic Ultra-High Thermal Conductivity Diamond Composite Materials

Award Number: 0750177
Program Manager: Cheryl F. Albus

Start Date: January 1, 2008
Expires: December 31, 2008
Total Amount: $531,726

Investigator: David Curliss, david.curliss@p2si.com
Company: Performance Polymer Solutions Inc.
91 Westpark Road
Centerville, OH 45459
Phone: (937) 298-3713

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will further develop and demonstrate an innovative class of composite ultra-high thermal conductivity materials for solid state electronics thermal management applications. There exists a growing need for high thermal conductivity materials that exhibit greatly increased isotropic thermal conductivity and lower density compared to existing thermal conductivity materials and composites. Materials with these characteristics do not presently exist, but are enabling for many other future applications. Under the Phase II effort, the P2SI Team will develop these materials and characterize the fundamental structure-property-processing relationships to enable manufacturing scale-up and commercialization. The P2SI concept is for an "Engineered Material" where the processing behavior and the resulting macroscopic performance (thermal conductivity) is a unique function of the composite architecture. Building the proposed ultra-high isotropic thermal conductivity materials from a multi-scale constituent level represents a leap in technology that was first developed from the fundamental level and validated in the Phase I program. The impacts of this research are twofold: providing a foundation for a new technology in materials science research; and utilizing these fundamental findings to develop and engineer enabling materials to meet growing needs in industry for thermal management applications.

Title: STTR Phase II: Large Scale Freeform Fabrication for the Construction Industry

Award Number: 0646569
Program Manager: Deepak Bhat

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

Investigator: Charles Eason, charleseason@optemadevelopment.com
Company: OPTEMA
5179 Lakeshore Dr.
Fairfield, CA 94534
Phone: (800)427-8133

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop and commercialize a novel way to construct large, modular objects, such as concrete walls and components used in building a home, using a solid freeform fabrication process. The novelty of the proposed process is that is is capable of producing structures with wall thicknesses which are thickner than other similar methods. The structures can have contoured faces and alignment guides to permit quick assembly of layerwise construction. The proposed research will focus on aerated concrete as the structural materiaol, having proven the basic concept on structural foam in the Phase I research. The method is expected to result in rapid construction of homes with minimal labor and onsight assembly of pre-fabricated components.

The broader impacts of this project, if successful, would represent a radical departure in a notoriously conservative industry, leading to the construction of inexpensive, pre-fabricated homes. The technology will address a significant market in the U.S. and developing countries to provide affordable homes to a very large population of low-income consumers. Other applications where this technique could be employed include construction of large objects such as boat hulls (pleasurecraft).

Title: STTR Phase II: Support Material Characterization for Ultrasonic Rapid Prototyping

Award Number: 0548721
Program Manager: George Vermont

Start Date: January 11, 2006
Expires: December 31, 2007
Total Amount: $468,233

Investigator: Dawn White, dawn@solidica.com
Company: Solidica
3941 Research Park Dr C
Ann Arbor, Michigan 48108
Phone: (734)222-4680

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will complete the development of a support material for Ultrasonic Consolidation (UC) direct metal rapid prototyping and demonstrate the ability to build structures with high aspect ratios or overhanging features. This ability to apply UC to more complex shapes will enable engineers to design important parts more rapidly and less expensively. Basic iinformation developed on the mechanical properties of metals experiencing ultrasonic excitation will also be useful in other industrial processes, such as extrusion and ball milling.

The project will use the results from Phase I to identify a user friendly, cost effective, environmentally benign and easily removed support material, and demonstrate that its application can be integrated with the commercial UC platform.

Title: SBIR Phase II: Reactive Multilayer Joining of Metals and Ceramics

Award Number: 0349727
Program Manager: Cheryl F. Albus

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: David Van Heerden, dvh@reactivenanotech.com
Company: Reactive NanoTechnologies
111 Lake Front
Hunt Valley, MD 21030
Phone: (410)771-9801

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop technology for joining metallic and ceramic components; this is a reactive joining process that uses reactive multilayer foils as local heat sources for melting solders. These foils are a new class of nano-engineered materials, in which self-propagating exothermic reactions can be initiated at room temperature using a hot filament or laser. By inserting a multilayer foil between two solder layers and two components, heat generated by the reaction in the foil melts the solder and consequently bonds the components. This new method of soldering eliminates the need for a furnace or protective atmospheres and, with very localized heating, avoids thermal damage to the components. The reactive bonding process is far more rapid than most competing technologies, and results in strong and cost-effective joints. The last and potentially most important benefit is the fact that joining with multilayer foils enables the use of lead free solders and therefore offers tremendous environmental benefits.

The broader impacts that could result from this project could be to microelectronic packaging facilities.

Title: STTR Phase II: Modulation-Assisted Deep Hole Drilling of Micro/Meso-Scale Biomedical Components

Award Number:	0822879
Program Manager:	Cheryl F. Albus
Start Date:	July 1, 2008
Expires:	June 30, 2010
Total Amount:	$499,660

Investigator: James Mann, jbmann@m4sciences.com
Company: M4 Sciences Corporation
1800 Woodland Avenue
West Lafayette, IN 47906
Phone: (765) 479-6215

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project aims to develop a Modulation-Assisted Machining (MAM) system with novel capabilities for micro/meso-scale deep-hole drilling of biomedical components. The system is structured around a new device; an accessory developed for computer numerically controlled (CNC) machine tools. This new device superimposes a low-frequency sinusoidal modulation onto machining processes enabling controlled chip formation and easy disposal, enhanced lubrication of tool-chip contact, reduces energy consumption, and, potentially, a reduction in tool wear. When implemented in the appropriate system framework, unprecedented increases in productivity and efficiency of deep-hole drilling processes are envisaged. The broader impact/commercial potential of this project will be commercialize MAM technology in manufacturing of biomedical components and related applications in automotive and aerospace fluid systems manufacturing. Complemented by a strong education and training program. By driving the development of a class of clean machining processes with reduced effluent streams and energy consumption, and improved efficiency, this project will impact sustainable manufacturing for the discrete products sector, with broad societal benefits.

Title: SBIR Phase II: Micro-quantity Internal Cooling (MQuIC) of Cutting Tools for Increased Productivity via Micro-ducts

Award Number: 0646365
Program Manager: Cheryl F. Albus

Start Date: March 15, 2007
Expires: February 28, 2009
Total Amount: $499,951
Investigator: William Endres, wjendres@endresmachining.com
Company: Endres Machining Innov.
1402 E Sharon Ave, Ste 1001
Houghton, MI 49931
Phone: (906)487-9364

Abstract:

This Small Business Innovation Research (SBIR) Phase II research aims to develop and commercialize cutting tools with internal micro-geometric features to provide relatively direct and localized cooling of the tool-chip contact zone. The proposed innovation is (i) incorporation of micro-scale internal features and (ii) a production process that can provide high-volume manufacturing of these modified cutting tool inserts. Conventional approaches of using coatings for effective cooling during machining have limited effectiveness, but the proposed approach is claimed to provide a novel method of providing internal cooling mechanism to machine difficult-to-machine (DTM) materials.

If successful, this technology will enable better tool-life during the machining of hard-to-machine materials at finish feeds, which can have tremendous impact for machining of DTM alloys. By requiring minimal coolant use due to effective heat transfer from machining operation, the research will lead to new manufacturing methods with a positive impact on environmental pollution.

Title: STTR Phase II: Predictive Molding of Precision Glass Optics

Award Number:	0646503
Program Manager:	Rathindra DasGupta
Start Date:	March 15, 2007
Expires:	February 28, 2009
Total Amount:	$499,757

Investigator: Yazid Tohme, tohme@nanotechsys.com
Company: Nanotech
426A Winchester St
Keene, NH 3431
Phone: (603)352-3030

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will develop physics based computational models of the glass molding process that accurately predict the shape of the optic from knowledge of the mold geometry, the material properties of the glass, and the molding parameters. The computational models will be developed through systematic characterization of the properties of glasses at high temperatures, and incorporation of the viscoelastic response of the glass with thermal expansions and elastic deflections of the mold and glass. This project will also develop user interface software capable of building the finite element (FE) model directly from user input of coefficients of the industry-standard Asphere Equation and translating results of the FE analysis into Asphere coefficients.

The computational tools developed in the proposed research will eliminate the current need for production of more expensive trial mold geometries before discovering the proper mold geometry and processing parameters required to produce in-tolerance optics. The proposed research will allow manufacture of opto-electronic products with superior capabilities compared to those available today. In addition, the project will contribute to the development of science and engineering workforce through training of graduate students at the University of Florida and Clemson University.

Title: SBIR Phase II: Low Cost Pressure Infiltration Casting Process to Support High Volume Manufacture of Graphite-Metal Thermal Management Components

Award Number: 0646263
Program Manager: Rathindra DasGupta

Start Date: February 15, 2007
Expires: January 31, 2009
Total Amount: $499,963

Investigator: James Connell, jconnell@charter.net
Company: ATT
91 S. Streeet
Upton, MA 01568
Phone: (508)529-4413

Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop the use of a gas pressure infiltration casting process to manufacture graphite-metal billet materials that would be used to produce components for high power electronic device packaging. The heat dissipation rate of electronic devices has increased dramatically as a result of advances in semiconductor materials, faster switching speeds, compression of circuit physical architecture, and miniaturization of device envelops. These market trends are expected to continue and there is a critical need for advanced materials with improved thermal conductivity capable of meeting the package heat dissipation requirements of current and future high power electronic systems. In addition the materials will need to have a coefficient of thermal expansion (CTE) that minimizes the CTE mismatch that occurs at the interface between packaging components of different materials. The objective of the Phase II effort is the development and demonstration of cost-effective package assemblies that incorporate graphite-metal components with a thermal conductivity of from 500 to 600 W/m-oK and a coefficient of thermal expansion that can be adjusted between 5.0 and 10 ppm/oC.

The markets for packaging products based upon the graphite-metal material technology include: (1) RF power amplifiers for communications systems; (2) switching devices for power conversion systems; and (3) light emitting diode devices for solid state lighting. The research will produce the key knowledge required to enable the production of low-cost, high-volume graphite-metal components to satisfy the packaging requirements for the above applications. The packaging products supported by this manufacturing technology will benefit a broad spectrum of commercial, industrial, and military high power electronics end users. The adoption and wide-spread use of the graphite-metal packaging products for electronic systems will enable commercial electronic devices based upon more efficient higher power semiconductor materials that will provide benefit to society in the form of reduced energy consumption and improved environmental quality.

Title: SBIR Phase II: Advanced Tonnage Analysis System for Forging Processes

Award Number: 0620436
Program Manager: Rathindra Dasgupta

Start Date: September 1, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Tzyy-Shuh Chang, chang@ogtechnologies.com
Company: OG Technologies, Inc.
4300 Varsity Dr Suite C
Ann Arbor, MI 48108
Phone: (734)973-7500

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop an advanced tonnage signal processing system for the forging industry. This system will utilize advanced signal processing methods and statistical control techniques to distinguish between normal (in-control) and abnormal (out-of-control) tonnage signals, detect faulty process conditions (cold die, die wear, mismatch, improper lubrication, etc), and to conduct real-time process monitoring in the forging process.

The use of the advanced tonnage signal analysis system will contribute to reduction in energy consumption and carbon emissions, and improved tool (die) life in the forging process. This system also has the potential to be used in other deformation processes including rolling, stamping, extrusion, and drawing.

Title: SBIR Phase II: Long-Life Nozzles for Abrasive-Slurry-Jet Cutting

Award Number: 0622266
Program Manager: Rathindra Dasgupta

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $471,821

Investigator: Robert Dean, RCD@Synnovations.com
Company: Synergy Innovations, Inc.
10 Water St Ste 324
Lebanon, NH 03766
Phone: (603)448-5454

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will develop a high-pressure abrasive slurry jet cutting tool for almost all materials. The key aspect of this innovation is the elimination of nozzle grit erosion by fluid dynamic means. Past attempts to use abrasive slurry cutting tools have been troubled by unacceptable wear of the nozzles by the abrasive, and the associated loss of the abrasive.

The successful development of this technology will lead to a new generation of cutting equipment with reduced operating times and costs. This project will also provide internship opportunities for college undergraduates.

Title: SBIR Phase II: Ultrahigh-Pressure Flash Abrasive-Waterjets for Precision Machining

Award Number:	0620277
Program Manager:	Joseph Raksis
Start Date:	August 11, 2006
Expires:	August 31, 2008
Total Amount:	$345,708

Investigator: Peter Liu, peterl@omax.com
Company: OMX
21409-72nd Ave S
Kent, WA 98032
Phone: (253)872-2300

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and optimize a flash abrasive-waterjet for precision machining of delicate materials. The use of water in a phase change mode will offer advantages over abrasive waterjets, that can damage delicate materials, and liquid nitrogen abrasive cryogenic jets, that require expensive equipment.

The technology will be most useful for manufacturing parts with complex geometries from composites, glasses, laminates and other advanced materials, for use in the aerospace, electronics and defense industries.

Title: SBIR Phase II: Advanced Laser Patterning of Large Area Thin-Film Electrochromic Devices

Award Number: 0618631
Program Manager: Joseph Raksis

Start Date: July 13, 2006
Expires: June 30, 2008
Total Amount: $497,013

Investigator: Harvey Kalweit, hkalweit@sage-ec.com
Company: SAGE Electrochromics Inc
One Sage Way
Fairbuilt, MN 55021
Phone: (507)331-4902

Abstract:

This Small Business Innovation Research (SBIR) Phase II project has the objective of developing and transfering to the production line laser ablation technology for the manufacture of large area thin-film electrochromic (EC) windows. Shadow masking is commonly used to pattern the electrochromic coatings on glass, but it results in unacceptable edge definition and is expensive. Laser ablation can replace masking to allow precise definition of window areas, regardless of size and shape, and has the potential to significantly reduce manufacturing costs.

Broader acceptance of electrochromic windows for commercial and residential buildings will enable significant energy savings, and the laser ablation technology is applicable to non-flat shapes, which could extend use of EC windows to other applications.

Title: SBIR Phase II: Powder-Powder Mixing and Powder-Liquid Mixing by a Novel High-Intensity Vibrational Mixer

Award Number: 0548753
Program Manager: Joseph Raksis

Start Date: February 14, 2006
Expires: January 31, 2008
Total Amount: $460,987

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

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will enable the development of a high intensity, low frequency resonant-acoustic mixer for industrial uses, focusing on the incorporation of solid powders into liquids. Since there are no mixing blades or moving parts, issues of clean up and cross-contamination are minimized. The work will expand the scientific understanding of powder-liquid mixing in a high intensity resonant acoustic field, and provide an alternative mixing approach for emerging nano-sized materials.

Outcomes of the work will be a deeper understanding of the powder mixing phenomenon and a knowledge base for the design and optimization of complete industrial mixing systems.

Title: SBIR Phase II: Non-Traditional Material Removal

Award Number: 0548735
Program Manager: George Vermont

Start Date: January 23, 2006
Expires: January 31, 2008
Total Amount: $337,214

Investigator: Aric Shorey, shorey@qedmrf.com
Company: QED
1040 University Ave
Rochester, NY 14607
Phone: (585)256-6540

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop abrasive jet technology for manufacturing/finishng microoptics. Abrasion is accomplished by shear flow at the surface of the substrate submerged in an abrasive suspension and impinged upon by a bubble jet. This technology will allow the precision finishing of surfaces with an aperture size as small as 1 millimeter, and provide a scientific basis for, and demonstrate the feasibility of, new technology for optics fabrication.

Enabling the finishing of small, high precision molds and lenses will allow manufacture of higher resolution cameras for camera phones and other consumer products, and for medical and surveillance devices.

Title: SBIR Phase II: A Multilevel Method for Rapid Evaluation of Sound Fields

Award Number: 0548629
Program Manager: Rosemarie Wesson

Start Date: December 29, 2005
Expires: December 31, 2007
Total Amount: $499,706

Investigator: Rajendra Gunda, rajendra.gunda@ansol.com
Company: Advanced Numerical Solutio
3554 Mark Twain Ct.
Hilliard, OH 43026
Phone: (614)771-4861

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to extend the current high frequency limit of acoustic analysis by two orders of magnitude and facilitate numerical simulation of extremely large sound structure interaction problems. The proposed method will advance the state of the art in numerical acoustics by integrating the Fast Multipole Method (FMM) with the direct and indirect formulations of the Boundary Element Method (BEM).

The FMM-BEM technology reduces analysis time in computational acoustics by two orders of magnitude. Accurate acoustic analysis of automotive and aircraft interiors in the entire audible frequency range will become practical for the first time. The technology will also allow detailed computation of the acoustic characteristic of submarine hulls, and quantitative assessment of the occupational safety concerns of workers subjected to jet engine noise at airport ramps.

Title: SBIR Phase II: Modular Oxygen Enrichment Device to Improve Combustion Efficiency

Award Number: 0548714
Program Manager: Rosemarie Wesson

Start Date: December 13, 2005
Expires: January 31, 2008
Total Amount: $506,000

Investigator: David Walker, sdgroup@separationdesign.com
Company: SDGroup
931 Rolling Meadows Road
Waynesburg, PA 15370
Phone: (724)852-1035

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an innovative modular oxygen enrichment system. It is accepted that the reduction of cycle time can lead to a concurrent decrease in the mass of a sorptive separation system. However, ultra-rapid-cycle systems invariably create mechanical and physical challenges. Specifically, limiting factors are the operational lifetime of the mechanical components, and the micro diffusion rate of the adsorbent system. This project will remove these limitations by replacing mechanical valves with electro-kinetic pumps, and by utilizing microscale adsorbent structures that radically improve diffusion rates.

Conventional air separation units exhibit a poor mass/output ratio, which contributes to high cost. Oxy-air combustion offers the possibility of significant fuel savings and other environmental benefits. The broad impact of this research is not only fuel savings attainable from improved combustion efficiency, but also application to other processes where oxygen is the rate limiting factor. Fuel cells, aquaculture, biomass conversion, and water treatment will also profit from this exportable technology.

Title: SBIR Phase II: Development of Porous Lubricated Nozzles for Suppression of Nozzle Wear in Abrasive Water Jet Systems

Award Number: 0422151
Program Manager: Cheryl F. Albus

Start Date: August 15, 2004
Expires: July 31, 2006
Total Amount: $485,362

Investigator: John Murphy, jbmurphy@jhu.edu
Company: Lubrijet, Inc
130 Starhill Lane
Baltimore, MD 21228
Phone: (410)516-5427

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop technology for prevention of nozzle wear in abrasive water jets, which limits the lifetime and accuracy of jet cutting, and currently requires entrainment of abrasives downstream of the nozzle in a larger mixing tube. The method consists of a porous nozzle surrounded by a reservoir containing high viscosity lubricant pressurized by the same pump that drives the slurry in the nozzle. The lubricant is forced through the porous walls by the pressure difference generated due to the high-speed slurry flow, and creates a thin film, which protects the nozzles' interior walls. Pilot tests have successfully reduced the nozzle wear by more than an order of magnitude. Two systems are being developed: A Porous Lubricated Mixing Tube (PLMT) that can be retrofitted into existing commercial systems, and a Porous Lubricated Abrasive Suspension Jet (PLAS-Jet) with premixed particles prior to injection. The latter enables operation at lower pressures, and cutting of harder materials with smaller jets (micro-machining). Extensive cutting and nozzle wear tests during Phase II will optimize the nozzle material, geometry and manufacturing procedures, and will determine the lubricant properties and injection rate. Other components will also be improved including the particle and lubricant feed systems.

The broader impact (commercial potential) of the proposed technology will be abrasive water jets that can be utilized for cutting and machining of sheet metal, ceramics and composites by diverse users, ranging from small machine shops to the automotive and aircraft industries. Wear of the mixing tube in present systems adversely affects all the applications of jet cutting by limiting the lifetime of the nozzle and accuracy of the cut, by causing machine-down time, and by preventing commercial applications of micro-jets. A PLMT retrofitted with minimal investment into the thousands of abrasive jet systems already in the market will greatly reduce these adverse effects. The PLAS-Jet with premixed particles has several additional advantages that reduce the cost and extend the applications of jet cutting technology. Cost reduction results from the lower pressure required for achieving the same cutting effect (e.g. 10000 vs. 50000 PSI), the more efficient use of the abrasives, and the less frequent replacement of nozzles. The lower pressures also simplify the development of compact portable systems for remote applications in hazardous environments, such as during decommissioning of nuclear plants, and for military applications, e.g. removal of mines and other obstacles. Furthermore, unlike mixing tubes, the PLAS-Jet diameter can be reduced to levels enabling expansion of jet cutting to precision micromachining.

Title: SBIR Phase II: Spray Forming Titanium Alloys Using the Cold Spray Process

Award Number: 0349787
Program Manager: Cheryl F. Albus

Start Date: February 15, 2004
Expires: January 31, 2006
Total Amount: $464,407

Investigator: Richard Blose, blose@ktech.com
Company: Ktech Corporation
2201 Buena Vista SE
Albuquerque, NM 87106
Phone: (505)998-5830

Abstract:

This Small Business Innovation Research Phase I project proposes to develop a new, low-cost methods for direct fabrication of metal parts at near-net shapes (NNS). This technology is critical for many industries and in particular, for manufacturing parts of expensive metals and alloys such as titanium. Such technologies have an impact on many industries because of the potential to quickly manufacture complicated parts with minimal waste. Currently used methods typically involve melting and solidification, which can cause high residual stresses, undesirable phases, and other problems. To solve the problems described a new method for spray forming is being used. This method is based on using the cold spray process avoiding undesired material, chemistry, and phase properties associated with thermal spray-forming methods. Studies conducted during Phase I demonstrated the feasibility of the cold spray process for rapid prototyping and direct fabrication of spray form shapes of Titanium alloys. The anticipated result of this activity is to deliver a technology yielding superior material properties of sprayed material and reduce cost of manufacturing.

The broader impacts of cold spraying near net-shapes technology could be very important technology for aerospace, including aircraft, military aircraft and spacecraft. This technology is promising for many other industries including automotive, medical, power, chemical, sport goods, and others. The proposed research activity will enhance scientific and technological understanding of the spray processes based on using high-speed particle flow.

Manufacturing Process Control

Title: STTR Phase II: A Multi-Axis Planning System (MAPS) for Direct Fabrication Processes

Award Number: 0822739
Program Manager: Ian M. Bennett

Start Date: August 15, 2008
Expires: July 31, 2010
Total Amount: $500,000

Investigator: Jianzhong Ruan, jzruan@gmail.com
Company: Product Innovation and Engineering, L.L.C.
11513 Pine Forest Dr.
Rolla, MO 65401
Phone: (573) 308-7175

Abstract:

This Small Business Technology Transfer Research (STTR) (STTR) Phase II research project focuses on the development of an innovative Multi-Axis Planning System (MAPS), for layered manufacturing processes. By enabling current direct metal deposition systems to fully control and utilize multi-axis capability to make complex parts, MAPS will enable fully-automated process planning for multi-axis layered manufacturing processes to directly control metal deposition machines used in automated fabrication. The building of complicated shapes without support structures is a major challenge for current direct metal deposition processes. This proposed Phase II research will continue to research and develop the 'centroidal axis' algorithm in multi-axis slicing, with an emphasis on completeness and robustness for complicated shapes such as geometry with multiple loops and internal structures. This algorithm will allow manufacturing systems to handle parts with multiple loop features. Additional features to be developed under this Phase II project include a deposition visibility map for efficient computation on the collision-free slicing/deposition sequence in a multi-axis scenario, and a '3-D layer' toolpath generation which will provide an alternative turning algorithm for the deposition process. The proposed project will impact the manufacturing industry by incorporating fully-automated multi-axis control capability into the rapid manufacturing industry to produce fully functional metal parts with complicated shapes. This capability will lead to dramatic reductions in lead time and manufacturing costs for high-value, low-volume components with high performance material. Assuming the outcomes are successful, the project will several segments such as aerospace, military, motor sports, automotive, industrial machinery, medicine, dentistry, and consumer products.

Title: SBIR Phase II: Infrared Confocal Measurement System

Award Number: 0750368
Program Manager: Cheryl F. Albus

Start Date: April 1, 2008
Expires: March 31, 2010
Total Amount: $499,401

Investigator: David Marx, dmarx@tamartechnology.com
Company: Tamar Technology
996 Lawrence Drive
Newbury Park, CA 91320
Phone: (805) 480-3358

Abstract:

The Small Business Innovation Research (SBIR) Phase II project will design and construct prototype measurement systems based on near infrared (NIR) chromatic confocal sensor technology. Silicon is transparent in the NIR, and thus the sensor measures the distance to the front and back surfaces of the wafer simultaneously. The sensor will measure deep trenches and vias from the back side so that their aspect ratios are of no consequence. The proposed innovations lie in the sensor design and integration. The proposed measurement systems will address the following semiconductor industry needs: 1) in situ wafer thickness measurement during wafer thinning operations; 2) wafer thickness and shape measurements of ultra-thin wafers; and 3) the measurement of deep, high aspect ratio, etched trenches and vias in silicon. Direct, in situ, measurements during wafer thinning are not currently possible. Neither is the nondestructive measurement of trench depth of many types of deep etched trenches and vias. The measurement of the thickness of ultra-thin wafers (<150 micron) requires greater accuracy for less cost than is currently available. Present technology does not have the resolution for measuring thickness in this thinner range, nor does it have sufficient spatial density on the wafer to accurately describe its shape.

Title: STTR Phase II: Development of an In-Line Cylinder Bore Inspection System

Award Number: 0723669
Program Manager: Cheryl F. Albus

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

Investigator: Stephen Segall, segall.ioms@gmail.com
Company: IOMS
1349 King George Blvd.
Ann Arbor, MI 48108
Phone: (734)971-1065

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project is working toward commercialization of cylinder bore probe inspection technology. During Phase II continued improvements and enhancements to the existing cylinder bore probe technology (in cooperation with the ERC for Reconfigurable Manufacturing at the University of Michigan) will continue. The scientific feasibility of this cylinder bore inspection technology was proven during the Phase I project; continued work on the operation of an automated inspection station with an array of probes working in parallel in a factory environment will be demonstrated during the Phase II project. Enhancing the technology may create opportunities for performing inspections at other locations on the engine block production line and for other cylindrical machined surfaces.

The broader impacts anticipated from this inspection process will be improved quality, reduced production costs and improve performance of vehicles used by hundreds of millions of people worldwide. It is also anticipated that this technology could lead to an optimized manufacturing process that would produce engines with reduced emissions, reduced oil consumption, improved efficiency and longer lives. Optimizing surface finish may have a greater effect on diesel engines, which are more efficient than gasoline engines.

Title: STTR Phase II: An Inference Engine for an Intelligent Imaging System for Detecting and Eliminating Hot Rolled Surface Defects

Award Number: 0646502
Program Manager: Rathindra DasGupta

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

Investigator: Tzyy-Shuh Chang, chang@ogtechnologies.com
Company: OG Technologies, Inc.
4300 Varsity Dr Ste C
Ann Arbor, MI 48108
Phone: (734)973-7500

Abstract:

The Small Business Technology Transfer Research (STTR) Phase II project will develop an inference engine for an intelligent imaging system that can detect and eliminate surface defects in hot rolling operations. These defects account for roughly 50% of steel rejects. The proposed product is an automatic system that generates appropriate corrective actions for defect elimination. It is proposed to further develop the inference engine and validate it on selected industrial cases.

The potential value of the research is to reduce material waste by over 200,000 tons of steel, or $120 million in productivity, per year for the US steel industry. It is also expected to deliver benefits in North America with energy savings of 1.14 Tetra W-hr and reduced carbon-equivalent emission of 94,000 tons per year. Other benefits include reduced water usage and more efficient downstream processes. The project carries strong educational implication, with the company working closely with academia and facilitating student interns.

Title: SBIR Phase II: A Robust and Cost-Effective Tool for Diagnosing Manufacturing Noise Problems

Award Number: 0620287
Program Manager: Ian Bennett

Start Date: August 23, 2006
Expires: July 31, 2008
Total Amount: $500,000

Investigator: Manmohan Moondra, manmohan@sensound.com
Company: SenSound
221 Lewsiton Rd
Grosse Pointe Farms, MI 48236
Phone: (313)885-4550

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize a next generation quality control tool to assess the quality of any sound-generating product on a production line. The most significant scientific merit of this new technology is its capability to suppress the interference of background noise and extract the real acoustic characteristics of any target source in a noisy environment. Current measurement devices measure the overall signal, which includes the signal of a target source and background noise.

This research is expected to have broad impact on reducing noise pollution and improving workforce capabilities in a manufacturing environment. This technology will help the U.S. manufacturers to compete globally by reducing noise emissions, lowering warranty costs associated with noise related issues, and helping ensure compliance with a growing number of local and federal government regulations and laws on noise pollution.

Title: STTR Phase II: Advanced Control of Electron-Beam Deposition for High Precision Optical Coatings

Award Number: 0548726
Program Manager: James Rudd

Start Date: April 13, 2006
Expires: March 31, 2008
Total Amount: $505,940

Investigator: Douglas Smith, dsmith@vptec.com
Company: Cyber Materials
70 Industrial Park Road
Plymouth, MA 02360
Phone: (508)732-5107

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project leverages the substantial improvements in e-beam process control capability developed in Phase I into an integrated control system that can significantly increase yield and throughput for the $1.8 billion precision optical coating industry. Manufacturing partners indicate that the target performance levels would cut manufacturing costs by 35% and enable manufacturers to routinely achieve greater tolerances for advanced designs. This research is driven by a first-principles systems based approach that has created new intellectual property for monitoring, control, and process design.

Commercially, precision optical coatings are critical components for all optical instruments including microscopes, telescopes, vision and imaging systems, projection systems, and laser systems. Coatings have served these industries for years, but in a world where application requirements and scientific inquiry are constantly advancing, precision coatings are demanded that comply with even tighter tolerances. In particular, high energy laser science such as the NIF facility at Livermore require very precise and reliable coatings. This STTR research will be key to further improving manufacturing capabilities for a variety of important applications.

Title: SBIR Phase II: High Speed Optoelectronic Recognition of Al, Si, and Mg Alloys

Award Number: 0450452
Program Manager: Joseph E. Hennessey

Start Date: January 1, 2005
Expires: December 31, 2006
Total Amount: $499,998

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

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project will apply an optoelectronic detection system into an integrated high-speed manufacturing system aimed at commercial identification and sortation of aluminum scrap by alloy type - particularly aluminum alloys containing various alloying elements such as silicon and perhaps magnesium. The goal of the program is to commercially sort mixed aluminum alloys from an automobile shredder. Commercial technologies in existence today sort automobile shredder nonferrous metals based on density, but there are no technologies in commercial operation that sort the metals into 1) cast and wrought alloys, 2) various aluminum alloy series (100, 200, 3000, 7000 etc.), or 3) into individual alloy types. Sorting aluminum alloys based on chemical composition is the objective of this SBIR Phase II program. A very sophisticated, proprietary sensor and detection system has been developed and demonstrated in Phase I in order to demonstrate the capabilities of the technology.

The broader impacts (commercial potential) of this proposed technology has the potential to transform the efficiency and utilization of scrap metal in the U.S. In 2001, the aluminum industry consumed nearly 800 trillion Btu, was responsible for 1.8% of the total manufacturing energy consumed, emitted 43.5 million tons of CO_2, and consumed 1.6% of all U.S. electricity - mostly from primary production. Secondary production is much more efficient - economically and environmentally. Recovering aluminum from scrap consumes only about 6% of the energy required to produce primary aluminum and requires only 10% of the capital. In spite of efficiencies in making aluminum from scrap, exports in 2003 were 562,090 million tons because the industry could not utilize much of its low-grade scrap. This technology will allow utilization of this scrap in existing U.S. plants because the scrap will be converted from low-grade to high-grade scrap which is more consistent with U.S. consumption and needs. The result will be job preservation, reduced emissions, reduced energy needs, reduced raw material imports, and a better balance of payments.

Chemical Synthesis and Characterization

Title: SBIR Phase II: Hydrogen Production via Ultra-Rich Superadiabatic Combustion of Hydrogen Sulfide in a Reverse Flow Reactor

Award Number: 0646419
Program Manager: Rathindra DasGupta

Start Date: February 1, 2007
Expires: January 31, 2009
Total Amount: $499,999

Investigator: Jacques Bingue, jpbingue@innesol.com
Company: Innesol
9800 Connecticut Dr
Crownpoint, IN 46410
Phone: (219)794-1492

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a new process employing the superadiabatic reverse flow reactor to reform hydrogen sulfide into hydrogen with the simultaneous recovery of sulfur. Currently, the seven million tons of hydrogen sulfide produced each year as a byproduct of the reaction of sulfurous compounds with hydrogen are processed by Claus reactors into sulfur while wasting the much more valuable hydrogen content through oxidation. The successful development of the process would provide an economical means of dealing with hydrogen sulfide by retaining hydrogen. The Phase I project obtained the highest hydrogen yield ever achieved by a hydrogen sulfide process without the aid of external energy. Furthermore, the project attested that the reactor operates in regimes that eliminate sulfur dioxide. Building on the positive Phase I results; during this Phase II, a small pilot plant will be built and tested forming the basis for designing the commercial reactor with minimal modification.

The high price of gasoline and natural gas is partly due to the high cost of extracting sulfurous compounds in the crude oil refining process. This desulphurization process uses hydrogen, obtained mostly from natural gas, to react with the organosulphur species to form hydrogen sulfide. A process that can produce hydrogen as well as sulfur from hydrogen sulfide would save the energy industry hundreds of millions dollars per year in addition to decreasing the cost of gasoline, diesel, and natural gas for consumers. In addition, the process will also eliminate millions of tons of acid-rain-causing sulfur dioxide produced during disposal of hydrogen sulfide.

Title: SBIR Phase II: An Engineered Diffusion Barrier for Preparation of Pd Membranes on Tubular Porous Stainless Steel Substrate

Award Number: 0620528
Program Manager: Rosemarie Wesson

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $499,999

Investigator: Paul Liu, pliu@mediaandprocess.com
Company: M&P
1155 William Pitt Way
Pittsburgh, PA 15238
Phone: (412)826-3721

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development of an innovative diffusion barrier for the preparation of Pd thin film on tubular porous stainless steel substrate. A thin Pd film supported on tubular porous SS substrate provides a commercially viable avenue for the use of palladium membranes for hydrogen production/recovery, particularly for large-scale applications. During Phase II the diffusion barrier will be developed to a commercial scale membrane unit for performing field tests. Pd membranes due to their excellent hydrogen permeability and selectivity can streamline existing hydrogen separation and purification processes dramatically for fuel cell and hydrogen separation applications.

The projected worldwide market size when fully matured is in the range of $1 billion/yr. Refineries' demand for hydrogen is expected to post annual growth in excess of 10% as refiners use more hydrogen to meet clean fuel regulations. A Pd-base hydrogen selective membrane suitable for large scale operations will play a major role in meeting this demand, particularly for the retrofit market, such as hydrogen recovery from waste refinery streams, as an add-on stage for existing steam reformer for incremental capacity, etc. In summary the proposed diffusion barrier could offer a practically viable Pd-based hydrogen separation device, which can benefit fuel cell and industrial hydrogen applications, and greenhouse gas reduction.

Title: STTR Phase II: Development of Fourth Generation High Temperature Materials

Award Number: 0548639
Program Manager: George Vermont

Start Date: December 21, 2005
Expires: March 31, 2008
Total Amount: $680,587

Investigator: Jason Lincoln, jason.lincoln@p2si.com
Company: P2SI
91 Westpark Road
Centreville, Ohio 45459
Phone: (937)298-3713

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop and characterize the structure-property-processing relationships for a novel class of thermosetting organic/inorganic hybrid polyimide resins. The resins will be used to fabricate structural composites; expected properties of the composites are higher extended use temperatures, compatibility with existing fabrication procedures, and mechanical and environmental stability properties as good as currently used materials. The project will provide a scientific basis for a new class of thhermosetting resing with broad value in defense, aerospace and deep sea drilling applications.

Project activities will include an experimental design to identify top performing structures, scale up and statistical analysis of batch to batch variations, preparation and testing of flat panels and targeted structures, and user testing of the structures.

Title: SBIR Phase II: Feasibility of On-line Metalloid Recovery in Gasification Systems

Award Number: 0422050
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2004
Expires: July 31, 2006
Total Amount: $499,650

Investigator: Margaret Laumb, mlaumb@microbeam.com
Company: Microbeam Technologies Incorporated
4300 Dartmouth Drive
Grand Forks, ND 58203
Phone: (701)777-6530

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will demonstrate the ability to selectively condense and recover deposits rich in a valuable element from the gas-cooling regions of integrated gasification combined cycle (IGCC) plants. Deposits plugging gas-cooling heat exchangers in commercial coal IGCC systems are rich in a valuable element. The work will involve the design and construction of a pilot-scale on-line metalloid recovery (OMR) system that will be tested at bench scale on simulated synthesis gas, and on slipstreams from small-scale gasifiers. Phase II work will determine the effects of particulate matter and pressurized systems on the ability to concentrate and remove the valuable element from the gas stream. The on-line recovery of deposits rich in a valuable element will have two distinct commercial benefits. The first benefit is the cost savings associated with eliminating down time required for cleaning.

By eliminating one cleaning outage, a gasification plant could save $4.9 million. The second benefit is the creation of an additional revenue stream from the recovery of these deposits, which can be sold to a recycler.

Title: SBIR Phase II: Low-Cost Hydrogen for Next Generation Vehicles

Award Number: 0422223
Program Manager: Rosemarie D. Wesson

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $491,721

Investigator: Robert Copeland, copeland@tda.com
Company: TDA Research, Inc
12345 West 52nd Avenue
Wheat Ridge, CO 80033
Phone: (303)940-2301

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop a low cost process for producing high-pressure hydrogen. This process uses a proven, regenerable, low cost CO2 sorbent to minimize capital costs and improve efficiency. The key to the process is a sorbent that shifts the equilibrium of the reforming and shift reactions that convert hydrocarbons to hydrogen. The sorbent will be produced using commercial production equipment and tested to determine its lifetime and performance. In the near term, an improved hydrogen production process would significantly reduce the cost of the hydrogen used in oil refineries to make reformulated (cleaner burning) gasoline, and bulk chemicals such as fertilizers and chemical intermediates.

In the longer term, the new system can significantly reduce the cost of producing hydrogen to distribution centers that will be needed for hydrogen fueled vehicles and other fuel cell applications.

Title: SBIR Phase II: Purification of Metallic Nitride Nanomaterials by Chemical Separation

Award Number: 0349691
Program Manager: T. James Rudd

Start Date: January 1, 2004
Expires: December 31, 2006
Total Amount: $724,884

Investigator: Steven Stevenson, steven.Stevenson@usm.edu
Company: Luna Innovations, Incorporated
PO Box 11704
Blacksburg, VA 24062
Phone: (601)266-4119

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will involve production and purification of a powerful Magnetic Resonance Imaging (MRI) contrast agent based on a newly discovered nanomaterial (Trimetasphere), consisting of a metallic nitride nanocluster inside a fullerene type cage. Trimetaspheres recently demonstrated a factor of 21 times improved relaxivity over currently used MRI contrast agents. The project will involve designing and building a powder-feed continuous reactor, including large rod capability, developing chemically-based separations techniques and optimizing heat treatment of the chemically separated Trimetasphserses mixtures. The nanoproduction and chemical-based separations techniques for these Trimetasphere nanomaterials will provide the basis for the large-scale production of the Trimetasphere based MRI contrast agents.

Commercially, these Trimetaspheres have tremendous medical applications that will benefit US citizens with better medical care through improved diagnostics, new pharmaceuticals, and simultaneous diagnostic and treatment reagents, at a fraction of current cost. The development of more sensitive contrast agents, if translated into smaller, less expensive MRI instruments, will open entirely new markets for the equipment manufacturers.

Novel Catalytic Systems

Title: STTR Phase II: Metal Oxide Nanofibers for Filter and Catalyst Support Structures

Award Number:	0822914
Program Manager:	Cheryl F. Albus
Start Date:	July 1, 2008
Expires:	June 30, 2010
Total Amount:	$500,000

Investigator: Gary Carlson, carlson@mempro.com
Company: MemPro Ceramics Corporation
PO Box 3806
Copper Mountain, CO 80443
Phone: (303) 224-9999

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project seeks to take advantage of unique performance properties of ceramic nanofiber supported catalysts for applications in automotive, power generation, and chemical process industries. The efficiency of ceramic nanofiber composite materials to capture nano-sized particulates (inorganic and soot) is of particular interest to the automotive industry. Also, an opportunity to field test a composite catalyzed nanofiber material in a power generation facility to remove low-levels of NOx has been developed through commercialization activities within the power generation industry. This is a significant opportunity that will require the fabrication of a ceramic nanofiber/polymeric composite media and a field test apparatus. Successful completion of this opportunity will provide the background necessary to develop a first-generation ceramic nanofiber product. The broader impact/commercial potential of this project will provide the initial detailed examination of catalyst deactivation mechanisms using nanofiber support structures as well as providing a critical investigation of nano-sized particulate capture by nanofiber composite materials. This baseline information is beneficial to define and support future investigations of ceramic nanofiber materials. It is anticipated that catalyzed ceramic nanofiber/microfiber media will maximize the efficient use of catalytic materials (precious metals), enhance destruction of greenhouse gases (NOx and CO) from combustion processes, and capture harmful particulates from various gas process streams. These characteristics will help the power generation industry (fossil fuel burning), the motor vehicle, and the chemical industry meet current and future emission reduction standards while simultaneously benefiting the environment. Also as globalization leads to added pressures on U.S. companies to produce products and materials at a lower cost to remain competitive, reduction in the overall cost of energy production and transportation costs will improve U.S. competitiveness.

Title: SBIR Phase II: Catalytic Filter for Diesel Exhaust Purification

Award Number: 0750259
Program Manager: Cynthia A. Znati

Start Date: January 1, 2008
Expires: December 31, 2009
Total Amount: $500,000

Investigator: Mark Fokema, fokema@aspensystems.com
Company: Aspen Products Group, Inc
184 Cedar Hill St
Marlborough, MA 1752
Phone:

Abstract:

This Small Business Innovation Research (SBIR) Phase II aims to develop a catalytically active filtration device for the continuous removal of particulate matter from diesel engine exhaust. Particulate emissions from diesel engines are viewed as a significant health hazard. New diesel fuel and exhaust emission regulations to be phased in through 2010 require that diesel engine exhaust be extensively cleaned; current purification products are considered too large, too expensive and impose too great a fuel economy penalty on the diesel engine. A particulate filtration system that continuously oxidizes particulate matter using oxygen contained in the engine exhaust and does not require regeneration will be prepared, characterized and refined. The technology that will be developed has the capability to remove ultra-fine particulates with dimensions as small as 20 nm. The broader impact/commercial potential from the technology will enhance the scientific understanding of the synthesis and stability of novel ceramic nanostructures as well as the interaction of soot with dispersed catalytic species. The successful application of this technology will lower the cost of purifying diesel engine exhaust, enabling wider application of highly fuel efficient diesel engines, which will in turn reduce the overall fuel consumption and pollutant emissions.

Title: SBIR Phase II: Enabling Low-Temperature Synthesis of Vertically Aligned Carbon-Nanotubes by Selective Heating of Catalyst

Award Number: 0724878
Program Manager: Cheryl F. Albus

Start Date: September 1, 2007
Expires: August 31, 2009
Total Amount: $499,820

Investigator: Alexsey Vasenkov, jls@cfdrc.com
Company: CFD Research Corporation
215 Wynn Dr NW FL 5
Huntsville, AL 35805
Phone: (256)726-4800

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop, validate, and demonstrate a new technology for a low-temperature synthesis of vertically-aligned carbon nanotubes (VACNTs) and nanofibers (VACNFs). The low-temperature manufacturing process is critical to decrease the cost and improve the quality of VACNTs/VACNFs-based materials and devices. This project will further advance and demonstrate the low-temperature technology by producing: a novel research-grade reactor with four special components: a RF plasma source for vertical alignment of free-standing VACNT/VACNF, a pulsed RF power source with tunable frequency in the GHz range for inductive heating of catalytic nanoparticles,.a nonconducting substrate to eliminate substrate Joule heating; and a system for active cooling of the substrate.

The broader impacts anticipated from the proposed low-temperature synthesis approach will result in a novel research-grade reactor and a multiscale simulator for a direct, low-temperature synthesis of VACNTs at pre-selected locations on the surfaces of temperature-sensitive materials. This approach could lead to a new US-based high-technology manufacturing business.

Title: SBIR Phase II: Nanocomposite Carbon and Graphitic Foams Produced via a Catalytic Approach

Award Number: 0620353
Program Manager: Rosemarie Wesson

Start Date: September 6, 2006
Expires: August 31, 2008
Total Amount: $467,005

Investigator: Seng Tan, sctan@sprintmail.com
Company: Wright Materials Res Co
7155-H Columbia Gateway Drive
Coumbia, MD 21046
Phone: (410)730-8600

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will optimize and scale up the processing of the proposed rapid post-processing and nanocomposite technique for microcellular carbon and graphitic foams to possess superior insulating and conducting properties, respectively. Thermal conductivity and insulation properties may be tailored to either very high or very low. Thermal-mechanical properties of the nanocomposite carbon and nanocomposite graphitic foams after the optimization and scale up research will be characterized. The results of this work will demonstrate that the oxidation stabilization time may be reduced by an order of magnitude, meanwhile enhancing the mechanical properties, as compared to the conventional technique.

Lower processing cost and superior thermal-mechanical properties may result in widespread uses of microcellular nanocomposite carbon and graphitic foams for various applications including high-temperature insulation, space structures, and thermal management applications like heat exchangers.

Title: SBIR Phase II: Novel Polycarbonate Synthesis

Award Number: 0620438
Program Manager: Deepak Bhat

Start Date: August 31, 2006
Expires: August 31, 2008
Total Amount: $500,000

Investigator: Scott Allen, sda@novomer.com
Company: Novomer
South Hill Business Campus
Ithaca, NY 14850
Phone: (607)330-2321

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to commercialize a new class of biodegradable plastics from carbon dioxide and epoxides. The technology is based on an innovative catalyst system that significantly increases process efficiency and reduces cost. A novel approach for catalytic polymerization will be developed by directly incorporating carbon dioxide into the polymer, which will transform this greenhouse gas into a synthetic building block of a polycarbonate plastic material, with widespread industrial applications.

The project will demonstrate an alternative use of a significant greenhouse gas as an alternative feedstock for the plastic industry, which has the potential for greatly reducing the Nation's dependence on petroleum-based raw materials. In addition, the polycarbonate materials synthesized using the novel process will beneficially impact a number of industries, such as specialty adhesives, investment casting, ceramic binders and biomedical applications.

Title: SBIR Phase II: Compact, Lightweight Flexible Fuel Reformer for Solid Oxide Fuel Cells (SOFC)

Award Number: 0548677
Program Manager: Rosemarie Wesson

Start Date: January 23, 2006
Expires: February 29, 2008
Total Amount: $473,502

Investigator: William Whittenberger, waw@catacel.com
Company: Catacel
7998 Gotham Rd.
Garrett, OH 44231
Phone: (330)468-4984

Abstract:

This Small Business Innovation Research (SBIR) Phase II project demonstrates a flexible fuel reformer (FFR) that employs unique mechanical construction and operation to enable extended catalyst life in the presence of sulfur-containing heavy fuels. The FFR utilizes a low-cost heat exchanger that is constructed from metal foil and coated with a dual-function sulfur-tolerant catalyst. Combustion and steam reforming reactions occur simultaneously on opposite sides of the foil, allowing excellent heat transfer. Cycling the combustion and reforming reactions regenerates the catalyst by burning off carbon and sulfur deposits, resulting in continuous hydrogen production with low steam consumption. Selected catalyst formulations will be evaluated in the laboratory to understand their performance at conditions expected during both reforming and combustion. A 100 hour demonstration of a 1kw FFR that continuously produces hydrogen of a uniform composition from diesel fuel will complete the project.

The innovation demonstrates a new method of steam reforming, which shows high potential to yield a viable scheme for producing hydrogen from commercially available fuels. The FFR can operate with a variety of liquid fuels, including gasoline, diesel fuel, and jet fuel. Near-term SOFC commercial opportunities include fuel cell powered auxiliary power units for commercial trucks, aircraft, and military applications.

Title: SBIR Phase II: Solid Acid Catalyst with Optimally Distributed Active Sites

Award Number: 0548636
Program Manager: Rosemarie Wesson

Start Date: January 4, 2006
Expires: December 31, 2007
Total Amount: $513,600

Investigator: Mitrajit Mukherjee, mmukherjee@exelusinc.com
Company: Exelus, Inc.
99 Dorsa Ave
Livingston, NJ 07039
Phone: (973)740-2350

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a practical, cost-effective solid-acid catalyst alkylation technology, which will be an economically viable replacement for current alkylation processes, which use toxic liquid acids such as HF and H_2SO_4. The new technology will significantly reduce capital cost and operating expenses by using a novel multifunctional solid-acid catalyst that produces high-octane ultra-clean gasoline in a simple fixed-bed reactor. The multifunctional solid-acid catalyst significantly outperforms conventional solid-acid catalyst both in terms of catalyst activity and long-term stability. The octane number of the alkylate product obtained using this new catalyst is substantially higher than that obtained using a conventional solid-acid catalyst.

Fifty refineries in the US use hydrofluoric acid (HF) in their alkylation units. The new "green" iso-paraffin alkylation technology is an economically viable alternative to HF catalyzed processes, which would eliminate such risks posed by toxic liquid acids. The multifunctional catalyst promises significantly improves yields and selectivities, minimizing waste by-products and disposal problems associated with liquid acids, and reduces CO_2 emissions.

Photo/Electrochemical Applications

Title: STTR Phase II: Photochemically Switched Chiral Materials for Chiral Nematic Displays

Award Number: 0750379
Program Manager: Cheryl F. Albus

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

Investigator: J. William Doane, bdoane@kentdisplays.com
Company: Kent Displays Inc
343 Portage Blvd
Kent, OH 44240
Phone: (330) 673-8784

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop an extremely low cost photodisplay for stored value cards such as gift cards, payroll and income support cards where, for the first time, the value of the card and other information can be displayed to the user updateable with each use. The enabling display technology based on photo switchable chiral materials provides displays that are thin, flexible, rugged, and above all, of such low cost that they add little to the cost of a card. Such photodisplays can provide a high resolution image without the need and cost of drive and control electronics necessary for electronic displays. The photodisplays are optically updated by a display writer in which images such as, numerical, bar codes, and other digital data can be repeatedly updated. The broader impact/commercial potential from this technology will advance the basic and applied science of photochemical chiral compounds for use in liquid crystalline materials by designing, synthesizing and studying new compounds to exploit their unique optical and electro optical effects. Thin, flexible photodisplays developed from these materials are similar to a photographic film, but with the advantage that the image can be erased, rewritten, hidden from view and made to reappear. The photodisplay films have the properties of an electronic display in which the image can be changed but without the driving electronics that forces electronic displays out of many markets. A further advantage of the photodisplay is that it can be mass produced by continuous roll-to-roll manufacturing equipment of the type already developed for the label industry. The photodisplay therefore opens new display markets in many applications such as stored value cards, point of purchase signs, identity and security tags, signage and many other uses where updatable displays were not possible before because of cost, bulkiness and inflexibility of existing electronic displays.

Title: SBIR Phase II: Cost-Effective Manufacture of High-Power Li-Ion Batteries for NGV

Award Number: 0349621
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2004
Expires: December 31, 2005
Total Amount: $499,900

Investigator: Thomas Kaun, kauntd@juno.com
Company: InvenTek Corporation
320 Willow Street
New Lenox, IL 60451
Phone: (815)483-9564

Abstract:

This Small Business Innovative Research (SBIR) Phase II project proposes a prototype Lithium-ion battery that has inherent cost advantages for a NGV FreedomCar and hybrid electric vehicle, HEV, requiring compact pulse-power. The unique rolled-ribbon cell can meet the cost requirements and deliver thousands of pulses and recharges. The battery design projects power at 2-4kW/kg and power density at 7.5kW/liter similar to an ultracapacitor, with 20 times greater specific energy at 100- 120Wh/kg .

The rolled-ribbon design is a technology that enables US producers to compete by lowering the materials requirement, packaging and safeguard costs of a large high-power battery. It fulfills the need for high power at low cost. In addition, this disc-shaped design exhibits excellent passive thermal management with inherent safety. Gasoline savings will reduce air pollution and oil imports.

Separations Technology

Title: SBIR Phase II: New Synthetic Approaches to Higher Performance, Lower Cost CO2/CH4 Gas Separation Membranes

Award Number: 0750637
Program Manager: Cheryl F. Albus

Start Date: January 15, 2008
Expires: December 31, 2009
Total Amount: $523,994

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

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a new gas separation polymer membrane technology created in Phase I to significantly improve the ability to separate carbon dioxide from methane. Successful utilization of this new technology to separation of these commercially important gases will provide better performance at lower cost than current methods for separating carbon dioxide and methane. The approach to this problem involves construction of new-to-the-world polymer architecture. The monomer units, which are the building blocks to the polymer membranes desired, will be individually designed to pass carbon dioxide molecules through the membrane faster than methane molecules. The broader impact/commercial potential from the technology developed in the project will be a commercially robust membrane able to resist degradation under operation in real field conditions, which will lead to the production of prototype gas separation modules for field testing and will further expand applications to other gas separations such as oxygen and nitrogen.

Title: SBIR Phase II: Catalytic Nanochannel Reactor Arrays for Fuel Reforming

Award Number: 0724408
Program Manager: Rathindra DasGupta

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

Investigator: Dmitri Routkevitch, droutkevitch@synkera.com
Company: Synkera
2021 Miller Dr Unit B
Longmont, CO 80501
Phone: (720)494-8401

Abstract:

The Small Business Innovation Research (SBIR) Phase II project proposes to develop and commercialize advanced nanochannel array reactors for efficient and cost-effective fuel reforming for fuel cells and other applications. Conventional reformers have significant performance, size, reliability and cost issues that prevent broad-scale introduction of polymer electrolyte membrane (PEM) fuel cell systems, especially in the portable power market segment. To overcome these limitations, a highly innovative approach based on the nanoporous ceramics is being pursued to create ultra-light and ultra-compact reactors. That approach was successfully validated during Phase I. The results unequivocally demonstrated the feasibility of methanol reforming and confirmed the strong competitive advantages of the proposed architecture over conventional reactors.

The Phase II aims to develop application-specific reactor prototypes and to initiate their integration into PEM fuel cell systems. The expected outcome will be a manufacturing technology for low-cost and compact yet highly efficient and reliable reactors for point-of-use hydrogen generation. This technology has a potential to facilitate the development of more affordable fuel cell power system for broader government, commercial and consumer applications, especially in the portable power (0.1-1kW) market segments, and will benefit our society by contributing to energy security and availability of environmentally friendly energy solutions.

Title: SBIR Phase II: Low-cost Ceramic Membranes for Drinking Water Treatment

Award Number:	0724326
Program Manager:	Rathindra DasGupta
Start Date:	September 1, 2007
Expires:	August 31, 2009
Total Amount:	$500,000

Investigator: Christopher Hoffman, hoffman@ceramem.com
Company: CeraMem Corporation
12 Clematis Avenue
Waltham, MA 02453
Phone: (617)899-4495

Abstract:

The Small Business Innovation Research (SBIR) Phase II project seeks to develop a novel approach for fabrication of ceramic membranes that would provide a significant reduction in fabrication costs. Membrane filtration is becoming an important process for drinking water treatment. Much of this growth is due to development of low-cost polymeric membranes that can compete economically with traditional methods of water treatment. Ceramic membranes can be used to achieve the same level of water quality as provided by polymeric membranes, with several distinct advantages: ceramic membranes provide higher fluxes, reduced fouling rates, and longer lifetimes with fewer integrity issues. Historically, ceramic membranes have not been competitive with traditional methods or polymeric membranes due to high manufacturing costs. Recent developments that offset the high manufacturing costs have allowed ceramics to be competitive with polymerics in some markets. By developing the proposed innovation, ceramic membrane module cost will be further reduced, giving ceramics an advantage over currently employed polymeric membranes.

Increased membrane usage in water treatment will lead to safer drinking water for the 90% of Americans that receive their water from community water systems. For the water systems that employ ceramic membranes, there will be less cost, maintenance, and concerns of system integrity failures. Additionally, the technology developed in this program would be applicable to ceramic microfiltration and ultrafiltration membranes for all food, beverage, chemicals, pharmaceutical, energy, wastewater, and water applications. Energy efficient separation processes requiring robust membranes would become more economically viable, potentially lowering the 4,500 T Btu of energy consumed annually for industrial separations.

Title: SBIR Phase II: High Flux Metal-Ceramic Hydrogen Separation Membranes

Award Number:	0548757
Program Manager:	Rosemarie Wesson
Start Date:	March 6, 2006
Expires:	February 29, 2008
Total Amount:	$422,292

Investigator: Dimitri Routkevitch, droutkevitch@synkera.com
Company: Synkera
2021 Miller Dr Unit B
Longmont, CO 80501
Phone: (720)494-8401

Abstract:

This Small Business Innovation Research (SBIR) Phase II project targets development of an innovative membrane for separation of hydrogen. These membranes are based on an innovative nanostructured architecture and a unique fabrication process. The proposed approach enable an ultra-thin Pd separation layer, which can support a 10X or greater increase in hydrogen flux over the state of the art, with no reduction in hydrogen selectivity and superior reliability. The performance of the prototypes will be thoroughly validated in actual operating environments.

The expected result of the proposed work is a viable technology for the production of robust hydrogen separation membranes with advanced performance, superior reliability and lower cost. Such an enabling technology could facilitate a variety of current applications, such as hydrogen separation for fuel cells and point-of-use hydrogen purification. With further research and development, hydrogen could also serve as an alternative source of energy for heating and lighting homes, generating electricity, and transportation.

Title: SBIR Phase II: High-Efficiency Poly(Tetrafluoroethylene) (PTFE) Membranes

Award Number: 0522198
Program Manager: Rosemarie D. Wesson

Start Date: July 1, 2005
Expires: June 30, 2007
Total Amount: $505,994

Investigator: Hilton Pryce-Lewis, hilton@gvdcorp.com
Company: GVD Corporation
19 Blackstone St Ste 1
Cambridge MA, 02139
Phone: (617)661-0060

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the need for improved filtration in the semiconductor industry, where exceptional chemical stability, thermal stability, and purity make poly(tetrafluoroethylene) (PTFE) the media of choice. GVD has successfully demonstrated unprecedented filtration efficiencies for the retention of 20 nm size particles using PTFE membranes. The asymmetric structure of the GVD membranes avoided > 90% of the increase in energy utilization traditionally associated with improved filtration efficiency. The asymmetry was created using GVD's unique initiated chemical vapor deposition (iCVD) technology. In Phase II, GVD will demonstrate large area production at a competitive cost by designing, building, and operating an iCVD roll-to-roll coater, the first of its kind in the world.

The improved economics of roll-to-roll manufacturing will permit entry of a new family of PTFE membranes into a variety of markets where improvements in product quality and efficacy can be enabled by advanced filtration. These membranes can also address the separations needs of emerging industries such as nanotechnology, where unit operations at the nanometer scale still remain a challenge. More broadly, iCVD technology can produce composite membranes which marry the beneficial surface properties of PTFE with the improved mechanical strength and performance of a less costly base membrane. This could result in a family of membranes with multifunctional separations capabilities that do not sacrifice cost for efficacy.

Title: SBIR Phase II: Multilayer Membrane-Based Permeation for Cost-Effective Olefin/Paraffin Separation

Award Number: 0421976
Program Manager: Rosemarie D. Wesson

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

Investigator: Yingjie Qin, yjqin1@yahoo.com
Company: Chembrane Research and Engineering Inc
183 Highland Avenue
Kearny, NJ 07032
Phone: (201)997-4366

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on olefin/paraffin separation. Ethylene and propylene are produced in larger quantities than any other organic chemicals. A new membrane system is under development, which provides high olefin recovery, extremely high olefin fluxes, drastically improved olefin/paraffin selectivities over conventional facilitated transport membranes, and long-term operation stability. During Phase II, a laboratory prototype will be demonstrated. Integration of this membrane system into an olefin plant will drastically improve ethylene, propylene and butadiene in a more energy efficient and economical way. Polymer-grade olefins can be easily produced with this membrane process with minor post-treatments.

Economic analysis showed that incorporation of the proposed membrane system into an ethylene plant can drastically reduce capital and operating costs of the entire plant. As a result of reduced power consumption, this membrane process will correspondingly reduce emission of greenhouse gas CO2.

Title: SBIR Phase II: Novel Lightweight, Low Cost Fuel Cell Membrane Electrode Assemblies

Award Number: 0422186
Program Manager: Rosemarie D. Wesson

Start Date: July 15, 2004
Expires: June 30, 2006
Total Amount: $500,000

Investigator: Anuncia Gonzalez-Martin, anuncia.gonzalez-martin@lynntech.com
Company: Lynntech, Inc
7607 Eastmark Drive, Suite 102
College Station, TX 77840
Phone: (979)693-0017

Abstract:

This Small Business Innovation Research (SBIR) Phase II project concerns the development of proton exchange membrane (PEM) fuel cells with improved power density (kW/L) and specific power (kW/kg), reduced cost, and simplified assembly. A new type of electrically conductive polymer sheet has been developed that can be used as both, gas diffusion layer and bipolar plate in PEM fuel cells. The material is light, inexpensive, highly conductive, chemically inert, easy to process, and corrosion resistant. The use of this conductive polymer in PEM fuel cells will reduce cell weight, volume, and cost, while simplifying cell assembly. During the Phase II project, the conductive polymer materials will be optimized as bipolar plates and gas diffusion layers, and they will be integrated into PEM fuel cell stacks.

The new material has significant commercial potential because of its multi-functionality, lightweight, effectiveness, and low cost. The potential customers are developers currently working with PEM fuel cells operating on hydrogen, methanol, and reformed hydrocarbon fuels. This includes all of the automotive manufacturers and the manufacturers of stationary fuel cell power systems.

Title: SBIR Phase II: Separation of Light Hydrocarbon Mixtures by Pervaporation

Award Number: 0349776
Program Manager: Rosemarie D. Wesson

Start Date: January 15, 2004
Expires: December 31, 2005
Total Amount: $500,000

Investigator: Ingo Pinnau, ipin@mtrinc.com
Company: Membrane Technology & Research Inc
1360 Willow Road Suite 103
Menlo Park, CA 94025
Phone: (415)328-2228

Abstract:

This Small Business Innovative Research (SBIR) Phase II project focuses on the separation of light hydrocarbon mixtures-specifically, propylene/propane mixtures-by membrane pervaporation. A preliminary analysis indicated that the recovery of propylene from reactor purge gas streams using separation systems based on these materials is economically attractive. These purge streams are numerous-more than 400 streams of this type exist worldwide - but too small to be treated by distillation. Nonetheless, the amount of propylene involved is substantial. An estimated 685 million pounds of propylene are recoverable from reactor purge streams in the United States alone. In the Phase II project, the current best membrane will be optimized, scaled up and formed into bench-scale membrane modules.

This project involves the separation of propylene/propane mixtures; application to the separation of many other mixtures is possible. The proposed membrane pervaporation process addresses a market need - the economical recovery of propylene, a valuable chemical feedstock, from propane-containing waste gas streams that cannot be satisfied by alternative technologies.

Title: SBIR Phase II: Development of an Electrically Regenerated Diesel Particulate Filter

Award Number:	0349683
Program Manager:	Rosemarie D. Wesson
Start Date:	January 1, 2004
Expires:	December 31, 2005
Total Amount:	$499,326

Investigator: Luke Ferguson, harmonics@hmnx.com
Company: Harmonics, Inc.
9524 Roosevelt Way NE
Seattle, WA 98115
Phone: (206)525-6217

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop an effective diesel particulate filter (DPF) that can be reliably regenerated with integral electrical heating elements. A fabrication process will also be developed that ensures economical manufacturability of the filter in high volumes. The greatest challenge in the design of reliable particulate filter and trap systems has been achieving adequate regeneration, or the oxidation (burning) of particulates that accumulate in the filter substrate diesel engine operation. The objectives of Phase II will include designing an actively regenerating filter structure, optimization of EC material for use in the DPF substrate, development of manufacturing processes suitable for scale up to volume production, construction of prototype DPF substrates, testing, and ultimately integration of the EC-integrated DPF into a functioning DPF system ready for field testing. The anticipated result of the Phase II project is an actively regenerating EC-integrated DPF prototype substrate suitable for field testing in the US EPA.s Voluntary Retrofit Program. The EC-integrated DPF will fulfill new emissions controls scheduled to take effect in 2007.

There is presently a compelling need for a compact, simple-to-maintain, durable, and effective diesel particulate filter for both new and existing diesel- powered vehicles. The EC-integrated DPF could potentially reduce diesel particulate emissions by 9.5 million tons annually, preventing thousands of premature deaths due to respiratory illnesses, cancer and heart disease.