Environmentally Benign Technology

Title: SBIR Phase II: Environmentally Benign, High-Pressure Plasma Cleaning Tool for Photoresists

Award Number: 0239331
Program Manager: Rosemarie D. Wesson

Start Date: February 1, 2003
Expires: January 31, 2005
Total Amount: $499,999

Investigator: Steven E. Babayan, stevebabayan@hotmail.com
Company: Surfx Technologies LLC
10624 Rochester Avenue
Los Angeles, CA 90024
Phone: (310)592-3241

Abstract:

This SBIR Phase II project focuses on the development of a cleaning tool for the removal of tenacious organic residues from 200 mm wafers. These residues arise from ion bombardment of the photoresist films during processing. Organic residue removal encompasses approximately half of the cleaning operations in a semiconductor manufacturing plant. Surfx Technologies has developed a novel high-pressure plasma cleaning process that uses environmentally benign reagents and generates minimal waste. Results from Phase I indicate that ion-implanted resists may be stripped away in 5 min at 125 C, without any film popping and particle contamination as is normally observed during dry processing. The Phase II project will thoroughly research and optimize the process chemistry. In addition, a prototype cleaning system will be developed that meets all the technical criteria established by the semiconductor industry for organic cleaning operations.

This SBIR Phase II project has broad commercial and societal impact. Semiconductor equipment devoted to organic residue cleaning represents a multibillion-dollar market. If our environmentally benign, high-pressure plasma-cleaning tool can achieve all the technical objectives outlined in the proposal than it stands a good chance of garnering a significant share of this market. Moreover, it will replace current water-wasteful and hazardous wet cleans with an innovative process that uses non-toxic reagents and generates minimal waste. This will substantially benefit our society by mitigating the environmental, health and safety impacts of semiconductor manufacturing.

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 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.

Title: SBIR Phase II: Environmentally Compatible Recycling Method for Cadmium Telluride Devices

Award Number: 0078469
Program Manager: Winslow L. Sargeant

Start Date: September 15, 2000
Expires: August 31, 2002
Total Amount: $400,000
Investigator: Shalini Menezes, interphases@att.net
Company: Interphases Research Co
166 N. Moorpark Rd, Suite 204
Thousand Oaks, CA 91360
Phone: (805)497-2677

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an electrochemical method specific to recycling photovoltaic modules, which contain extremely low quantities of hazardous metals in large bulk-streams. It uses an innovative closed-loop approach to remove, separate, and regenerate semiconductor films in a single compact system, and do it with minimum waste. Phase I identified key process parameters, focusing on efficient removal and recovery of semiconductors from devices. Retrieval of sulfur-free cadmium telluride demonstrated method feasibility. Phase II will design a practical system to recycle the entire module for in-plant or centralized applications. It will identify the optimum parameters to delaminate modules, dissolve semiconductors, regenerate useful semiconductor precursor films, and re-utilize the electrolyte. The research will lead to a viable prototype recycling capability featuring low cost, high efficiency, low cycle-time, and production line amenability. Converting defective panels into efficient modules will lead to rapid turn-around and high production yields. Potential commercial applications are expected in the photovoltaic industry with a solution to managing hazardous waste disposal and improvement in module production yield. It has short-term applications for recycling other end-of-life products such as flat panel displays, infrared detectors, and mirror scrap.

Benefits are anticipated in increased productivity, large savings in disposal costs, recovery of scarce raw materials, and enhanced commercial success of the emerging cadmium telluride photovoltaic industry, which has grown 50-fold in production capacity within two years.

Title: SBIR Phase II: Green Solvent Mixtures as Alternatives to Environmentally Damaging and Toxic Solvents

Award Number: 0238674
Program Manager: Rosemarie D. Wesson

Start Date: January 15, 2003
Expires: December 31, 2004
Total Amount: $500,000

Investigator: John S. Flanagan, sflanagan@microcoating.com
Company: CCVD dba MicroCoating Tech
5315 Peachtree Industrial Blvd.
Atlanta, GA 30341-2107
Phone: (678)287-2400

Abstract:

This SBIR Phase II Project will develop software to aid formulation chemists in the replacement of environmentally damaging and toxic solvents such as those listed as hazardous air pollutants (HAP) in Section 112(b)(1) of the Clean Air Act. Phase I provided successful proof of concept for MCT's approach to use mixtures of "green" solvents that are tunable to obtain a wide range of solvent characteristics. This approach allows for the replacement of a broad spectrum of harmful solvents by using a small number of benign solvents. The system is flexible, allowing end users to control factors such as the organic functional groups present to fit their application. MCT will incorporate this method into software to guide non-specialists through the selection of solvents and optimization the mixture. MCT will collaborate with the research groups of Professors Charles Eckert and Charles Liotta at the Georgia Institute of Technology to develop a predictive model for the solubility of metal-organic compounds in organic solvents. We will perform quantitative solubility measurements on the systems initially studied in Phase I and use the resulting data to verify and improve the solubility model. The resulting solubility model will be incorporated in the solvent selection software.

The recent trend towards environmentally friendly products has caused an increase in the use of green solvents in product formulations and industrial processes. Regulations governing the use of solvents classified as Hazardous Air Pollutants (HAP) or as Volatile Organic Compounds (VOC) are forcing companies to look for alternatives to solvents presently in use. The Reference, there is an opportunity for the introduction of products that are designed to assist companies that need to Reference products or processes that use organic solvents. The niche market for Reference tools is estimated to fall into the $30 million range. MCT's goal is to release a software product that meets these needs within 3 years, and to gain the majority of the market share, producing revenues of $10 million over a period of 6 years. MCT will license software developed under Phase II to companies that manufacture chemicals and allied products. Solvent replacement tools can be applied to find alternative solvents almost anywhere solvents are in use, including coatings, pharmaceuticals, printing inks, toiletries, cosmetics, adhesives, household and car care, rubber and polymer manufacturing, industrial cleaning and degreasing, agrochemicals, oil seed and food extraction and dry cleaning.

Title: SBIR/STTR Phase II: Integration of Electromagnetic Actuation Using VOST Design

Award Number: 0215960
Program Manager: Cheryl F. Albus

Start Date: August 1, 2002
Expires: July 31, 2004
Total Amount: $499,994

Investigator: Ronn G. Smith, VOST@fiberpipe.net
Company: Big Horn Valve
248 W. Works
Sheridan, WY 82801-4213
Phone: (307)672-0968

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will produce an emission-free control valve to address an industry need for environmentally safe valves. The axially rotated Venturi Off-Set Technology valve will be equipped with a conical seat for internal sealing and a magnetic coupling for leak-proof actuation.

The commercial potential of this project will provide the Petroleum industry with valves that are emission-free which will result in a cleaner environment.

Title: SBIR Phase II: Innovative Blasting to Eliminate Nitrogen Dioxide Formation While Maximizing Energy Efficiency in Surface Mining

Award Number: 0216042
Program Manager: Rosemarie D. Wesson

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

Investigator: Eugene L. Watson, ewatson@wyoming.com
Company: Industrial Alchemy
6901 Valley View Place
Cheyenne, WY 82009
Phone: (307)637-2765

Abstract:

This Small Business Innovation Research (SBIR) Phase II project addresses the urgent need to improve control of the blast chemical reaction. These blasts are produced by drilling boreholes into the overburden and filling them with an ammonium nitrate/fuel oil (ANFO) mixture. These explosive charges are then ignited to push the overburden into a previously excavated trench. This Phase II project will complete the design, fabrication, and testing of a prototype detonation system to be deployed in surface mining boreholes to referentially initiate detonation of the powder column, thus insuring a high efficiency blast without the unwanted release of toxic air pollutants.

This project will lead to commercialization of a method of improving the efficiency and environmental quality of the cast blasting technique used by the surface mining. The market for this detonation system is any mining that involves cast blasting, primarily the surface coal mining industry. The United States is one of the two world leaders in coal production with nearly one billion tons of coal being produced in 2001.

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 (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: 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: 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: 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: 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
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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.

Polymer, Powder, & Composite Systems

Title: SBIR Phase II: Carbon Fiber/Boron Nitride Matrix Composites: A Unique Low Wear Friction Material

Award Number: 0321629
Program Manager: Cheryl F. Albus

Start Date: August 1, 2003
Expires: July 31, 2005
Total Amount: $492,069
Investigator: Christian L. Mangun, cmangun@ekos-corp.com
Company: EKOS
101 Tomaras Avenue
Savoy, IL 61874-9547
Phone: (217)356-7162

Abstract:

This Small Business Innovation Research (SBIR) Phase II project proposes to develop a testing application for intermediate and full-scale boron nitride (BN) composites for a wide variety of wear applications with a focus on aircraft brakes. Viability of this material was demonstrated in Phase I where 3-dimensional needled carbon fiber/C-BN hybrid matrix composites displayed an order of magnitude decrease in wear as compared to current carbon fiber/carbon matrix composites (C/C). The plan is to fabricate stable boron nitride composites from a unique pre-ceramic polymer (borazine) through a commercially viable technique, namely resin transfer-molding process.

The commercial and broader impacts of this technology of a composite using BN as a matrix appears to provide the best opportunity of addressing the desired cost-performance characteristics (both a decrease in raw material components and in maintenance due to fewer brake overhauls). In addition, the improved properties of these materials over current aircraft brakes have the potential to increase passenger safety in emergency braking situations.

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: 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 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.

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 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: Thin Film Deposition & Dynamic Characterizations Using Sub-Psec Eximer Laser Sources

Award Number: 9983366
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2003
Total Amount: $399,586
Investigator: Kenneth Church, khc@cmst.com
Company: Sciperio, Inc.
5202-2 N Richmond Hill Road
Stillwater, OK 74075
Phone: (405)624-5751

Abstract:

This Small Business Innovation Research (SBIR) project continues the Pulsed Laser Deposition project using a femto-second or sub pico-second pulsed laser. The sub pico-second regime is a recent (just a few years old)development in the laser industry. As technology progresses these lasers are becoming more common to both the end user and the commercial manufacturer. There are now solid state femto-second lasers available in the product line of some well known laser companies. The recent advances made in the production and sales of the new sub pico-second laser and the results achievable by these lasers have opened up new opportunities in tribological coatings. The Phase I results demonstrated superior hardness using the sub pico-second laser as compared to the traditional nano-second lasers. The coatings were also much smoother when observed under a scanning electron microscope. These initial findings suggest a need to continue the study for applications in the tool and space industries as well as the military. Coatings with such improved performance would be considered a significant contribution to both the scientific and industrial communities. Current coatings are short lived and therefore expensive to maintain.

A longer life coating, even if it was more expensive, would provide significant savings do to the life of the tool, device or machine. Some devices are not even practical to make do to poor performing coatings. Coatings produced using a sub pico-second laser source will change that.

Title: SBIR Phase II: Novel Microphase Separated Solid Polymer Electrolytes

Award Number: 0091492
Program Manager: T. James Rudd

Start Date: February 15, 2001
Expires: January 31, 2003
Total Amount: $500,000
Investigator: Dharmasena Peramunage, pera@eiclabs.com
Company: EIC Laboratories Inc
111 Downey Street
Norwood, MA 02062-2664
Phone: (617)769-9450

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop novel nano-structured solvent free polymer electrolytes for solid-state Li-ion batteries. The important characteristics of these electrolytes are that they are of high ionic conductivity and have excellent mechanical strength. The combination of these properties results from an ordered structure on the nanometer scale, consisting of a co-continuous network of an epoxy scaffold and a polymer electrolyte. This unique structure is obtained by self-assembly during curing of the epoxy in the presence of a partially emersiable block copolymer containing the ion-conducting phase. Polymer electrolyte batteries based on the new electrolytes promise great configuration flexibility in design and substantially increased energy density.

The new polymer electrolytes will permit fabrication of high performance Li- ion batteries for use in portable consumer products such as cellular telephones, portable power tools, video cameras and laptop computers. Other applications include "dye sensitized solar cells", and electrochromic devices.

Title: SBIR Phase II: Protective Metal Foam Hybrid Composites

Award Number: 0238610
Program Manager: T. James Rudd

Start Date: February 15, 2003
Expires: January 31, 2005
Total Amount: $500,000
Investigator: Dana T. Grow, siouxman@siouxmanufacturing.com
Company: SMC
Main Street
Fort Totten, ND 58335-0400
Phone: (701)766-4211

Abstract:

This Small Business Innovation Research Phase II project will develop a low-cost manufacturing process for multifunctional composite materials that have specific air and ground transportation applications. Existing materials designed to protect against explosions or impacts tend to be heavy and to be appendages on structural systems. The new materials, which consist of an aluminum foam surrounded by facing plies of resin-infused glass, carbon, or aramid, will be lightweight and designed to integrate affordability and functionality. Innovative manufacturing methods, using out-of-autoclave processes that are derivatives of liquid molding approaches, will be developed to incorporate automation to improve quality and decrease processing time. A number of fiber-ply/foam combinations will be fabricated with a focus on manufacturing a container for explosives transport and on a hardened aircraft door. Prototypes will be fabricated for customer testing. The improved processing and unique properties are expected to lead to a variety of other applications.

These applications of aluminum foam core composites for making protective structures will meet the national need for materials that provide increased protection and security. The market for protective materials is expected to grow, and is already a sizeable $150 - $200 million per year.

Title: SBIR Phase II: Low-Cost Glass Fiber Composites Tailored Towards Concrete Reinforcement

Award Number: 0215179
Program Manager: T. James Rudd

Start Date: August 1, 2002
Expires: July 31, 2004
Total Amount: $499,995

Investigator: Fadhel Aouadi, dpdinc@aol.com
Company: DPD Inc
2000 Turner Street
Lansing, MI 48906-4053
Phone: (517)347-5648

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will refine the polymer matrix of glass fiber composites with ion exchangers in order to enhance their longevity in the alkaline environment of concrete. Glass fiber composites offer a desirable balance of performance and cost for replacement of corrosion-prone steel reinforcement in concrete; their rapid deterioration in the alkaline environment of concrete is, however, a major setback. Ion exchangers are insoluble solids carrying cations (or anions), which can be exchanged with ions of the same sign. Cation exchangers of hydrogen form replace alkali metal cations (e.g., K + in alkaline solutions diffusing into the polymer matrix) with H +. This exchange of cations neutralizes aggressive alkaline solutions by converting K + OH - (and Na + OH -, etc.) into H2O. Through laboratory investigations and industrial-scale pultrusion efforts, the Phase I research demonstrated that introduction of selected ion exchangers into the polymer matrix (or a surface layer of matrix) does not interfere with the pultrusion process, and yields significant gains in alkali resistance of glass fiber composites. The Phase I effort also established a theoretical context for selection of the dosage of cation exchanger in the polymer matrix of glass fiber composites, and verified the economic viability of our approach. The proposed Phase II project will: (1) develop Refined theoretical principles and design procedures for formulation of polymer matrices with ion exchangers; (2) develop and experimentally verify optimum polymer matrix formulations incorporating ion exchangers; (3) optimize the pultrusion process of glass fiber composites with the Refined polymer system, and fully characterize the end products; and (4) evaluate the structural performance and durability of concrete systems reinforced with Refined glass fiber composite bars through comprehensive laboratory studies complemented with a field investigation involving design, construction and monitoring of a reinforced concrete bridge deck. The Phase II effort will receive critical support from major manufacturers of composite rebars (including Hughes Brothers, the world leader in this field), the leading supplier of ion exchangers (Dow Chemical), Michigan Department of Transportation, and Michigan Economic Development Corporation. Michigan State University (Composite Materials & Structures Center) will also take part in the proposed research effort.

Close to one-third of reinforced concrete structures, including bridges, parking structures, buildings in coastal areas and offshore structures, are exposed to corrosive environments (deicer salt, seawater spray, etc.); domestic sales of steel for reinforcement of these concrete structures is about $2 billion/yr. Glass fiber composites embodying our technology are resistant to both corrosive effects and the alkaline environment of concrete; they offer a desirable balance of performance and cost to replace steel reinforcement in corrosive environments. Major savings in life-cycle cost can be realized at competitive initial cost through replacement of steel reinforcement with alkali-resistant glass fiber composites in concrete structures exposed to corrosive environments. Glass fiber composite jackets and sheets applied onto concrete surfaces for repair/rehabilitation purposes are also prone to attack by the alkaline pore solution of concrete, representing another market opportunity for our technology. We have filed a patent application, and have reached agreements with Dow Chemical (leading supplier of ion exchangers) and Hughes Brothers (world's leading manufacturer of composite bars for concrete reinforcement) towards transfer of the technology to marketplace.

Title: STTR Phase II: Enhanced High Volume Reinforced Al/SiC Metal Matrix Composites

Award Number: 0132166
Program Manager: T. James Rudd

Start Date: January 15, 2002
Expires: December 31, 2003
Total Amount: $499,998
Investigator: Dean Baker, powdermet@earthlink.net
Company: Powdermet, Inc.
9960 Glenoaks Boulevard, Unit A
Sun Valley, CA 91352-1047
Phone: (818)768-6420

Abstract:

This Small Business Technology Transfer (STTR) project will develop advanced, nano-engineered thermal spray powders for producing composite coatings with revolutionary enhancements in performance. The Phase I project demonstrated the production of high volume reinforced (25-65 wt % SiC) aluminum and nickel matrix composite materials using CVD fluid bed coated powders and low cost consolidation techniques. Dramatic increases in flexure strength and modulus were achieved; with results showing greater than 5% (80% increase) ductility and a 600% increase in flexural strength compared to current metal matrix composite state of the art. A greater understanding of the nano-engineered particles being produced, and the relationship between nano-structural features and the resulting mechanical property improvements will be developed leading to repeatable, predictable performance and application to additional composite and coatings systems.

The commercial potential will be for producing low cost; high volume fraction consolidated spray-deposited composite systems with significant improvements in mechanical properties and desired physical properties for structural and corrosion applications for the electronic industry.

Title: STTR Phase II: Alignment of Low Cost, High Modulus, High Strength Carbon Nanofibers in Composites

Award Number: 0110456
Program Manager: Cheryl F. Albus

Start Date: August 15, 2001
Expires: July 31, 2003
Total Amount: $499,980
Investigator: Ronald L. Jacobsen, rljacobsen@ApSci.com
Company: Applied Sciences, Inc
Cedarville, OH 45314-0579
Phone: (513)766-2020

Abstract:

This Small Business Technology Transfer Research (STTR) Phase II project will develop low-cost, composites reinforced with carbon nanofibers. Methods demonstrated in Phase I will be further developed to generate alignment and promote adhesion of nanofibers polymer systems. These efforts help to capture the extraordinary intrinsic mechanical, electrical, and thermal properties of carbon nanofibers in practical, affordable composites. One thrust of the program seeks to align nanofiber in extruded and spun flows, in materials that include polypropylene, polyester, and nylon. The composite filaments produced by these means will then be formed into net-shape composite components for a variety of applications. A second thrust focuses on fabrication of nanofiber papers for applications that include fuel cell electrodes. Potential end users of the technology and leaders in their respective markets will evaluate materials and prototypes produced during Phase II.

Specific commercial applications targeted by the Phase II work include nanofiber reinforced polyester and nylon tire cord, thermally conductive plastics for electronics packaging, nanofiber paper for fuel cell components, and conductive, high service temperature plastics for electrostatic precipitators needed to clean exhaust streams from power and chemical production. Each of these applications has an associated Phase II partner participating in the program.

Title: SBIR Phase II: Spinning Performance of Melt-Spun Fibers Containing Microencapsulated Phase Change Material

Award Number: 0110499
Program Manager: T. James Rudd

Start Date: October 1, 2001
Expires: September 30, 2003
Total Amount: $499,991

Investigator: Yvonne G. Bryant, ygbryant@TRDCorp.com
Company: Triangle Res & Devel Corp
P O Box 12696
Research Triangle Park, NC 27709-2696
Phone: (919)832-5959

Abstract:

This Small Business Innovation Research (SBIR) Phase II project continues the development of the spinning performance of melt-spun fibers containing microencapsulated phase change materials (microPCMs). In Phase I, polypropylene fibers less then 3 denier per filament were demonstrated with a good balance of physical properties (tenacity, percent breaking elongation, modulus, etc.) and thermal energy storage capability (latent heat content). Phase II will focus on process and materials variables that affect, in particular, the structure and properties of the as-spun fiber, and in general, the overall spinning process. A key objective is to convert the microcapsule wet cake into a well-dispersed microPCM/polymer concentrate devoid of volatilizing components for adding to virgin polymer and extruding into fiber. Innovative spinning concepts will be employed to improve the capture of microPCMs to maximize thermal energy storage properties.

The commercial availability of melt spun fibers and resulting fabrics with enhanced thermal energy storage capabilities will enable products with superior performance for use in situations where comfort, endurance, or survivability in cold or hot environments is demanded. Thus, the perfection of this technology for the production of good quality fabric could be a major breakthrough in the textile industry.

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 (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: 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.

Surface Treatments/Coatings

Title: SBIR Phase II: Smart Fiber Composite System Capable of Early Detection of Material Failure

Award Number: 0091576
Program Manager: T. James Rudd

Start Date: May 1, 2001
Expires: April 30, 2003
Total Amount: $499,302

Investigator: Kirk Newton, knewton@tritonsys.com
Company: Triton Systems Inc
200 Turnpike Road
Chelmsford, MA 01824
Phone: (978)250-4200

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will build on results of Phase I research to fully demonstrate an early warning system for potential failure of ceramic matrix composite (CMC) materials. In Phase I, a novel detection technique called Composite Failure Onset Response Test (ComFORT (TM)) was demonstrated for use with high temperature CMCs. ComFORT (TM) is a composite failure detection technique whereby proprietary thermally stable electrically conductive ceramic fibers are selectively placed, together with regular reinforcing fibers, and are then processed into a dense ceramic composite. Once in place, existing hardware is used to monitor the condition and the health of the electrical signal, while an especially designed algorithm minimizes false negatives during use. As the ceramic composite begins to fail, the failure of the fiber reinforcement is preceded by the failure of the conductive coating, which is recognized through a weakening or loss of electrical conductivity. This novel technique lends itself to a powerful early warning system, whereby the conductive fiber can be designed to fail before catastrophic failure of the composite itself. Proper placement of these conductive fibers enables tracking of even minute levels of breach within the composite. Moreover, through a novel design, it may be possible to extend the performance to detect matrix cracking. The lack of reliability and little to no warning before catastrophic failure has prevented a more widespread use of CMC's. The smart fiber system to be developed in this project will allow the use of CMC's in more demanding applications with greater certainty of success.

The successful commercialization of the proposed technology will lead to the insertion of continuous fiber reinforced composites into power generation, energy, air, space and missile applications, where high temperature, lightweight, and mechanically reliable materials are needed, and the cost of part failures is high. Ceramic composites can be used in a larger number of these applications, if part reliability can be assured. Substantial benefits in operating efficiency of gas turbine, automotive and rocket systems can be realized with increased operating temperatures.

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.

Title: SBIR Phase II: Interface Functionalization of Commercial Substrates to Promote Adhesion of Solventless Inks

Award Number: 9982958
Program Manager: Rosemarie D. Wesson

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $400,000
Investigator: Richard Ellwanger, ree@sigmalabs.com
Company Sigma Labs Incorporated
10960 N Stallard Place
Tucson, AZ 85737
Phone: (520)575-8013

Abstract:

This Small Business Innovation Research Phase II project will address in-line treatment for functionalization of commercial substrate surfaces. The proposed treatment will consist of an appropriate combination of vacuum plasma treatment, atmospheric plasma treatment, and/or acrylate coating. It is expected to functionalize the surface of commercial substrates such as packaging films, labeling sheet, paper webs, and Teflon(tm) sheet to readily accept and bond with solventless printing inks, thus reducing the need for solvent-based inks. The EPA Toxic Release Inventory (TRI) for 1995 shows that 1.224 billion pounds of organic solvents were released into the atmosphere over this country in 1995. The number 3 chemical (146 million pounds) contributing to TRI air emissions for 1995 was toluene, a major constituent of printing ink formulations. Regulatory and community pressure to reduce the use of solvent-based inks as a pollution prevention measure is already a significant driving force and will only intensify in the future. Proof-of-concept has been achieved in Phase I. Sigma Technologies has indeed been able to alter the surface functionality of a variety of commercial substrates to the extent that water-based ink formulations will adhere well to the functionalized surfaces without sacrifice of ink deposit quality.

Several major players in the packaging film and related industries are very interested in our progress in the area of interface functionalization. They are under pressure from the USEPA to reduce their use of solvent-based inks and are operating in a highly competitive, often narrow margin, business venue. They are watching us closely and at least two of these clients will participate in the proposed Phase II effort by providing in-kind matching funds expenditures to provide inking runs on treated substrates and to help us evaluate ink deposit quality. If we are able to maintain this high level of interest through the Phase II effort we are confident that firm orders for equipment and process development for Sigma Technologies will result.

Title: SBIR Phase II: The Study of Superior Quality Thin Films Derived from Liquid Combustion in a Thermal Plasma

Award Number: 9983420
Program Manager: Rosemarie D. Wesson

Start Date: June 1, 2000
Expires: May 31, 2003
Total Amount: $739,723
Investigator: Miodrag Oljaca, moljaca@microcoating.com
Company: CCVD, Inc dba MicroCoating Technologies (MCT)
5315 Peachtree Industrial Blvd.
Atlanta, GA 30341
Phone: (678)287-2400

Abstract:

This Small Business Innovation Research Phase II project for clean and efficient combustion of liquid fuels is of importance in many technologies including internal combustion engines, gas turbines, waste-incineration and, more recently, advanced materials processing. The efficiency of the thermal combustion of a fuel controls the efficiency and emissions of a process. Two governing factors in the combustion of a liquid fuel are atomization and vaporization of the liquid prior to its ignition. Two advanced thin film coating deposition techniques utilize the combustion of a liquid fuel containing a dissolved metal complex to deposit films of desired materials on to substrates. The first, flame spray pyrolysis, is a rapid deposition process yielding thick films, however, the films are generally of poor quality due to inefficient atomization. This leads to rough films of low density and purity. In contrast, combustion chemical vapor deposition (CCVD) utilizes an efficient atomization and vaporization process that makes it a true vapor deposition method. The CCVD process incorporates a patented atomization method for liquid fuels, trademarked as the Nanomiser. The Phase I effort studied the flame physics and chemistry of the deposition of high quality barium strontium titanate (BSTO) thin films by CCVD. BSTO is a high performance ferroelectric. This Phase II project will build upon the results of Phase I by expanding the levels of analysis and modeling of the CCVD process to develop a thorough, predictive model and thereby improve the CCVD process. The data and models developed in Phase II will be of extreme importance to spray combustion processes in general. MCT is targeting development of high quality thin film materials for use in electronics, corrosion protection, optical coatings, nanopowders, superconductors, fuel cells as well as other applications yielding a potential multibillion dollar market.

Results from this research will be used to increase combustion efficiency and satisfy key requirements for performance of thin film ferroelectrics. This will enable commercialization of the CCVD process applications through a combination of R&D services, advanced license agreements and pilot production services.

Title: SBIR Phase II: New Oxide Coatings for Protection of Alloys in a High-Temperature Oxidizing Environment

Award Number: 0078347
Program Manager: T. James Rudd

Start Date: September 1, 2000
Expires: August 31, 2002
Total Amount: $380,669
Investigator: Donald Alger, alger@mail.ohio.net
Company: Alger Stirling Company
4050 Paradise Road
Seville, OH 44273
Phone: (330)722-6181

Abstract:

This Small Business Innovation Research (SBIR) Phase II project's objective is to provide oxide coatings that resist deterioration in a high-temperature oxidizing environment. A new, innovative process is will be developed that should form strongly-adherent, high-temperature, oxidation resistant coatings on steel alloys, iron and nickel superalloys, aluminides, and superalloy matrix composites. Using this process in Phase I, Alger Stirling Company (ASC) alpha-Al2O3 as well as ASC alpha-Al2O3/Ti2O3 protective coatings, whose coating-to-substrate bond strength was measured to be in excess of 10,000 psi, were formed on six different aluminum-containing and aluminum-and-titanium-containing alloy substrates. Phase II testing (1) will optimize oxide thickness to provide maximum oxide/substrate bond strength, and (2) perform lifetime testing of the oxidized specimens in a high-temperature oxidizing environment.

These coatings have broad application in industry throughout the nation. Products that utilize the ASC coatings can achieve longer lifetimes because of the surface protection provided by the coatings. Such longer lifetime translate directly to user dollar savings that are, first of all, a benefit to the entire nation and, second, make the products more competitive in foreign markets.

Title: SBIR Phase II: Ultra-Hard Boron Coatings through Vacuum Arc Deposition

Award Number 0078385
Program Manager: Rosemarie D. Wesson

Start Date: August 15, 2000
Expires: July 31, 2002
Total Amount: $399,996

Investigator: C. Christopher Klepper, cck.brontek@nrvdc.org
Company: HY-Tech Research Corporation
104 Centre Court
Radford, VA 24141
Phone: (540)639-4019

Abstract:

The Small Business Innovation Research (SBIR) Phase II project aims to demonstrate the operation of a commercially viable boron deposition source based on vacuum arc technology. The source is for the deposition of boron-based, self-lubricious coatings of hardness comparable to diamond, which are also compatible with high-temperature applications. A special sintering method, developed in the Phase I, produced boron cathodes that survive the severe vacuum arc environment, when properly supported and heated. This patentable Phase I technology will be applied in the Phase II to demonstrate the production of the desired films. The emphasis will be in ultra-hard forms of nearly-pure boron, although some compounds are also of interest. Water cooling of the anode and surrounding structures will be used to avoid damage in continuous operation of the source. Well established wall conditioning techniques will be used to reduce contamination of the films from the inner surfaces of the vacuum chamber.

Partnering with both a major coatings company and with a major manufacturer of heavy machinery, that require low-friction, hard-coatings for components, will enhance this Phase II project with valuable in-kind support, as well as a clear path to the Phase III commercialization. Boron coatings have excellent hardness, tribological (low friction) and corrosion resistance properties. Their high temperature and combustion environment compatibility would make them ideal for advanced automotive applications. For example, such coatings could potentially eliminate the need for added lubricants in high temperature, low heat loss diesel engines, leading to substantial reduction in particulate emissions.

Title: SBIR Phase II: Surface Engineering of Metals with Plasma Polymers

Award Number: 0216100
Program Manager: T. James Rudd

Start Date: September 15, 2002
Expires: August 31, 2004
Total Amount: $499,219

Investigator: Giles Dillingham, gdillingham@btgnow.com
Company: Brighton Technologies Group, Inc.
4125 Dane Avenue
Cincinnati, OH 45223
Phone: (513)591-3100

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will replace current environmentally damaging metal pretreatment processes with an environmentally benign process whereby the metal surface is etched then coated with a sub-micron film of plasma polymerized SiO2. Current metal pretreatment processes for painting and adhesive bonding perform well, but generate tremendous volumes of wastes, including hexavalent chromium and various inorganic acids. To obtain performance superior to the current state-of-the-art wet chemical surface treatments, the surface chemistry and morphology of the plasma polymerized films need to be tailored for specific interactions with the adhesive. Effects of variables including substrate chemistry, monomer chemistry, and ion kinetic energy on surface chemistry and morphology of plasma polymers will be determined. Then, the effect of the resulting structure on the strength and durability of adhesive joints will be determined.

By combining in-situ analytical techniques with accelerated aging and mechanical testing of adhesive specimens, a superior, environmentally benign process based on plasma polymerization will be developed and commercialized. These primers will have well understood morphologies and surface compositions tailored to the adhesive chemistry through control of the deposition conditions and/or chemical derivitization of the plasma polymer surface.

Title: SBIR Phase II: Development of NZP-Based Advanced Thermal Barrier Coatings

Award Number: 0111605
Program Manager: T. James Rudd

Start Date: October 15, 2001
Expires: September 30, 2003
Total Amount: $499,747
Investigator: Ramachandran Nageswaran, rnageswaran@coiceramics.com
Company: COI Ceramics, Inc.
181 West 1700 South
Salt Lake City, UT 84115
Phone: (801)364-6446

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop and optimize the NZP (sodium zirconium phosphate type) ceramic-based thermal barrier coating (TBC) technology for use in advanced turbine and power generation systems. These advanced systems drive the need for higher operating temperatures to achieve better efficiencies without compromising durability. Such requirements heighten the threat of: (i) microstructural changes, which reduce thermal barrier effectiveness; (ii) premature oxidative spalling; and (iii) susceptibility to mechanical stresses in conventional yttria-stabilized zirconia (YSZ)-based TBCs. Some NZP ceramics have very low thermal and oxygen conductivity, excellent thermal cycling resistance and high temperature stability but also have low thermal expansion. Phase I demonstrated the feasibility of thermal spraying simple and functionally graded (to minimize thermal expansion mismatches) TBCs of NZP with YSZ that are better thermal barriers and also have very good thermal cycling resistance to 1200 degrees C. The primary goal for Phase II is to complete the scientific and engineering development in order to commercialize the NZP-based TBC technology. A team of academic and industrial collaborators will work under the guidance of committed end-users to achieve this goal.

Potential successful development of the NZP-based TBC concept will enable applications in high efficiency power generating systems and gas turbine engines; specifically, for turbine vanes and blades, and combustors and afterburners. Coatings based on NZP can also double up as environmental barrier coatings (EBCs), and find use in diesel engines and as abradable seals. The financial benefits of the NZP-based coatings could be over $100M arising from reduced component maintenance and fuel and operational costs.

Title: STTR Phase II: Light Transparent, Electrically Conductive Coatings by Filtered Cathodic Arc Plasma Deposition

Award Number: 0216628
Program Manager: T. James Rudd

Start Date: July 15, 2002
Expires: June 30, 2004
Total Amount: $499,993

Investigator: Michael McFarland, mcfarland@aasc.net
Company: Alameda Applied Sciences Corporation
2235 Polvorosa Avenue, Suite 230
San Leandro, CA 94577-2249
Phone: (510)483-4156

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will build upon and extend the encouraging results obtained in the Phase I program, which investigated the properties of thin, electrically conductive, UV transparent films and tri-layer metal coatings as possible diamond switch electrode structures for power electronics. Phase I benchmarked UV transmission, electrical conductivity and substrate adhesion for 14 to 44 nm Mo films, deposited using an energetic filtered cathodic arc deposition process. A companion program demonstrated a significant reduction in the diamond switch on-state resistance, and hence, improvement in switch efficiency, using these films as contact electrodes. The Phase II program will apply these results to a commercially relevant specification by demonstrating that the thin film deposition process can be scaled and the complex thin film mesa-shaped electrode topology can be realized. The anticipated mesa-shaped design will consist of a series of narrow tri-layer conduits, with the relatively large spaces in between coated with the thin UV transparent, electrically conductive film. This design maximizes the UV input into the diamond, which is used to activate the switch, while minimizing the electrical resistance. The properties of the electrode will be benchmarked against commercially relevant operating requirements.

The project's commercial potential is considered significant since it both supports the entry of diamond switch technology into the $21 billion per year power electronic device market as well as advancing the energetic deposition process thin film knowledge base, which in turn provides an improved platform for launching additional commercial ventures.

Title: SBIR Phase II: Noncorroding Steel Reinforced Concrete

Award Number: 0091686
Program Manager: Joseph E. Hennessey

Start Date: June 1, 2001
Expires: May 31, 2004
Total Amount: $499,204

Investigator: Dominic J. Varacalle, Jr., djv@iictr.com
Company: Concrete Sciences Corporation
748 Greenwood Avenue
Glencoe, IL 60022
Phone: (847)776-7200

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new class of cement-steel interfaces for high performance steel reinforcing bars for concrete. In Phase I the project demonstrated a bar coating system that can protect against corrosion of steel in concrete structures and has improved adhesion characteristics between steel reinforcement and the cement matrix. Phase II continues to refine the properties and techniques for producing this new class of High Performance Non-corroding Steel-Reinforced Concrete.

Improved corrosion resistance of steel reinforcement in concrete structures could address a major infrastructure problem that has been estimated to require up to $3 trillion for repair. The potentially cost effective coatings to be developed and commercially applied during production runs in steel mills would result in a value added product of major importance for managing the infrastructure. Improvements in adherence and corrosion resistance would be highly beneficial, for example, in corrosive highway deicing environments and marine structures.

Title: STTR Phase II: Nano-Layered Composites as High-Temperature Hard Coatings

Award Number: 0226328
Program Manager: Cheryl F. Albus

Start Date: January 1, 2002
Expires: November 30, 2003
Total Amount: $375,000
Investigator: Ilwon Kim, ikim@fctnet.com
Company: Functional Coating Technology, LLC
1801 Maple Ave. suite 5320
Evanston, IL 60201-3135
Phone: (847)467-5377

Abstract:

This Small Business Technology Transfer (STTR) Phase II Project aims to develop novel nano-layered coatings for high-temperature tribological applications, specifically cutting-tool coatings that perform well at elevated temperatures (up to 1000 degrees C). There is a high level of interest in these coatings because of the desire to cut at higher rates and due to increasing environmental concerns over the use of coolants during machining. Traditional coating materials do not perform well under these conditions, primarily because their hardnesses decrease rapidly as temperature rises. Research in Phase I developed a new class of coatings, combining many alternating nanometer-thick layers of metals and nitrides, which show substantial hardness enhancements. Hardnesses up to 44 gigapascals (GPa) were maintained after high temperature annealing, demonstrating the feasibility of these new materials as high-temperature stable coatings. Strong dislocation confinement in nano-layers is likely to yield higher high-temperature hardness than in monolithic coatings, providing improved wear resistance. In Phase II, nano-layered coatings will be developed that optimize key properties including hardness, thermal expansion match with the substrate, stability against dissolution into different workpieces, and oxidation resistance.

Nano-layered coated cutting tools have the potential to make dry-cutting a practical alternative, and to improve wet-machining performance.

Title: SBIR Phase II: Latent-Reactive Surface Modification Reagents for Biofilm Control

Award Number: 0216532
Program Manager: T. James Rudd

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $496,893

Investigator: Patrick E. Guire, pguire@surmodics.com
Company: SurModics, Inc.
9924 West Seventy Fourth Street
Eden Prairie, MN 55344
Phone: (612)829-2707

Abstract:

This Small Business Innovation Research Phase II project continues the development of new thermally activable reagents for bonding microbicidal polymers to inner surfaces of a variety of opaque tubing materials, initiated in Phase I under the Advanced Materials and Manufacturing (AM) topic, Surface Engineering subtopic (F). Materials have been developed with bulk physical properties needed for transport of aqueous mixtures; however, the development of biofilm on the wet surfaces is a continuing serious problem in the dental, pharmaceutical, food processing, and marine transport industries. Surface modification of waterlines could decrease the formation of biofilm while retaining the desired bulk properties of the tubing. Photochemistry has been proven commercially successful in enhancing the surface properties of medical devices with radical-based surface modification initiated by RF plasma or ultraviolet light. However, these energy sources are not effective for modifying the inner surfaces of opaque tubes such as waterlines used with dental units and plumbing in pharmaceutical plants. This project is designed to develop latent-reactive radical generators activatible with thermal energy, which penetrates these opaque devices. This innovative approach to scheduled activation of radical generators will provide a method to modify inert surfaces, which cannot be activated with external light or plasma sources.

Microbial colonization and biofilm formation remain a major cost and threat to human health and product quality for dental and pharmaceutical industries, health care and public lodging, and marine vessel utilization. Successful development of microbicidal and antifouling coating technology for the luminal surface of opaque transport and storage vessels for aqueous liquid ingestible products, constitute an incremental market size of tens of millions of dollars, not subject to current commercial coating technology.

Title: SBIR Phase II: Eddy Current Condition Monitoring of Metallic Flaws Under Surface Coatings Using Giant Magnetoresistance (GMR) Sensors

Award Number: 0216200
Program Manager: T. James Rudd

Start Date: September 15, 2002
Expires: August 31, 2004
Total Amount: $499,995
Investigator: Carl H. Smith, chsmith@nve.com
Company: NVE Corporation
11409 Valley View Road
Eden Prairie, MN
Phone: (973)635-7576

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop prototypes of fieldable eddy-current systems with GMR and SDT sensors that can detect defects in metals even with significant lift off from the material under inspection due to such things as thermal barrier coatings. Techniques for maintaining the a constant distance between the eddy-current probe and the conductive surface despite intervening coatings will also be developed in this project. Such a system can be used to lengthen the lifetime of mission critical components such as aircraft bearings, which at present have to be replaced on schedule using rather conservative lifetime estimates.

The main commercial application of these systems would be military and commercial aircraft. A simple system capable of rapidly scanning an area would require eddy-current probes that can inspect a large surface in a single pass. Compact and low-power arrays of GMR and Spin Dependent Tunneling (SDT) sensors developed for this program can be used in this application as well as other applications such as nanotechnolgy read heads to read implanted magnetic noise that is extremely difficult to compromise. The implications for more secure forms of identification are clear for the post 9/11world.

Title: SBIR Phase II: Surface Modification of Textiles for Protective Clothing
Award Number: 0239038
Program Manager: T. James Rudd

Start Date: February 1, 2003
Expires: January 31, 2005
Total Amount: $499,998
Investigator: Don B. Elrod, don.elrod@lynntech.com
Company: Lynntech, Inc
7610 Eastmark Drive, Suite 202
College Station, TX 77840-4024
Phone: (979)693-0017

Abstract:

This Small Business Innovation Research Phase II project involves the modification of the surface of textiles through graft polymerization of an oxidizing polymer resulting in a fabric, which has the ability to eradicate/neutralize pathogenic microorganisms, pesticides, and chemical/biological weapons. The fabric could be used to produce medical textiles in order to reduce the transmission of infectious pathogens in hospitals, protect agricultural workers from contact with pesticides, and protect military personnel and first responders from contact with chemical/biological weapons in the event of terrorism or war. The Phase I research showed that the grafted fabric was highly effective against both microbial and chemical agents. The modified fabric was also found to be non-irritating to both intact and abraded (compromised) skin. In this Phase II project the research will consist of optimizing the graft polymerization process, extensive testing of the optimized fabric against microbial and chemical challenges, durability testing through repeated laundering, mechanical property evaluation, extensive cytotoxicity and irritation testing, capacity and regenerability assessment, stability assessment in storage, pilot plant production runs, and custom production/testing of fabric for a strategic partner.

The fabric technology to be developed in this project has a vast amount of potential in a variety of niche applications in the medical, agricultural, and military arenas. In addition to the huge markets that exist for these products, there are obvious societal benefits that are inherent with the technology. Infection control is a huge problem in medical facilities resulting in prolonged hospital stays and leads to higher medical costs. The modified fabric could be constructed into medical textiles for use as surgical drapes, scrubs, lab coats, bed sheets, privacy drapes, gowns, etc. Farm workers could protect themselves from exposure to the pesticides they use in the field. The fabric could be employed in the production of protective clothing for first responders and military personnel who find themselves in an environment where there is a potential risk of exposure to chemical/biological weapons.

Title: SBIR Phase II: A New Pseudo Amorphous High Temperature Oxide Material

Award Number: 0132146
Program Manager: T. James Rudd

Start Date: March 15, 2002
Expires: February 29, 2004
Total Amount: $499,999
Investigator: Kimberly Steiner, ksteiner@atfinet.com
Company: Applied Thin Films
Evanston Business & Tech Center
Evanston, IL 60201-3135
Phone: (847)491-2447

Abstract:

This Small Business Innovation Research (SBIR) project will investigate the use of a new high temperature amorphous oxide material, CerablakTM, as a protective coating on components used in the molten aluminum industry. CerablakTM is a newly discovered sol-gel derived material that is thermally stable up to 1400 degrees Celsius over many hours. A patented precursor is used to form a continuous, dense, and smooth thin film using a simple dip coating process. The key property of CerablakTM is its relatively low oxygen diffusivity, which enables its use for oxidation protection of metal and alloy surfaces exposed to elevated temperatures. The Phase I project showed that the material is non-wetting and compatible with molten aluminum. CerablakTM coatings developed on full-size thermocouple protection tubes showed excellent durability and non-wetting behavior. The Phase II project will optimize the coating quality for use in protection of thermocouple protection tubes, riser stalk tubes, molds, and dies.

The commercial applications include protective coatings for metals and alloys used in turbine components and petrochemical refining, molten metal processing, thermal protection systems for space propulsion, cookware, and glass.

Title: SBIR Phase II: ECR (Electron Cyclotron Resonance) Plasma Treatment of Polymer Tubing Such As Catheters

Award Number: 0238947
Program Manager: Rosemarie D. Wesson

Start Date: March 15, 2003
Expires: February 28, 2005
Total Amount: $445,576
Investigator: James G. Moe, jmoe@spirecorp.com
Company: Spire Corporation
One Patriots Park
Bedford, MA 01730-2396
Phone: (781)275-6000

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop new techniques to treat both internal and external surfaces of polymer tubing such as catheters. The treatments will modify the surfaces to facilitate attachment of bioactive coatings, clean, sterilize, or reduce friction; similar processes can also deposit organic or inorganic coatings. Plasmas driven by electron cyclotron resonance (ECR) will treat the lumen and external surfaces more uniformly, and over a greater range of parameters, than conventional plasmas and can be spatially localized to provide different effects on each.

The ECR plasma process should be expandable to large-scale, low-cost commercial production coating and surface modification of catheters. Surface treatments to facilitate attachment of bioactive coatings to hemodialysis and other catheter types would have societal benefits by extending the period between catheter replacements clear therapeutic and economic.

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: 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 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: 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: Incorporation of Carbon Nanotubes into Nylon Filaments

Award Number: 0321695
Program Manager: T. James Rudd

Start Date: July 1, 2003
Expires: June 30, 2005
Total Amount: $499,995

Investigator: Richard A. Bley, eltron@eltronresearch.com
Company: Eltron Research, Inc.
4600 Nautilus Court South
Boulder, CO 80301-3241
Phone: (303)530-0263

Abstract:

This Small Business Innovation Research Phase II project will continue developing a method for incorporating Single Walled Carbon Nanotubes (SWNT) into nylon to act as reinforcement. Their incorporation will be achieved by wrapping the SWNTs with a functionalized polymer that interacts with the SWNTs mechanically, but is not chemically bound to them. The polymer will be chemically bound to the nylon and in this way will act as a load-transferring conduit between the nylon matrix and nanotubes in the final composite. How well the polymer transfers the extraordinary strength and durability of the carbon nanotubes to the nylon composite will depend on how well this new interface, between the SWNT and the nylon matrix, functions. For nylon fibers, the degree to which it is possible to align the SWNTs along the major axis of the fiber filaments will play a role in the fiber's thermal and electrical conductivity as well as strength. The primary focus of this work is to optimize the SWNT/nylon matrix interaction in order to obtain the best load transfer properties. Methods to align the SWNTs along the long axis of the nylon filaments in order to maximize fiber strength will also be investigated.

Commercially, this high strength nylon composite will have significant applications in the aerospace industry for use in fabricating lightweight, retrievable, satellite launch vehicles, reusable space craft etc. The military will also be interested in this technology because of the combination of exceptionally high strength, lightweight and stealth capability. The successful development of this technology will result in new lightweight thermoplastic composites that have extraordinarily high flexural, tensile and impact strengths and can be easily molded into any shape desired. This new technology will eventually be applicable to many other materials. Additionally, since these composites are thermoplastics and not a thermosets, they will be more easily recycled.

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 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: SBIR Phase II: Reliable, Low Cost Support System for Flywheel Energy Storage

Award Number: 0078459
Program Manager: Rosemarie D. Wesson

Start Date: December 15, 2000
Expires: June 30, 2004
Total Amount: $483,061

Investigator: Joseph Imlach, jiice@alaska.net
Company: Imlach Consulting Engineering
460 Falke Court
Anchorage, AK 99504
Phone: (907)337-8954

Abstract:

This Small Business Innovation Research Phase II project will result in the development of a prototype flywheel energy storage system (FESS) utilizing the innovative passive, non-contacting bearing developed in the Phase I project. This new type of passive magnetic support and damping (PMSD) system consists of integrated stiffness and damping elements in a configuration that overcomes the most significant problems of previous systems. The new bearing technology will result in a more efficient, more reliable, and less expensive FESS than is currently available. The resulting FESS will facilitate the use of alternative energy systems in remote and/or hostile environments. Phase II efforts will focus on 2 objectives: (1) The refinement and experimental validation of design equations predictive of PMSD performance; and (2) The development, installation, and testing of PMSD systems in a prototype FESS. The FESS system for the prototype will be a commercial unit provided by the commercialization partner, and modified to accommodate the new technology. The partner currently manufactures FESS for commercial power quality and uninterruptible power supplies applications. Follow-on funding commitments and other agreements have been secured from the Alaska Science and Technology Foundation and from the commercialization partner to pursue additional technical work and for Phase III commercialization. In addition to providing storage for alternative energy systems, there are numerous commercial applications for FESS incorporating the PMSD technology including utility load leveling and uninterruptible power supplies (UPS).

The commercialization partner expects that the combination of technical and cost advantages demonstrated in Phase I would enable rapid market acceptance and encourage application of FESS in new markets. The PMSD technology is also applicable to turbo-molecular pumps (TMPs). These are used in the manufacture of silicon chips and in scientific instrumentation requiring high vacuums. Predicted market penetration into these areas is in excess of 18,000 units per year by 2005 and in excess of 30,000 units per year by 2009.

Title: SBIR Phase II: Continuous SiC Matrix Composite Fabrication Using UV Curable Precursors

Award Number: 9983317
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: April 30, 2003
Total Amount: $399,999
Investigator: Kenneth Kratsch, matech@thegrid.net
Company: MATECH Advanced Materials
31304 Via Colinas Ste 102
Westlake Village, CA 91362
Phone: (818)991-8500

Abstract:

This Small Business Innovative Research Program (SBIR) Phase II project utilizes a unique photo-curable, high weight-yield preceramic polymer in a continuous fabrication process to produce a low-cost beta-silicon carbide (SiC) ceramic composite. Phase I succeeded in both photo curing and cold-initiation rapid curing (5 minutes) of a new polymer with higher ceramic yield, easier processability, and greater scalability than anticipated. Phase II will optimize the new polymer for both 'cure on demand' and viscoelastic volumetric compression in order to increase ceramic matrix density and to eliminate polymer springback between fabric layers. Use of pre-preg technology will enable large sheets and rolls of fabric to be impregnated and cured into a rubbery, coated fabric-polymer body that can be easily stored, cut to pattern, and applied in a ply-by-ply process. Process machinery will be scaled up to produce component sizes of commercial interest with fast curing and automated part fabrication.

Potential commercial application are anticipated in gas recirculating fans, heat exchangers, radiant burner screens and tubes, gas turbine engine combustion liners and tip shrouds, hot liquid filtration, containment shells, gas-fired melting immersion burner tubes, and furnace pipe hangers. Ultimately, large composite structures may be constructed for vehicles such as hypersonic aircraft.

Title: SBIR Phase II: Innovative Snap Joining of Composite Structures

Award Number: 9983318
Program Manager: Joe Hennessey

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $374,173
Investigator: W. Brandt Goldsworthy, wbg@wbgoldsworthy.com
Company: W. Brandt Goldsworthy & Associates Inc
23930-40 Madison Street
Torrance, CA 90505
Phone: (310)375-4565

Abstract

This Small Business Innovation Research (SBIR) Phase II project will develop snaplock design concepts for composite materials, which is a novel and patentable joining and assembly technology. Two snaplock connections were built in Phase I for testing, whereby application to a snaplocked and lightweight, tapered transmission pole was found feasible in both technical and economic terms. Phase II will design, build, and test a prototype 75-foot transmission pole, using pultrusion of two building-block profiles. A tapered beam (or tube) of any desired length is obtained by performing secondary cutting, machining, and assembly, which are operations that can be automated.

Potential commercial applications are seen chiefly in the $5 billion international market for electric power transmission poles. Additional applications are expected in highway sign bridges, intermodal shipping containers, housing, and tiltrotor aircraft.

Title: SBIR Phase II: Nanolaminate Structural Composites

Award Number: 0078403
Program Manager: T. James Rudd

Start Date: June 1, 2000
Expires: November 30, 2002
Total Amount: $399,996
Investigator: Angelo Yializis, ayializis@sigmalabs.com
Company: Sigma Labs Incorporated
10960 N Stallard Place
Tucson, AZ 85737
Phone: (520)575-8013

Abstract:

This Small Business Innovation Research (SBIR) Phase II project deals with the fabrication of ultra high strength Polymer/Metal Multi-layers (PML) nanolaminates. In Phase I, Sigma Technologies has demonstrated that the Aluminum/Polymer nanolaminates have distinctive advantages over Aluminum, (a) a superior tensile strength (over 3 fold in some cases), (b) and a lower density. Furthermore, Sigma has developed, based on experimental results, a numerical model to predict the tensile strength of multilayer composites. The attractive features of the PML composites have generated a significant interest in this product by a major aerospace and avionics OEM (Original Equipment Manufacturer. Additional functionality of this composite includes ultra-high gas and vapor barrier, high electrical conductivity, electromagnetic shielding, preferential heat conductivity that is useful for low observable applications, and structural self-monitoring characteristics.

In Phase II, Sigma will further optimize the properties of the PML composites and upgrade equipment that is already in place to produce 7ft x 4ft PML panels. Parts will be tested independently by Sigma and its industrial and university partners. Market research has shown that several applications may be served by the multifunctional structural PML composites. Sigma will follow a systematic plan to identify niche markets and supply samples for evaluation.

Title: SBIR Phase II: Engineered Lumber from Sawmill Residue

Award Number: 0078473
Program Manager: T. James Rudd

Start Date: September 15, 2000
Expires: February 28, 2005
Total Amount: $749,999
Investigator: Ernest Schmidt, eschmidt_wsiwood@vcn.com
Company: Wyoming Sawmills Incorporated
PO Box 6088
Sheridan, WY 82801
Phone: (307)674-7484

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will enable conversion of low value residual edgings from sawmill operations into a structural quality engineered wood composite called Structural Strand Lumber (SSL). Edgings are created at sawmills when round logs are sawn into rectangular pieces of lumber. The SSL concept is to cut these edgings into strands, align them directionally, and then glue and compress them into a high value product. Edging material currently is used for low value wood chips for use in paper production. The SSL process will enable sawmills to convert up to 14% more of forest raw materials into structural quality lumber compared to conventional practices. SSL manufacturing will yield a high value added wood product, dramatically reduce waste, reduce demand on natural resources, and increase sawmill operating efficiency. These benefits will reduce dramatically the environmental impacts of sawmill operations. Phase I research provided a fundamental understanding of key processes, and clearly demonstrated the feasibility of the SSL concept. Phase II will demonstrate the operation of critical SSL components, and enable a manufacturing facility prototype demonstration early in the Commercialization Phase.

If the research is successful, dramatic increases in the fraction of a log that can be used for quality structural materials will result. The cost of the engineered material will be competitive with solid high-grade structural material. The method is applicable to virtually all sawmills operating in the United States and around the world. More efficient utilization of existing wood supply will be enabled by this innovation.

Title: SBIR Phase II: Net Shape, SiC-Toughened Molybdenum Disilicide Composites

Award Number: 0079262
Program Manager: T. James Rudd

Start Date: October 1, 2000
Expires: December 31, 2002
Total Amount: $394,814
Investigator: Ramachandran Nageswaran, rama@smahtcer.com
Company: COI Ceramics, Inc.
181 West 1700 South
Salt Lake City, UT 84115
Phone: (801)364-6446

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims at further developing and optimizing the innovative technology for the cost-effective fabrication of dense silicon carbide (SiC) fiber-reinforced molybdenum disilicide ($MoSi_2$) composites with enhanced strength and toughness up to very high temperatures (1400 degrees C). Molybdenum disilicide has very attractive thermal, oxidative, and corrosion resistance properties for applications in turbine engines, burner rigs, hot gas filters, molten metal lances, and heating elements, but is structurally weak. Reinforcement with a mechanically superior second phase material makes $MoSi_2$-based composites serious candidates for such applications if the composites can be processed to net shape cost effectively. The Phase I project demonstrated the feasibility of reaction forming the $MoSi_2$ matrix with controlled amounts of SiC whiskers or particles, which themselves are formed in-situ. Further, several SiC(f)/$MoSi_2$ compositions were developed that are strong, dense, and resistant to pesting. These compositions were developed using a single step process that combines Self-Propagating High-Temperature Synthesis (SHS) of elemental mixtures of Mo, Si, and C with psuedo-Hot Isostatic Pressing (HIP) -- electroconsolidation. Phase II research will demonstrate the near-net shape capability of the process along with the ability to produce robust $MoSi_2$-based composites.

Based on design specifications from turbine engine manufacturers, the project will also fabricate prototypes for testing at the end of Phase II. Immediate commercial use of the SiC(f)-toughened $MoSi_2$ composites can be realized as heating elements, combustion and burner rigs, and molten metal filters. Future applications include uses for aviation and gas turbine engine components, heat exchangers, hot gas filters, and waste incinerators. Other advanced applications include energy storage devices such as ultracapacitors.

Title: STTR Phase II: Magneto-Rheological Fluids for Sensor Actuator Systems

Award Number: 0110447
Program Manager: T. James Rudd

Start Date: September 1, 2001
Expires: August 31, 2003
Total Amount: $500,000
Investigator: R Radhakrishnan, radha@matmod.com
Company: Materials Modification Inc
2721-D Merrilee Drive
Fairfax, VA 22031-0113
Phone: (703)560-1371

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will develop advanced magnetorheological fluids for various damping applications. The Phase I project focused on a microwave plasma synthesis technique (NANOGENTM) and chemical precipitation technique; both techniques were successfully used to synthesize nanoparticles of iron, cobalt and iron oxide. NANOGENTM was selected as one of the 100 most innovative technologies in 1998 when it won the prestigious R&D 100 Award. MR fluids were prepared from these fluids and preliminary results on their damping behavior was found to be comparable with commercially available fluids. The Phase II project will scale-up the production of nanopowders and will conduct testing of their damping characteristics to help foster the development and application of MR fluids in key technology driven areas.

The possible commercial applications will be in automobile suspensions, hybrid actuator valves, semi-active vibration control in turbines and bridges as well as for seismic damping.

Title: SBIR Phase II: Subgrade Repair and Stabilization
Award Number: 0111712
Program Manager: T. James Rudd

Start Date: August 1, 2001
Expires: July 31, 2004
Total Amount: $500,000
Investigator: Lawrence Farrar, lcfarrar@montecresearch.com
Company: Resodyn Corporation
1901 South Franklin
Butte, MT 59701
Phone: (406)723-2222

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and demonstrate a novel vitrification process for subgrade soil stabilization. The process includes a method to inject readily available materials into the vitrification zone eliminating subsidence that would otherwise occur as the soils densify during vitrification. The process is based on the use of modifiers that adjust the vitrified soil properties. The Phase I work demonstrated feasibility of the process and that the vitrified material was suitable for subgrade stabilization and resulted in materials having strengths qualified for structural reinforcement applications. Economic analysis completed in Phase I indicated that the method is competitive with conventional subgrade repair methods. The Phase II work will establish the commercial merit of the process by demonstrating its economy, robustness and versatility to produce subgrade synthetic rock from soils in the field. The Phase II work includes participation by a university and an end user. The proposed research and development will yield a fundamental understanding of the relationships between the vitrification process parameters, soil and synthetic rock properties. This will enable optimization of the process in commercial applications.

The commercial market for the proposed technology includes soil stabilization of inadequate foundation and slope materials around many kinds of structures including building, bridges and waterways. Customers will be highway departments (state and federal), airport authorities, municipalities and the industrial sector. Essentially, the process will be useful to any entity, including contractors that deal with maintenance of subgrade and/or new construction that have "local" subgrade instability issues to overcome.

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: 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 (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).

Manufacturing Processes

Title: STTR Phase II: IntelliStitch AI: Intelligent Computerized Embroidery Design Automation for the Textile Industry

Award Number: 0239356
Program Manager: Cheryl F. Albus

Start Date: January 15, 2003
Expires: December 31, 2004
Total Amount: $499,321

Investigator: David A. Goldman dgoldman@softsightinc.com
Company: Soft Sight, Inc.
3105 Knapp Road
Vestal, NY 13850-3038
Phone: (607)797-4073

Abstract:

This Small Business Technology Transfer (STTR) Phase II project will develop an automated means for embroidery design specification for use in the textile industry. This technology will provide simplified mechanisms for converting scanned artwork into high quality embroidery design data. This data will then be utilized by commercial sewing equipment to produce embroidered artwork that has become quite common on all types of garments and woven goods. Embroidered artwork is often quite expensive to produce and in many cases may substantially exceed the costs of the actual garments being imprinted. These costs arise from a variety of factors including an embroidered design's size and complexity. Well-designed embroidered artwork permits efficient production with high yields (i.e. minimal defects produced). Automating design creation provides additional benefits by eliminating the time consuming manual process that must otherwise be undertaken by a human expert.

The commercial and broader impacts of this technology facilitate lower manufacturing costs while allowing consistent production of high-quality goods. Additionally, this research may have broader applications within other fields such as document processing, image recognition, or other areas where image understanding and interpretation are important.

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.

Title: SBIR Phase II: Novel High-Temperature Molybdenum Alumino-Silicide Heating Elements for Advanced Manufacturing Processes

Award Number: 9983184
Program Manager: Winslow L. Sargeant

Start Date: June 15, 2000
Expires: May 31, 2003
Total Amount: $750,000

Investigator: Srinivas Penumella, r&d@mhi-inc.com
Company: Micropyretics Heaters International (MHI, Inc.)
613 Redna Terrace
Cincinnati, OH 45215
Phone: (513)772-0404

Abstract:

This Small Business Innovative Research (SBIR) Phase II project will develop 2000 degree Centigrade (C) molybdenum alumino-silicide (Mo(Si,Al)2) heating elements for advanced manufacturing processes such as sintering, brazing, annealing, semiconductor processing, ceramic processing, and pyrolysis of solid waste. Current technology in heating elements permits temperatures only as high as 1850-1900 degree C. The main technical barriers are (1) spalling of the silica protective layer at 1850-1900 degree C, which exposes the bare MoSi2 to catastrophic oxidation, and (2) extensive weakening by rapid grain growth. Phase II will (1) use alloying elements to form oxidation-resistant ternary phase Mo(Si,Al)2, which leads to the formation of a stable (up to 2080 degree C) adherent alumina layer, and (2) add nano-scale alumina or zirconia (~ 40 nanometers) to stabilize grain growth. Two compositions in the molybdenum-alumino-silicon ternary alloy phase field were identified, synthesized, and tested in Phase I. A rapid heat-up 2000 degree C element would be a quantum leap in heating element technology and lead advances in high temperature manufacturing.

Rapid commercialization is expected because energy advantages and productivity (time wise) gains will accrue to the ceramic manufacturing, metal processing, compound semiconductor processing, glass processing, and joining industries. Total savings of nearly $40 million per year are anticipated in lower power consumption in the manufacturing industries that use this heating element technology.

Title: SBIR Phase II: Ceramic Cutting Tool for Titanium-Alloy Machining

Award Number: 9983385
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $399,512

Investigator: Tai-Il Mah, paiil.mah@afrl.af.mil
Company: UES, Inc.
4401 Dayton-Xenia Road
Dayton, OH 45432
Phone: (937)426-6900

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new ceramic material, yttrium-aluminum garnet (YAG), for cutting tools used in the machining of titanium (Ti) alloys. Phase I found it feasible to base a cutting tool on YAG, reinforced with silicon carbide (SiC) whiskers and TiC. Phase II will further explore the use of YAG-based composites as a cutting tool for Ti alloys through: 1) optimization of compositions and fabrication parameters to obtain a fully dense composite with uniformly dispersed reinforcement phases; 2) evaluate the optimized composite relative to state-of-the-art materials in machining Ti alloys; and 3) identify wear and failure mechanisms by detailed microstructural characterization of YAG-based composite cutting tools, before and after machining tests.

Potential commercial applications are expected in titanium-alloy machining operations in the aircraft and aerospace industries.

Title: SBIR Phase II: Rapid Fabrication of Titanium Boride (TiB2) Anodes for Electrolysis of Aluminum

Award Number: 9983499
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: December 31, 2003
Total Amount: $650,000

Investigator: R Radhakrishnan, radha@matmod.com
Company: Materials Modification Inc.
2721-D Merrilee Drive
Fairfax, VA 22031
Phone: (703)560-1371

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop non-consumable and wettable titanium diboride (TiB2)-based cathodes with near-theoretical densities and purity. Phase I demonstrated that titanium and boron powders could be reactively consolidated to produce near-theoretical density TiB2 parts using plasma pressure compaction. A 4-inch diameter by 3/8-inch thickness near-net shape cathode will be fabricated for evaluation in Phase II, and a novel water jet nozzle and abrasive jet mixer tube will be developed based on TiB2. Phase II will also develop zirconium dioxide (ZrO2)- and titanium (Ti)-toughened titanium diboride composites for evaluation as cutting tools.

TiB2 electrodes are expected to provide better performance, cost-effectiveness, a hazard-free workplace, and environmentally benign processing in aluminum production; and it is now thought that rapidly consolidated, near net-shape TiB2 parts can also be used in cutting tools for hard metal machining, in mixing tubes for abrasive jets, and in nozzles for water jets.

Title: SBIR Phase II: Blind Fastener Inflation for Structural Joining of Aluminum

Award Number: 0078454
Program Manager: Cheryl F. Albus

Start Date: August 1, 2000
Expires: October 31, 2002
Total Amount: $349,922

Investigator: Jack Kolle, jkolle@tempresstech.com
Company: Tempress Technologies, Inc.
18858 - 72nd Avenue South
Kent, WA 98032
Phone: (425)251-8120

Abstract:

This Small Business Innovation Research (SBIR) Phase II project continues the development of a hyper-pressure fluid pulse system for installation of blind structural fasteners. Riveting is the preferred method of assembling load-bearing aluminum airframe structures. Upset riveting requires the application of high load to both ends of the rivet using impact or hydraulic pistons. A structural fastener that could be installed from one side of the structure - blind fastening - would simplify aircraft assembly and repair. Existing blind fasteners are expensive, time-consuming and do not match the corrosion and fatigue performance of upset rivets. Phase I of this project demonstrated that a compact, hyper-pressure pulse generator can inflate aluminum alloy rivets with an interference fit and strength approaching conventionally upset rivets. Blind fastening was demonstrated in unsupported aluminum panels. Phase I analysis showed that rivet inflation can be accomplished with a much smaller tool. The Phase II effort will involve the development of a lightweight, hand-held tool with an enhanced trigger mechanism that will provide the pulse control required for reliable fastener installation. The work will continue the development of techniques for inflating rivets with aluminum pins to form a solid, all-aluminum fastener.

The objective in Phase II is to meet the performance specifications for a fluid-tight aerospace structural rivet. Airframe assembly represents a major portion of the cost of military and commercial aircraft. The process to be developed will halve the cost of manual airframe fabrication and can be used in an automated flexible-manufacturing environment. There are a variety of other potential applications of hyper-pressure pulse technology including: fastening composite/titanium airframes; automotive aluminum sheet bonding; pulsed-jet peening for stress-relief and forming of aluminum sheet; and research into the behavior of materials under dynamic loading at extreme pressures.

Title: SBIR Phase II: Tricontinuous Diamond /Carbide/Metal Composite (TCCC) Cutting Tools for High Rate, High Precision Machining of Nonferrous Material, Composites, and Ceramics

Award Number 0078371
Program Manager: Cheryl F. Albus

Start Date: July 15, 2000
Expires: June 30, 2003
Total Amount $400,000

Investigator: Oleg Voronov, ovoronov@aol.com
Company: Diamond Materials Inc
120 Centennial Avenue
Piscataway, NJ 08854
Phone: (908)445-2245

Abstract:

This Small Business Innovation Research (SBIR)Phase II project will conduct research to develop a new class of cutting tools for high rate/high precision machining of Al-Si alloys, composites, and ceramics. Advanced cutting tools will improve machining economics in the automotive, aerospace and related industries. The new cutters will be made from a patent pending Tricontinuous Diamond/Carbide/Metal Composite (TDCC) material formed using high pressure/high temperature sintering technology. The potential of this TDCC technology was demonstrated in Phase I, wherein proof-of-principle TDCC cutters outperformed conventional PCD cutters and showed up to two times longer tool life in Al-Si alloy machining tests. In Phase II development of the TDCC sintering process will be carried out, with emphasis on demonstrating TDCC tool performance improvement, cost reduction, and quality control applicable for mass production. In addition development and performance demonstration of prototype cutting tools that use TDCC inserts are planned.

The primary objective of Phase II research will be to demonstrate the commercial feasibility of making machining tools using TDCC material. Collaboration with a leading automotive parts manufacturer, that will provide facilities and equipment for testing of the TDCC tools, has been arranged. This will help insure that the successful completion of the Phase II effort will lead to Phase III commercialization in the area of high rate / high precision tool manufacturing for automotive and other markets. Use of low wear high impact resistance TDCC tools will significantly impact the automotive and aerospace parts manufacturing industry allowing high transfer line speeds, lower operation count, and better surface finish which in turn will lead to improved production efficiency and lower product cost.

Title: SBIR Phase II: Copper Selective Silica-Polyamine Extraction Materials for Processing Copper Ore Leach Liquors

Award Number: 0109983
Program Manager: Rosemarie D. Wesson

Start Date: September 1, 2001
Expires: August 31, 2003
Total Amount: $500,000
Investigator: Robert J. Fischer, bfischerpsi@micro-mania.net
Company: Purity Systems, Inc.
3116 Old Pond Road
Missoula, MT 59802
Phone: (406)543-4228

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will investigate production of an exciting new material CuWRAM (Copper Waste Recovery from Aqueous Media). Evaluation of these pilot procedures will support the design of full scale manufacturing facilities. A processing system utilizing the patented ISEP separations hardware obtained from Calgon Carbon Corp. and CuWRAM as the extractant material for copper extraction and separation from iron (III) will be produced. Extensive testing will provide information to: (1) establish the effectiveness of the CuWRAM - ISEP system on real samples; (2) establish the economic feasibility of this system under various conditions; and (3) develop a targeted marketing strategy based on the first two items. Results from the Phase I project have generated excitement throughout the mining community. Initial testing on actual mining solutions will be conducted with one of the largest copper producers in the U.S.

Commercial applications for a CuWRAM copper extraction include use in the primary extraction circuit of copper mining operations, recovery of copper for reuse in copper plating processes and recovery of copper from remediation projects.

Title: STTR Phase II: Solid Freeform Fabrication Based Dental Reconstruction

Award Number: 0321712
Program Manager: Cheryl F. Albus

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

Investigator: Stephen M. Schmitt, sschm11977@aol.com
Company: Tel Med Technologies
P.O. Box 8042
Port Huron, MI 48061-8042
Phone: (210)887-3042

Abstract:

This Small Business Technology Transfer Phase II project will develop and optimize the Rapid Freeze Prototyping (RFP) technology, producing ice patterns used in investment casting to fabricate dental castings for crowns, bridges, implant-retailed restorations and other prostheses, as well as to integrate the developed RFP technology with commercial digital imaging and computer-aided design technologies into an Internet CAD/CAM dental restoration system.

The commercial and broader impacts of this project will be to provide a significant time and cost savings using the patented RFP technology compared with the hand-crafted process of pattern making currently used by the vast majority of dental laboratories. Hundreds of thousands of dental castings are made each year by hand. The high labor cost of making these castings makes the dental market ideal for the application of the proposed RFP technology and other allied CAD/CAM technologies.

Title: SBIR Phase II: Detection Systems for High-Speed Optoelectronic Sortation of Low Z Metal Alloys

Award Number: 0321298
Program Manager: Cheryl F. Albus

Start Date: July 1, 2003
Expires: June 30, 2005
Total Amount: $499,991

Investigator: Leigh A. Peritz, lapwte@aol.com
Company: wTe
7 Alfred Circle
Bedford, MA 01730-2349
Phone: (617)275-6400

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a novel prototype optoelectronic sensing system for the high-speed identification and sorting of metals, particularly aluminum alloys. The goal is to develop the capability to sort aluminum into its exact alloy designations. The technology is expected to sort materials in less than 50-milliseconds per item automatically without operator intervention while the scrap is in motion on a high-speed conveyor belt. The scrap recycling industry reports that more than 30 billion pounds of nonferrous metals are produced each year in the U.S. alone. The U.S. Environmental Protection Agency (USEPA) reports that more than 10 billion pounds of these nonferrous metals are discarded each year in landfills, because recycling is either technically or economically impractical. Existing methods of sortation that employ visual examination and hand sortation, or alternatively employ heavy media separation, cannot sort aluminum by alloy type. Refining is accomplished in smelting facilities that are expensive to build and often polluting. Using advanced spectrographic detection techniques, including computer analysis; the proposed technology will improve alloy identification accuracy and automatically sort aluminum metal alloys at speeds never before attainable.

The commercial impact of this project will be increased scrap utilization, increased scrap value, reduced pressure on non-renewable resources, and reduced environmental pollution. The potential worldwide market exceeds $2 billion annually.

Title: SBIR Phase II: A Process for Preparing Nanometer-Sized Ceramic Particles at High Production Rates

Award Number: 0131395
Program Manager: Cheryl F. Albus

Start Date: March 1, 2002
Expires: February 29, 2004
Total Amount: $500,000
Investigator: Wen C. Huang, Huang2001@yahoo.com
Company: Nanotek Instruments, Inc.
1214 43rd St. NW
Fargo, ND 58102
Phone: (701)277-1772

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize a new technology for mass-producing nanometer-sized ceramic powders at dramatically reduced costs. The technology, Combined Atomization and Reaction Technique (CART), involves providing an atomizing gas medium containing a reactant element such as hydrogen, oxygen, carbon, nitrogen, chlorine, fluorine, boron, or sulfur; preparing a metal alloy melt super-heated to a spontaneous reaction temperature at which the alloy can undergo a self-sustaining reaction with the selected reactant element; and introducing reactant gas to concurrently mix, atomize, and react with the critically super-heated alloy melt to form ultra-fine ceramic particles in an atomizer chamber. This Phase II project will design and build a prototype pilot-scale CART apparatus to demonstrate the commercial viability of the technology as applied to the synthesis of nano-sized oxides of selected metals that are deemed to have the greatest commercial potential.

The commercial potential of ultrafine powders are in the production of catalysts, coatings and films, conductive pastes, cosmetics, electromagnetic components, electronic devices, fire retardant materials, magnetic fluids, sintered and injection-molded parts, ceramic composites, magnetic storage media, phosphors, pigments, polishing media, and toners. Indium-tin oxide (ITO) powders are used to prepare sputtering targets for deposition of transparent films for use in flat-panel display technology. Nano-grained materials can be employed to replace various load-bearing and non-structural parts in automobiles, infrastructures, offshore structures, piping, containers, electronic equipment housings, etc. Nano-grained cermets and ceramics are outstanding cutting tool materials. Transparent nano-grained ceramics can be utilized in a broad array of applications, including transparent ceramic appliance components, clear "glassware" and artistic artifacts. Transparent ceramics may also be used in ballistic protection armor by law enforcement, security police and armored car personnel.

Title: SBIR/STTR Phase II: Rapid, Low-Cost Processing of Continuous Fiber-Reinforced Ceramic Composites

Award Number: 0132134
Program Manager: Cheryl F. Albus

Start Date: February 15, 2002
Expires: January 31, 2004
Total Amount: $499,756

Investigator: Stuart T. Schwab, stschwab@thortech.biz
Company: Thor Technologies, Inc.
P.O. Box 5188
Albuquerque, NM 87185-5188
Phone: (505)348-4980

Abstract:

This Small Business Technology Transfer (STTR) Phase II Project will validate the polymer infiltration/microwave pyrolysis (PIMP) process and ceramic product whose feasibility was demonstrated in Phase I. The Phase I project demonstrated a reduction in pyrolysis time of greater than 90%; the Phase II project will confirm a corresponding cost reduction. During the Phase I, a strategic partnership with a major original equipment manufacturer (OEM) was established. The Phase II project will reference the process to produce ceramic parts for a specific commercial application, and will validate the weight and performance enhancements projected in Phase I. The PIMP process will be expanded to the pilot plant scale, and with the collaboration of the OEM and a business development specialist.

Commercial applications exist for fiber-reinforced ceramics, if they can be produced at low cost. The potential applications range from gas-fired turbine engines for power plants and aircraft to brakes, waste incineration and chemical production

Title: SBIR Phase II: Volumetric Microbatteries Using Soft Lithography

Award Number: 0239326
Program Manager: Cheryl F. Albus

Start Date: January 15, 2003
Expires: December 31, 2004
Total Amount: $499,996
Investigator: Charles D. E. Lakeman, clakeman@tplinc.com
Company: TPL, Inc.
3921 Academy Parkway North, NE
Albuquerque, NM 87109-4416
Phone: (505)342-4471

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop novel microbatteries. As microsystems emerge from the lab into applications such as implantable medical devices, smart surgical tools, and discrete, autonomous sensors, there is a critical need for power systems of a similar physical size (a few cubic mm or smaller) to the new miniaturized systems themselves. The microbattery developed under the Phase I effort exploits a volumetric approach to deliver power with a minimum volume and a minimum footprint. Compared with thin film batteries, which are surface area devices requiring a large footprint to achieve useful capacities. These novel devices meet the need for a small self-contained source of electrical power. The objective of the project will be to reduce the critical dimensions of the device to the order of 1mm, fully characterize their performance, and develop production and assembly procedures to manufacture integrated devices.

The commercial and broader impacts of this technology will be to emerging new devices based on microsystems technology (devices containing microelectronics and MicroElectroMechanical Systems, (MEMS)) such as implantable medical devices, microsensors for broad area surveillance, and microsatellites.

Title: SBIR Phase II: ELEX - Innovative Low-Cost Manufacturing Technology for High Aspect Ratio Microelectromechanical Systems (MEMS)

Award Number: 0216665
Program Manager: Cheryl F. Albus

Start Date: November 1, 2002
Expires: October 31, 2004
Total Amount: $497,929
Investigator: Adam L. Cohen, acohen@memgen.com
Company: MEMGen Corporation
1103 W. Isabel St.
Burbank, CA 91506-1405
Phone: (818)295-3996

Abstract:

This Small Business Innovation Research Phase (SBIR) II project will further develop ELEX (Electro-Extrusion) which is a manufacturing process for prototyping and batch manufacturing high-aspect ratio microelectromechanical systems (MEMS) and related microparts and microstructures. The goal is to replace (in many applications) the so-called LIGA process, which is an electrodeposition-based technique, requiring the use of a clean room and synchrotron.

The commercialization potential of this project to the MEMS industry will provide a dramatic reduction in cost and time, which will greatly accelerate the commercialization of MEMS and other microscale devices.

Title: SBIR Phase II: Innovative And Cost-Effective Process for Net-Shape Microfabrication of Ceramic Components

Award Number: 0321692
Program Manager: Cheryl F. Albus

Start Date: July 1, 2003
Expires: June 30, 2005
Total Amount: $499,759
Investigator: Balakrishnan G. Nair, bnair@ceramatec.com
Company: Ceramatec
2425 South 900 West
Salt Lake City, UT 84119-1517
Phone: (801)978-2121

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a ceramic hydrogen fuel appliance (CHFA) using ceramic microreactor modules (CMMs) using a low-cost, net-shape manufacturing process, and a new material, that was developed in the Phase I project. The new material developed was demonstrated to have excellent capability for cost-effective microfabrication of ceramic components with sub-micrometer precision. Further, it has good materials properties, including very high component surface area and thermochemical stability to temperatures as high as 1000 degrees C, that make it an ideal material for fabrication of CMMs.

The commercial and broader impacts of this technology will be as hydrocarbon fuel reference that supply hydrogen to fuel cells used as auxiliary power units (APUs) on board automobiles/trucks.

Title: SBIR Phase II: A Novel Joining Process for Tubular Structures in Automotive and Aerospace Applications

Award Number: 0132096
Program Manager: Cheryl F. Albus

Start Date: April 1, 2002
Expires: March 31, 2004
Total Amount: $495,399

Investigator: Wentao Cheng, wcheng-emc2@columbus.rr.com
Company: Emc2
3518 Riverside Drive
Columbus, OH 43221-1735
Phone: (614)459-3200

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and commercialize the Magnetic Pulse Welding (MPW) system, a novel materials joining process. The goal is to establish MPW as a reliable and economic method to weld tubular structures. The project will conduct research and engineering that will address the critical technical hurdles for the commercial implementation and dissemination of the new welding technology.

The commercial applications would revolutionize the assembly process of the hydroformed tubular structures in automotive chassis and space frame applications. This process will promote the hybrid automotive body structure design that uses tubes of both aluminums and steels and will enable joining of different materials such as titanium to superalloys for aerospace and electronic applications.

Title: SBIR/STTR Phase II: Development of High Efficiency NanoFilter Media

Award Number: 0132118
Program Manager: Rosemarie D. Wesson

Start Date: February 15, 2002
Expires: January 31, 2004
Total Amount: $499,999
Investigator: Jayesh Doshi, nanofiber@aol.com
Company: eSPin Technologies, Inc.
100 Cherokee Blvd., Suite 325
Chattanooga, TN 37405-3860
Phone: (423)870-9994

Abstract:

This Small Business Innovation Research Phase II project will demonstrate using a prototype design the commercial feasibility of electrospinning to produce nanofibers. Nanofibers will be combined with conventional filter media to form a novel NanoFilter media for liquid and air filtration applications. These applications have been shown to remove particles smaller than 3 microns from effluent streams with superior filtering efficiency and attractive cost potential. The acrylic nanofibers will be electrospun as a nanoweb directly on to a conventional support (filter media) substrate. The web will be combined with a protective cover layer to form a sandwich structure, which will be collected as a roll. The filter will be easily tailored to achieve the desired composite filter performance by varying architecture: substrates, nanofiber diameter, nanoweb density, and the nanoweb thickness. This project will be carried out collaboratively with academic centers and major corporations as its strategic partners. Nanotechnologies developed in the coming years will form the foundation for a significant commercial platform.

Commercial applications in a variety of filtration processes such as: high-end industrial raw material purification, biological separations, ultra pure air and water systems, hospital clean rooms, agriculture and food industries filters, and microelectronic industries next generation clean environment needs are anticipated.

Title: SBIR Phase II: Photo-Curable Silicon Oxycarbide Fiber for Diesel Engine Particulate Filters

Award Number: 0239336
Program Manager: T. James Rudd

Start Date: January 15, 2003
Expires: December 31, 2004
Total Amount: $500,000

Investigator: Edward J. Pope, matech@thegrid.net
Company: MATECH Advanced Materials
31304 Via Colinas Ste 102
Westlake Village, CA 91362-3901
Phone: (818)991-8500

Abstract:

This Small Business Innovation Research Phase II project will scale-up a manufacturing process for curable preceramic polymers in the fabrication of high yield and low cost Silicon Oxycarbide (SOC) fibers and bonded fiber mats for diesel engine particulate filters. In the Phase I effort, SOC fibers and fiber mats were successfully fabricated and the critical materials properties required for the diesel particulate filter application were attained. This development represents the first Silicon Oxycarbide glass-ceramic fibers to be fabricated from curable poly (dimethyl) siloxanes. In addition, the photo-curable and chemically-curable polysiloxane preceramic polymers demonstrated also have potential as a binder or matrix phases for other structural composites. This Phase II effort seeks to optimize fiber mat production techniques through collaboration with Cummins Engine Company's subsidiary Fleetguard/Nelson (FGN), the world's largest manufacturer of filters for the automobile and truck market.

In the project, critical factors related to automated manufacturing, process scale-up, fiber mat performance characteristics, and performance testing will be addressed to ensure a smooth transition to a commercial product. The diesel particulate filter (DPF) market will grow dramatically due to EPA requirements that all diesel vehicles be equipped with diesel particulate filters by 2007, thereby significantly improving the nation's air quality. The diesel manufacturing industry in North America now exceeds $85 billion in gross output annually. Total U. S. "on road" vehicles requiring DPF's will exceed 3 million units annually, resulting in a potential on road market size of in excess of $6 billion per year. The DPF product to be scaled up in this project has comparable performance to the current extruded ceramic honeycomb filter but with a projected unit cost of about one-tenth. This will have a dramatic impact on diesel filtration system costs with substantial environmental, energy, and trade deficit benefits.

Title: SBIR Phase II: Magnetohydrodynamic Formation of Metal Monospheres

Award Number: 0132241
Program Manager: Rosemarie D. Wesson

Start Date: February 1, 2002
Expires: January 31, 2004
Total Amount: $499,999
Investigator: Robert C. Dean, Jr., RCD@Synnovations.com
Company: Synergy Innovations, Inc.
10 Water Street, Rm. 405
Lebanon, NH 03766
Phone: (603)448-5454

Abstract:

This NSF Small Business Innovation Research Phase II project continues research and development of a commercial process for the manufacture of mono-size-dispersed, spherical powder (size 1-10 micron) from metals melting up to 200C. A unique magnetohydrodynamic (MHD) jet exciter will be designed, fabricated and developed as a component of the system essential to producing monosphere powder to high tolerances (e.g., as demanded by the electronics industry of ball grid arrays for surface-mount components). The electrostatic means, for preventing coalescence in the drop cloud, will be developed further. Development of cooling means for solidification will be completed. Specific industry quality control standards and testing will be applied to qualify the monosphere product. Finally, a referenced analysis of cost of manufacture, and a complete business plan will be produced. The outcome expected from this project is the technology base for the commercial, large-scale production of monospheres. This unique process innovation for large-scale production of monospheres, will provide a major new source of precise and economical powder for electronic solder balls and paste, powder metallurgy, composites, magnetorheological fluids, catalyst carriers, solid/fluid reactions and a multitude of other uses.

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: 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: 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: 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: 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 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: 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: Advanced Thermal Technologies
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: 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: 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.

Manufacturing Process Control

Title: SBIR Phase II: High Sensitivity Raman Spectrometer

Award Number: 0110453
Program Manager: Rosemarie Wesson

Start Date: August 15, 2001
Expires: June 30, 2003
Total Amount: $499,997

Investigator: Stuart Farquharson, stu@rta.biz
Company: Advanced Fuel Research Inc
87 Church Street
East Hartford, CT 06138
Phone: (860)528-9806

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will design, build, and test a hybrid Raman analyzer suitable for "on-demand" or continuous process monitoring. The Phase I project demonstrated feasibility by designing and testing a unique combination of components that yielded greater than 100 times improvement in sensitivity (defined as the signal-to-noise ratio) compared to traditional Raman analyzers. The novel design also demonstrated high resolution (1 cm -1), invariant wavelength stability, and freedom from fluorescence interference; which are critical requirements for autonomous chemical process monitoring or rapid raw-material identification. The Phase II project will further improve sensitivity, as well as demonstrate long-term temperature and vibrational immunity, and fast "turn-on" time. Complete internal analyzer diagnostics will allow greater than 1000 hours of unattended operation. As such, the analyzer will be rugged, compact and portable (10"x 12" footprint), low-maintenance, require minimum power, and suitable for numerous industrial applications.

The commercial applications will be directed toward the chemical manufacturing industries. The Phase II prototype will be used to develop specific applications with customers during Phase III.

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

Award Number: 0450452
Program Manager: Joseph E. Hennessey

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

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

Abstract:

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

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

Title: SBIR Phase II: Two-Wavelength Thermal Imaging Solutions to Materials Process Control Needs

Award Number: 9983275
Program Manager: Winslow L. Sargeant

Start Date: July 15, 2000
Expires March 31, 2004
Total Amount: $513,288
Investigator: James Craig, Info@stratonics.com
Company: Stratonics Inc
23151 Verdugo Drive Ste 114
Laguna Hills, CA 92653
Phone: (949)461-7060

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a prototype two-wavelength imaging pyrometer. To monitor high-temperature materials processes, it uses an indium gallium arsenide (InGaAs)-based camera. Two-wavelength imaging uses intensity ratios to provide accurate temperature measurement of objects with emissivity variation. Single wavelength imaging sensors mistake absolute intensity changes, caused by emissivity variation, for temperature changes. Temperature is a central parameter in many high-temperature materials processese. Long production runs require temperature control for consistent product quality. This thermal imaging sensor is expected to meet industry needs for accuracy, low temperature operation, and low cost.

Phase II will develop a 'research grade' imaging pyrometer for use in specialized laboratory experiments and a 'ruggedized grade' imaging pyrometer for testing in industrial facilities. Potential commercial applications of the thermal imaging sensor (with its 1-2 mm sensitivity) are expected in industrial process control sensors for high temperature materials processing.

Title: SBIR Phase II: Chatter Avoidance Software for High Speed Milling

Award Number: 0078904
Program Manager: Cheryl F. Albus

Start Date: September 1, 2000
Expires: August 31, 2002
Total Amount: $424,000
Investigator: Donald Esterling, don@vulcancraft.com
Company: VulcanCraft
201 Stable Road
Carrboro, NC 27510
Phone: (919)942-0423

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will integrate a novel, inexpensive device to measure tool dynamics with a general purpose analysis program that will optimize the use of high speed machining centers as a routine shop floor practice. High speed machining is often limited by chatter conditions. These conditions depend on system dynamics and cutting conditions. The product to be developed will provide an integrated hardware/software solution to assist users in selecting optimal spindle speeds and tool depths without the intervention of experts or specialized equipment. The product will handle general tool geometries, tool paths and in-process part geometries working in conjunction with an industrial grade NC verification program.

The program will specifically provide recommendations under low tool immersion (light cut) conditions that are commonly used to avoid tool wear in hard materials. Novel aspects include: (1) the study of chatter under transient conditions; (2) sculptured surface parts; (3) a new analytical solution that provides important physical insights under low tool immersion conditions; (4) a new simulation model that is not restricted to uni-directional feed; and (5) the extension of a new measurement device to provide full tool dynamic data.

Title: SBIR/STTR Phase II: Machine Vision System for Automated Imaging and Process Control

Award Number: 0132025
Program Manager: Cheryl F. Albus

Start Date: February 15, 2002
Expires: January 31, 2004
Total Amount: $499,994
Investigator: Steven D. Summers, ssummers@tplinc.com
Company: TPL, Inc.
3921 Academy Parkway North, NE
Albuquerque, NM 87109-4416
Phone: (505)342-4471

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an entirely new form of machine vision technology for process control of metallic components. The technology is based on an array of giantmagnetoresistance (GMR) sensors that produce high-resolution images of hidden defects, missing parts, and other features. Minute GMR sensors detect magnetic fields associated with eddy currents induced in the component being imaged. High spatial resolution images are achieved through the high density and small size of the sensors in the array, coupled with the high sensitivity, low noise, and fast response of the sensors. A GMR sensor array, combined with a magnetic field generator, can produce high resolution, three-dimensional images of parts as they are produced, using a rugged, non-contacting sensor system. The images provide on-line feedback for process control, quality assurance, and safety protocols. The Phase I project developed functional GMR sensor arrays, and successfully imaged defects in metallic parts clearly demonstrating that the technology is feasible.

The commercial potential of the proposed technology will be in manufacturing, quality assurance (QA), and process control. It will be used for rapid imaging and inspection of parts used in electronics, aerospace, automotive, transportation, construction, biomedical and other industries.

Title: SBIR Phase II: Reference Electrode with an Invariant Liquid Junction Potential

Award Number: 0110520
Program Manager: Cheryl F. Albus

Start Date: August 1, 2001
Expires: July 31, 2004
Total Amount: $497,215
Investigator: Scott T. Broadley, sbroadley@broadleyjames.com
Company: Broadley-James Corporation
19 Thomas
Irvine, CA 92618
Phone: (949)829-5524

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a long-lived, stable Reference electrode that dramatically improves potentiometric measurements, such as pH, redox, and other ion-specific measurements. The new Reference electrode exploits recent developments in microfluidics and nanotechnology to stabilize the liquid-junction potential, a source of error and a cause of frequent sensor calibration and maintenance. Stabilizing the liquid-junction potential of the Reference electrode opens a new realm of potentiometric sensor design and application. The technical feasibility of this innovative electrode was demonstrated in the Phase I project. Testing in a variety of environments showed variations less than 0.5 mV in the Reference electrode potential over an 8 hour period and response times less than 60 seconds, compared to potential variations up to 20 mV and response times of over an hour for conventional Reference electrodes. The flow of electrolyte through the junction was less than 0.1 l per minute, or 50 ml per year of continuous operation. The Phase II project will develop assembly processes, more robust structures, and develop and build sensors for field-tests.

The potential commercial application reduction in sensor calibration and sensor replacement would save the US process industries approximately $240 million per year in sensor costs and labor expenses. Exports of US manufactured sensors with this technology will significantly increase as foreign process industries seek similar cost savings. Furthermore, this Reference electrode can serve as a basic building block in microfluidic sensors, estimated to be a multi-billion dollar industry in the next decade.

Title: SBIR Phase II: Integrated Diagnostics for Operations and Maintenance of Installed Systems

Award Number: 0078670
Program Manager: Cheryl F. Albus

Start Date: January 1, 2001
Expires: December 31, 2004
Total Amount: $773,404

Investigator: Carole Teolis, carole@technosci.com
Company: Techno-Sciences, Inc.
10001 Derekwood Lane
Lanham, MD 20706
Phone: (301)577-6000

Abstract:

This Small Business Innovation Research Phase II project will focus on enhancing maintenance operations scheduling methodologies with condition assessment and diagnostic tools to produce an 'integrated' maintenance management system. The company has developed scheduling tools that allocate maintenance resources on the basis of elapsed calendar time and unit utilization. This project will augment these tools with condition assessment modules. If successful, the result would be a generally applicable system combining condition, time, and utilization as drivers for the maintenance process. The project will develop algorithms for condition assessment based on signal processing and feature extraction using both conventional sensors such as accelerometers, and 'next generation' sensors such as eddy current devices, fiber optic sensors, and MEMS sensors.

These methods, when applied to a maintenance service program, will lead to new methodologies for the synthesis of integrated diagnostics techniques and for the design of new hardware and software systems to realize those techniques for a wide range of practical applications.

Title: SBIR Phase II: A New Technology for Rapid Identification of Aluminum Metals

Award Number: 0239055
Program Manager: Cheryl F. Albus

Start Date: January 15, 2003
Expires: December 31, 2004
Total Amount: $500,000

Investigator: Edward J. Sommer, nrtinfo@nrt-inc.com
Company: National Recovery Tech Inc
566 Mainstream Drive
Nashville, TN 37228-1223
Phone: (615)734-6400

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a new technology for rapid identification and sorting of aluminum and its alloys from a mixture of non-magnetic metals and will provide a new high quality source of these valuable materials for industrial manufacturing processes. This project plans to complete development of an innovative new optoelectronic sensing method integral to the new technology and then design, construct, and test a near commercial scale prototype metals processing system based upon the new technology. The prototype system will be integrated into an existing pilot plant test facility located on-site at the commercial partner's metals recycling facility and will be tested on metal feed streams derived from an automobile shredder processing line located at the recycling facility. A primary objective is to develop an environmentally friendly computerized dry process which can be situated locally and which can rapidly and cleanly sort aluminum scrap from mixtures of nonmagnetic metals at low cost to replace large, costly, and environmentally burdensome heavy media processes and smelting processes for mixed metals.

The commercial and broader impacts of this technology will be to reduce the amount of scrap aluminum alloys that are discarded each year in landfills because recycling of these materials are neither technically nor economically practical. Existing methods of sortation use visual examination and hand sortation, or hand-held/bench-top analyzers that are cumbersome and slow in speed. Heavy media separators and smelting facilities for mixed metals are polluting and expensive to build and operate. Using advanced optoelectronic detection techniques, including computer analysis, the proposed technology will sort aluminum alloys from mixed nonferrous metals automatically at speeds never before attainable. If the approach is successful, the impact to increased scrap utilization, increased scrap value and reduced environmental pollution is enormous. The potential worldwide market exceeds $2 Billion annually.

Title: SBIR Phase II: Residual Stress and Part Distortion Prediction in Machined Workpiece Surfaces

Award Number: 0237958
Program Manager: Cheryl F. Albus

Start Date: February 1, 2003
Expires: January 31, 2005
Total Amount: $499,965

Investigator: Troy D. Marusich, troym@thirdwavesys.com
Company: Third Wave Systems, Inc.
7900 W. 79th Street, Suite250
Minneapolis, MN 55439-2340
Phone: (952)832-5515

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop and validate the predictive capability industry needs to dramatically improve machined workpiece quality by controlling machining induced stresses while simultaneously reducing distortion in aerospace and automotive parts. The objective for Phase II will be to continue the development and verification of analysis tools for predicting residual stress and part distortion. The goal is to supply industry with a validated analytical tool to easily and economically predict and prevent part distortion-reducing costs due to testing trials, part scrap, and time-to-market, increasing product quality and competitiveness.

The commercial and broader impacts of this technology will be provide industry with the ability to predict and prevent part distortion due to machining induced residual stress. Current techniques, which rely upon testing, and experience are not sufficient technically nor are they cost effective. Aerospace parts (large, monolithic, thin-walled, and expensive) and critical automotive powertrain applications, which demand flat surfaces to maintain fuel efficiency, component life, and lower emissions, are typical examples. A significant impact will be to manufacturing costs, lower scrap material, higher productivity, lower time-to-market, and increased product quality and performance.

Title: SBIR Phase II: On-Line, Non-Destructive, Rapid Characterization of Nanopowders and Agglomerates

Award Number: 0110341
Program Manager: Rosemarie D. Wesson

Start Date: September 1, 2001
Expires: August 31, 2003
Total Amount: $499,997
Investigator: Sivakumar Manickavasagam, siva@blazetech.com
Company: Synergetic Techs, Inc
One University Place Suite D-210
Rensselaer, NY 12144-3456
Phone: (518)525-2650

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will further develop, test, and demonstrate a novel approach for characterizing nano-scale powders and their agglomerates. Nanostructures are a novel family of materials that allow customization of structural, electrochemical, electrical, electronic, optical, magnetic, and chemical properties. The use of nanomaterials to fabricate valuable devices and to manufacture new products depends in large part on the ability to characterize these materials during synthesis, processing, and device production. Current high-resolution characterization techniques are off line, slow, expensive, and unreliable; the few on-line particle-sizing instruments available make questionable assumptions (e.g., that all particles are spherical in shape), which introduce unnecessary error into the diagnosis.

The commercial applications of this project is to use nano-scale powders, which are the fundamental building blocks of many products used in a wide variety of industries (e.g., advanced ceramics, pharmaceuticals, consumer products, etc.). As the technology develops, the application areas will increase. The ability to characterize nano-scale particles and agglomerates on-line is crucial for controlling the quality of products and for the invention of new products and processes. In addition, characterization of environmental particulates is critical for understanding air quality concerns and health effects - leading to improve clean air regulations and monitoring.

Title: SBIR Phase II: A Novel Instrument for the Determination of Extensional Rheology

Award Number: 0132046
Program Manager: Rosemarie D. Wesson

Start Date: February 1, 2002
Expires: January 31, 2004
Total Amount: $499,127
Investigator: Gavin J. Braithwaite, gavin@campoly.com
Company: Cambridge Polymer Group
52-R Roland Street
Boston, MA 02129-1234
Phone: (617)629-4400

Abstract:

This Small Business Innovation Research Phase II project describes the development of a Capillary Breakup Rheometer (CaBER) from a proven breadboard design to a commercially viable instrument for both analytical and process control functions. In this document the results of the successful completion of a Phase I SBIR are outlined. The fundamental operation of the CaBER's component parts is supported by data that validates the chosen components and verifies the suitability of the design. In addition, sample data from model fluids will be used to both illustrate the functionality of the CaBER and to highlight the broad applicability of the instrument. Ongoing developments of the CaBER include more robust software analysis, cheaper manufacturing costs and a more intuitive user interface. These improvements will result in an instrument that is invaluable to industry in both a research laboratory and a process control environment.

Currently there is only one commercially available extensional rheometer and a handful of academic rheometer designs. By providing a virtually unique tool for the determination of extensional viscosity in a freely draining fluid thread, this instrument will fill a segment of the instrumentation field that as here to fore been neglected.

Title: SBIR Phase II: A Novel Technique for Polymer Encapsulation of Nanopowders

Award Number: 0216489
Program Manager: Cheryl F. Albus

Start Date: July 15, 2002
Expires: June 30, 2004
Total Amount: $500,000
Investigator: Sanjay Kotha, skotha@matmod.com
Company: Materials Modification Inc
2721-D Merrilee Drive
Fairfax, VA 22031-0113
Phone: (703)560-1371

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will focus on developing polymer coated superparamagnetic nanobeads for isolation of biomolecules; namely cells and nucleic acids. The superparamagnetic nature along with the "nano" size of the particles offers low remnant magnetism, magnetization at low fields, and larger active surface area per unit volume. A proprietary microwave plasma synthesis technique was adopted to reduce these nanospheres and the feasibility of the technique was established during Phase Process scale up and extensive cell/DNA isolation testing will be the main R&D objectives for the Phase II project. Industrial partners will evaluate beads produced to evaluate parameters, which are critical for transitioning the technology to an immediate useful product.

The commercial potential of polymer-coated nanospheres can be used in various separation modules. This technology could also be extended to isolation and detection of pathogens in water.

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 (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: 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: 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 (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.

Chemical Synthesis and Characterization

Title: SBIR Phase II: Advanced Fullerene Production

Award Number: 0321643
Program Manager: Rosemarie D. Wesson

Expires: June 30, 2005
Total Amount: $500,000
Investigator: Michael D. Diener, mikee@tda.com
Company: TDA Research, Inc
12345 West 52nd Avenue
Wheat Ridge, CO 80033-1917
Phone: (303)940-2301

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop electron transfer methods for the recovery of the giant, insoluble fullerenes that comprise about half of the fullerenes made by the hydrocarbon combustion route. Of the fullerenes produced by the combustion process developed at TDA, and practiced at the tons/year scale, ca. 20 % of the raw soot weight is recovered as fullerenes (C60, C70, etc.). It was shown in this project that another ca. 15 - 20% of the soot could be recovered as giant fullerenes using electron transfer methods. This Phase II project will further research the chemistry of the insoluble fullerenes and develop the recovery technique using xylene-extracted soot as a feedstock. We will also implement the process at 100 times the scale performed during the Phase I project, to 100g insoluble fullerenes recovered per shift, to better identify and address issues in the chemistry and engineering of the process. Following the Phase II project, the process will be installed at a plant producing ~32 tons/year of insoluble fullerenes.

The process being developed in this project will be commercialized by fullerene soot producers, giving them the ability to effectively double the yield of the synthesis process. The recovered fullerenes will be useful for applications demanding a more robust, but still fullerenic material or coating, such as carbon coatings for artificial biomaterials, optical limiters, or as scaffolds for nanotechnological devices.

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 Trimetaspherses 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.

Title: SBIR Phase II: Uncopying Xerox - Acoustic Coaxing Induced Microcavitation (ACIM) Assisted DeInking of Paper

Award Number: 0078897
Program Manager: Rosemarie D. Wesson

Start Date: January 15, 2001
Expires: December 31, 2003
Total Amount: $397,345

Investigator: Sameer I. 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 an optimized prototype of the UNCOPIER-a chemical-free, energy-efficient, ACIM-based device designed to non-destructively deink laser-xerographic prints one sheet at a time. Acoustic Coaxing Induced Microcavitation (ACIM) is a novel, chemical-free, and energy-efficient process, which uses only "Silent Sound and Clean Water." Underlying ACIM's energy efficiency is microcavitation's ability to concentrate an enormous amount of energy on an extremely small (i.e. sub-microscopic) point. These controlled concentrations of energy result in nearly spontaneous cleaning, which does not hurt the substrate. ACIM is the ideal technology for deploying energy exactly at the point of use.

UNCOPIER technology will revolutionize the paper recycling industry in a number of ways, as well as innovation in the recycling process itself. Since the UNCOPIER leaves the deInked paper immaculately white and undamaged, it will save environmental resources by making it possible to manufacture new print grade paper from the recycled laser-xerographic prints. The UNCOPIER is being developed as an office machine to advocate a pioneer method for recycling paper-at-source deinking, "one sheet at a time." DeInking paper prior to recycling protects confidentiality. This novel approach will appeal to banks, hospitals, law firms, government agencies, and other institutions interested in recycling, but also concerned with safeguarding confidentiality. The UNCOPIER system will reduce recycling costs and enables vital commercial motivations for its improved recycling endeavors.

Title: SBIR Phase II: High Rate Synthesis of Highly Reactive Solvated Metal Atom Dispersion Nanoparticles

Award Number: 0215816
Program Manager: Cheryl F. Albus

Start Date: July 15, 2002
Expires: June 30, 2004
Total Amount: $499,959
Investigator: Slawomir Winecki, slawek@nanmatinc.com
Company: Nanoscale Materials, Inc.
1310 Research Park Dr.
Manhattan, KS 66502
Phone: (913)532-0179

Abstract:

This Small Business Innovation Research Phase II project focuses on the development and implementation of a Solvated Metal Atom Dispersion (SMAD) technique to support high rate production and commercial application of metal nanoparticle materials. Synthesis of gold and silver nanoparticle colloids for commercial use in the health care industry will be pursued as part of the proposed effort; the SMAD synthesis method will be optimized for commercial-scale manufacturing of gold and silver colloids. This approach yields high purity colloids, free of unwanted byproducts and ready for further processing without the cumbersome purification steps characteristic of other synthesis methods. This innovation significantly simplifies the manufacturing process of colloidal products and reduces production cost. The proprietary digestive-ripening step will be scaled up and developed to achieve monodispersion and particle size control of the metal nanoparticles contained in the colloids. Methods for transferring solvent-based colloids into an aqueous environment will be developed. Synthesis steps involved in the manufacturing of colloidal gold and silver will be integrated in a semi-continuous or continuous process.

The commercial potential of this project will be for immunological labeling and DNA detection using the colloidal gold solutions. The project offers an alternative-manufacturing route that significantly lowers the cost. Silver-based colloids have potential applications in burn wound treatment or as effective disinfectants and anti-inflammatory agents. The development of SMAD technology will enable high-volume manufacturing of many nanoparticle materials whose availability is currently limited by production inefficiencies. These nanomaterials will support future technologies in industry and find application in both commercial and academic research, as highly reactive catalytic materials, magnetic information storage media, ferrofluids, and magnetic tracers.

Title: SBIR Phase II: "RT Photocurable Preceramic Polymers to Si3N4 Ceramics"

Award Number: 0132155
Program Manager: T. James Rudd

Start Date: April 1, 2002
Expires: March 31, 2004
Total Amount: $500,000

Investigator: Edward J. Pope, matech@thegrid.net
Company: MATECH Advanced Materials
31304 Via Colinas Ste 102
Westlake Village, CA 91362-3901
Phone: (818)991-8500

Abstract:

This Small Business Innovation Research (SBIR) project will develop a program that will optimize poly (ethynyl) silazanes (PESZ) synthesis with an emphasis on improved efficiency and low production costs; will scale-up the production of PESZ polymers to pilot scale batch sizes; will optimize PESZ processing for component fabrication; will fabricate "real world" components, such as thrust deflectors and diesel engine particulate filters; and will obtain "real world" mechanical and performance testing data. Through the course of achieving these objectives, commercial opportunities will be pursued. This approach potentially permits the fabrication of extremely large ceramic matrix composites (CMCs) structures never before possible in much the same manner as large polymer matrix aircraft structures and boat hulls are currently manufactured.

The commercial application will be the fabrication of extremely large CMC structures that can be used in the aircraft industry.

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 (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: 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 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: 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.

Novel Catalytic Systems

Title: SBIR PHASE II: Novel Ambient Temperature Emissions Control Catalyst

Award Number: 0321551
Program Manager: Rosemarie D. Wesson

Start Date: June 1, 2003
Expires: May 31, 2005
Total Amount: $500,000
Investigator: James R. Kittrell, kseinc@aol.com
Company: KSE Inc
P O Box 368
Amherst, MA 01004-0368
Phone: (413)549-5506

Abstract:

This Small Business Innovation Research Phase II project is to complete the R&D to commercialize a novel catalytic technology for pollution control at ambient temperature. The novel technology will destroy VOCs using low temperature oxidation with a highly active class of novel Heteropoly Oxometalate (HPOM) catalysts. This new class of catalysts is dramatically more active than traditional platinum oxidation catalysts. The Phase II catalyst will provide new avenues for scientific research and education, by studying catalysis at mild conditions needed for advanced instrumentation at diverse geographic locations, and by expanding the applications to other societal needs in fuel cells, Fischer-Tropsch synthesis, etc.

Commercial applications will provide efficient, low cost industrial emissions control and enhanced indoor air quality. The firm's research facilities and prior SBIR licensing success will facilitate rapid deployment. The program should protect the nation's environment and improve economic competitiveness.

Title: SBIR Phase II: Redox Polymer Catalysts for Electrochemical Synthesis of Hydrogen Peroxide

Award Number: 0078383
Program Manager: Rosemarie D. Wesson

Start Date: September 1, 2000
Expires: August 31, 2002
Total Amount: $357,904

Investigator: Ram Gopal, ramgopal@electrosynthesis.com
Company: The Electrosynthesis Company, Inc.
72 Ward Road
Lancaster, NY 14086
Phone: (716)684-0513

Abstract:

This Small Business Innovation Research Phase II project will investigate the use of redox catalyst electrodes for the synthesis of hydrogen peroxide through electrochemical regeneration of the redox catalyst. In the Phase I research, catalysts were developed and their short-term stability for peroxide synthesis was successfully demonstrated. Flow cell operation with 10 cm2 electrode cells showed the preparation of hydrogen peroxide in acidic condition (1N H2SO4) at 60% current efficiency and up to 2% in peroxide concentration. However, Phase I work indicated poor catalytic current with oxygen for these redox systems, as well as an upper limit for hydrogen peroxide concentration (2%). Phase II research effort will be directed towards improving the catalytic effect of these redox catalysts through changes in preparative procedures, electrode structure, and fabrication technique. The electrodes will be tested and optimized for peroxide synthesis using oxygen/air and almost pure water (pH adjusted, if necessary) using flow cell experiments. The electrodes will be tested for long-tem stability (500 hours). Larger electrodes (100cm2) will be fabricated using the best composite electrode for long-term stability testing and process optimization. Commercialization of the process will be carried out with a Phase III partner upon the successful completion of Phase II work.

Potential Commercial Application of the Research Hydrogen peroxide is a clean oxidant, which reacts to form water as its reaction product. It is therefore environmentally acceptable in many industries. The market for hydrogen peroxide is expected to grow by almost 10% for the next few years. New technology (synthesis of hydrogen peroxide from water and air) described in this Phase II proposal could be implemented for various applications. These areas include wastewater treatment, on-site generation (for industrial and consumer application such laundry bleach etc.), as well as commercial peroxide production.

Title: SBIR Phase II: CO-Tolerant Pt-Mo Electrocatalysts for Proton Exchange Membrane (PEM) Fuel Cells

Award Number: 0078635
Program Manager: Cheryl F. Albus

Start Date: September 1, 2000
Expires: February 28, 2003
Total Amount: $400,000

Investigator: Hanwei Lei, hlei@tjtechnologies.com
Company: T/J Technologies, Inc
PO Box 2150
Ann Arbor, MI 48106
Phone: (313)213-1637

Abstract:

This Small Business Innovation Research Phase II project addresses the development of highly dispersed Pt-Mo electrocatalysts for application as anodes in proton exchange membrane (PEM) fuel cells. Alternative anode electrocatalysts remain a critical development area for the cost reduction and performance enhancement of PEM fuel cells operating on reformate hydrogen fuel. Specifically, there is a need for catalysts that are tolerant to reformate by-products such as CO. Supported Pt-Mo is a leading candidate for the next generation of these catalysts. The Phase I research successfully produced highly dispersed Pt-Mo catalysts supported on Vulcan XC-72 using two distinct methods. The catalysts produced by both methods show excellent hydrogen oxidation characteristics in 0.5 M H2SO4. The performance of these materials in 100 ppm CO/H2 indicated high activity but did not, however, show the degree of CO-tolerance expected on the basis of results from bulk Pt-Mo alloys. These findings were surprising in light of voltammetric evidence that showed electrochemical interaction between Mo and Pt. Phase II of this effort will develop a more comprehensive understanding of the nature of Pt-Mo interactions. The results from the Phase I research at T/J suggest that the promotion of enhanced H2 oxidation at lower potentials in CO/H2 fuel streams is critically dependent upon the nature of the Pt-Mo interaction. We intend to examine the influence of surface composition/coverage of Mo on solid Pt electrode surfaces in the presence of CO/H2 fuel streams as a function of potential using a rotating disk electrode (RDE) system. These fundamental studies of solid electrode surfaces will identify the basis of CO-tolerance.

Based on these results, we will pursue rational development of supported Pt-Mo catalysts with the appropriate surface chemistry and structure using three novel dispersion methods. As a part of this work, we will conduct in-depth physicochemical characterization of the catalysts as well as more comprehensive electrochemical analysis. We intend to produce prototype membrane electrode assemblies (MEAs) for testing in fuel cells. In addition, we will supply catalyst materials for external evaluation by leading catalyst manufacturers. These companies have committed over $840,000 in follow-on funding for this SBIR project. Low cost CO-tolerant catalysts developed under this SBIR project will enable the commercialization of high performance PEM fuel cells operating on reformed hydrogen. Reducing catalyst costs addresses a key obstacle hindering the commercialization of PEMFCs for vehicle propulsion and off-grid electric power generation.

Title: SBIR Phase II: Novel Catalyst Substrate for the Preferential Oxidation (PROX) of Carbon Monoxide

Award Number: 0078754
Program Manager: Rosemarie D. Wesson

Start Date: January 1, 2001
Expires: December 31, 2003
Total Amount: $756,000

Investigator: Marco Castaldi, mc2352@columbia.edu
Company: Precision Combustion, Inc.
410 Sackett Point Road
North Haven, CT 06473
Phone: (203)287-3700

Abstract:

This Small Business Innovation Research Phase II project advances the development of an improved catalytic reactor, based on a novel catalyst substrate design, for the preferential oxidation (PROX) of carbon monoxide in a hydrogen rich feed. The Phase I objectives were fully met and demonstrated the viability of this catalyst substrate for substantial reductions in the size, weight and cost of the PROX component and also identified parameters for designing a full scale PROX reactor. This Phase II effort will focus on catalyst optimization and integration of a PROX reactor based on the catalyst substrate in a fuel processor system for automotive fuel cell applications. This potential breakthrough could significantly advance fuel processing technology for automotive fuel cell applications. The proposed technology has the potential to provide near-order of magnitude improvements in fuel processor volume, weight and cost, with a broad range of potential spin off applications to other catalytic reactors.

Success with the PROX reactor would lead to exploring use of this substrate for other components in the fuel processor, including the reformer and the Water Gas Shift reactors.

Title: SBIR/STTR Phase II: Engineered Zeolite Catalyst for Paraffin Alkylation

Award Number: 0215552
Program Manager: Rosemarie D. Wesson

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $500,000
Investigator: Mitrajit Mukherjee, mm_exelus@hotmail.com
Company: Exelus, Inc.
99 Dorsa Avenue
Livingston, NJ 07039-1002
Phone: (973)740-2350

Abstract:

This Small Business Innovation Research Phase II project aims to develop a step-out technology for paraffin alkylation to produce high-octane clean gasoline. Conventional alkylation processes require large volumes of corrosive liquid acids, which can inflict serious injury via skin contact or inhalation. The new alkylation process will be fundamentally safer and cleaner, reducing the use and generation of toxic chemicals. It uses a first-of-a-kind engineered zeolite catalyst that is environmentally benign and eliminates the risks associated with liquid acids while producing alkylate of comparable quality. The new catalyst promises significantly improved yields and selectivities, minimizing waste by-products and disposal problems associated with liquid acids.

The engineered zeolite catalysts can be used most effectively for liquid phase alkylations of paraffins and aromatics, such as the production of high-octane alkylate, and industrially important petrochemicals such as
cumene and ethylbenzene.

Title: SBIR Phase II: Novel Low Cost Technology for High-Performance Integrated Microcombustor/Evaporator

Award Number: 0215792
Program Manager: Rosemarie D. Wesson

Start Date: August 15, 2002
Expires: July 31, 2004
Total Amount: $500,000
Investigator: Lev Tuchinskiy, ltuch@opusl.com
Company: Materials & Elctrochem/MER
7960 South Kolb Road
Tucson, AZ 85706
Phone: (520)574-1980

Abstract:

This Small Business Innovation Research (SBIR) Phase II project is aimed at the continued development of novel microscale combustors/evaporators, which are intended for evaporation of fuel and water in fuel reformers as well as for personal portable heating and cooling systems. The general objective of the Phase II program is to optimize and scale up a technology for microchannel combustor/evaporators demonstrated in the Phase I and to develop a compact device, which could generate at least 25- 30 watts of thermal energy per square centimeter of heat transfer area and transfer that energy to fluid with efficiency greater than 85 percent. Innovative fabrication technology and a new microreactor concept were combined to create a highly efficient device, which uses hydrogen or hydrocarbon fuel combustion for heating and/or boiling working fluids. Conditions of heat transfer and combustion of hydrogen and methane in microchannel combustor/evaporators will be determined and optimal design of the microscale device will be established.

Potential commercial applications include lightweight, safe and high performance microcombustors for microturbines, man-portable microheaters for cold climates, man portable cooling microsystems for hot climates, on-board fuel processors for hydrogen generation, distributed space conditioning of buildings, etc. Utilization of microchannel combustor/evaporators for these applications will result in increase of energy efficiency, reduction of air pollution and enhancement of life quality.

Title: SBIR Phase II: Novel Methodology for Purification and Separation of Platinum Group Metals

Award Number: 0216373
Program Manager: Rosemarie D. Wesson

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

Investigator: Waheguru P. Singh, waheguru.singh@lynntech.com
Company: Lynntech, Inc
7610 Eastmark Drive, Suite 202
College Station, TX 77840-4024
Phone: (979)693-0017

Abstract:

This Small Business Innovation Research Phase II project is focused on designing a series of extremely efficient metal extraction products (MEPs) with tailor-made properties for specifically extracting and purifying platinum group metal (PGM) anions from acid solutions. Existing PGM recovery and separation methods are complex and expensive. The Phase II project will fully develop the separation and purification of PGMs, scale up the MEP synthesis and expand the scope of the work to launch the technology into PGM recycling market.

These novel MEPs will have wide applications in the precious metal refining as well as recycling industries. It is estimated that the total value of precious metal catalysts in spent automobile catalytic reactors in the United States alone is $ 800 million a year. Additionally, these MEPs could also be used in the separation and purification of actinides, such as plutonium, and in the pre-concentration of trace amounts of anions (e.g. chromate, arsenate) to aid in environmental analysis. Modifications of the structure may also lead to the production of highly specific environmental sensors for the in-situ detection of contaminants in groundwater and other aqueous streams.

Title: SBIR Phase II: Carbon Monoxide-Tolerant Anode Catalysts for Proton Exchange Membrane Fuel Cells via Combustion Chemical Vapor Deposition

Award Number: 0091624
Program Manager: Rosemarie D. Wesson

Start Date: February 1, 2001
Expires: January 31, 2004
Total Amount: $499,938
Investigator: Richard Breitkopf, rbreitkopf@microcoating.com
Company: CCVD dba MicroCoating Tech
5315 Peachtree Industrial Blvd.
Atlanta, GA 30341-2107
Phone: (678)287-2400

Abstract:

This Small Business Innovation Research (SBIR) Phase II project seeks to implement a Combustion Chemical Vapor Deposition (CCVD) process for the production of anode electrocatalyst layers for Proton Exchange Membrane Fuel Cell (PEMFC) applications requiring reformate fuel feed gas. In Phase I it was demonstrated that fabrication of Pt:Ru electrocatalysts as unsupported, metallic nanoparticles is possible using CCVD. These electrocatalyst layers behave electrochemically in a similar manner to commercially available Pt:Ru electrocatalysts prepared on carbon supports using wet chemical methods, but can be deposited directly onto both gas diffusion media and proton exchange membranes. The Phase II project would involve optimization of catalyst composition, continued development of web coating technology for mass production of membrane electrode assemblies (MEAs) and commercialization of the technology through construction of production equipment and licensing.

Fuel cells are of huge interest to the marketplace, as illustrated by sizable investments in the technology and market capitalization of fuel cell companies. For example, Daimler Chrysler has targeted the year 2004 for planned production of fuel cell vehicles, and has slated more than $1.4 billion in investments to reach that goal. However, for commercial viability, performance and cost of the electrocatalyst layers must be improved. MCT, if successful, could contribute in both arenas.

Title: SBIR Phase II: Novel Low Temperature Partial Oxidation Reactor

Award Number: 0109981
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2001
Expires: July 31, 2004
Total Amount: $500,000
Investigator: Michael C. Bradford, mbradford@ceramem.com
Company: CeraMem Corporation
12 Clematis Avenue
Waltham, MA 02453
Phone: (617)899-4495

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop an economically competitive, novel, catalytic process for low temperature hydrocarbon partial oxidation. An innovative process for ethylene epoxidation will be developed as a commercially significant application. Most heterogeneous hydrocarbon partial oxidation reactions utilize engineered catalysts, which incorporate novel promoters to enhance selectivity. However, reactor heat management significantly impacts process energy efficiency, catalyst selectivity, and ultimately, process profitability. The Phase II project will develop an innovative process for hydrocarbon partial oxidation, which addresses these issues. In Phase I, technical and economic viability of the novel process was demonstrated. The Phase II project will focus on the intrinsic reaction kinetics, heat transfer, and mass transport. A continuous ethylene epoxidation process will be demonstrated at the bench-scale and small pilot-scale in novel, three-phase reactors. In addition, an engineering process design and cost analysis will be developed.

The commercial application from this project will be the heterogeneous hydrocarbon partial oxidation, if successful would greatly increase raw material and energy efficiency as well as increase process profitability in the chemical and petrochemical industries.

Title: SBIR Phase II: Novel Catalyst Substrate for the High and Low Temperature Water Gas Shift Reactor

Award Number: 0132126
Program Manager: Rosemarie D. Wesson

Start Date: March 1, 2002
Expires: February 29, 2004
Total Amount: $500,000
Investigator: Marco J. Castaldi, mcastaldi@precision-combustion.com
Company: Precision Combustion, Inc.
410 Sackett Point Road
North Haven, CT 06473-3106
Phone: (203)287-3700

Abstract:

This Small Business Innovation Research Phase II project seeks to develop a compact, lightweight, and low cost Microlith Water Gas Shift (WGS) reactor capable of rapid start-up, excellent transient response and high CO conversion efficiency with very low levels of methane formation. This technology offers a key low cost contribution to meeting objectives for efficiency and clean emissions. The Microlith based WGS reactor will be optimized by developing prototype reactor designs for fuel processor applications, and demonstrating predicted durability of up to 5000 hours.

Target customers and markets are fuel processor/fuel cell manufacturers developing and seeking to sell Proton Exchange Membrane (PEM) fuel cell products for stationary residential and distributed power, and for heavy duty vehicles in the short term, fuel processor/fuel cell manufacturers developing products for automotive markets in the long term and opportunistically, specialty chemical reactor applications (e.g. for hydrogen and syngas production and in ammonia synthesis) where the technology's size and performance.

Title: SBIR Phase II: Catalyst for Near-Zero NOx Emissions from Natural Gas Fired Power Plants

Award Number: 0109554
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2001
Expires: July 31, 2003
Total Amount: $499,900

Investigator: Joseph A. Rossin, Jarossin@GuildAssociates.com
Company: Guild Associates Inc
5750 Shier-Rings Road
Dublin, OH 43016-1234
Phone: (614)798-8215

Abstract:

This Small Business Innovative Research (SBIR) Phase II project involves the development of a catalyst to control NOx emissions from combined cycle power plants using natural gas fired turbines (natural gas fired power plants). During the Phase I effort, Guild Associates developed an environmental catalyst for the control of NOx emissions using NH3. Operating in the presence of excess (about 20-33%) NH3, the catalyst was able to achieve greater than 95% NOx reduction without NH3 slip. NH3 slip is avoided because the catalyst is able to simultaneously reduce the excess NH3 to N2 and H2O. The objective of this project is to modify the catalyst developed during the Phase I effort in order to enhance its commercial viability. Enhancing the commercial viability will involve increasing the reactivity of the catalyst and eliminating platinum metals from the formulation. Enhancing the reactivity will allow the catalyst to operate at higher space velocities. Eliminating platinum metals from the formulation will greatly reduce the cost of the catalyst. Successful completion of this effort will result in a simple, low cost technology for control of NOx emissions from natural gas fired power plants without NH3 slip.

Potential Commercial Applications include the control of NOx emissions from natural gas fired power plants. Other commercial applications include controlling NOx emissions from semiconductor manufacturing, fine and specialty chemical manufacturing and nitric acid manufacturing processes.

Title: SBIR Phase II: Combinatorial Synthesis of Electrocatalysts for Ozone Production

Award Number: 0091446
Program Manager: Rosemarie D. Wesson

Start Date: February 1, 2001
Expires: January 31, 2004
Total Amount: $500,000

Investigator: Charles L. Tennakoon charles.tennakoon@lynntech.com
Company: Lynntech, Inc
7610 Eastmark Drive, Suite 202
College Station, TX 77840-4024
Phone: (979)693-0017

Abstract:

This Small Business Innovation Research (SBIR) Phase II project describes an innovative combinatorial approach to the discovery of new electrocatalysts for electrochemical ozone generation. Ozone is increasingly being used in water treatment, as a sanitizing agent in the food industry and is preferred over chlorine and its derivatives. Electrochemical ozone generation, where ozone is generated by electrolysis of water, can potentially offer several cost and process advantages over the conventional electrical discharge methods of ozone generation. However, existing methods for generating ozone electrochemically use electrodes, which offer low Faradaic (i.e., current) efficiencies and have limited materials stability. In Phase I, ozone electrocatalysts were screened using a combinatorial approach, and two novel electrocatalysts for ozone formation were identified. A new rapid screening approach was also devised and will be used to evaluate focused combinatorial arrays in Phase II. Phase II will identify the precise stoichiometries of the new ozone electrocatalysts using the techniques pioneered in Phase I. The catalysts will then be synthesized on a macro scale and evaluated in ozone cells using existing ozone electrocatalysts as a benchmark.

The catalysts identified during this project will enable a more cost-effective generation of ozone with applications in municipal water treatment, point-of-entry and point-of-use water treatment, food sanitation, medical waste treatment and medical sterilization. Ozone could also be utilized in the chemical industry as a replacement for chlorine in a variety of processes, e.g. paper and pulp bleaching.

Title: SBIR Phase II: Bimetallic Oxygen Reduction Catalysts for Proton Exchange Membrane Fuel Cells

Award Number: 0110419
Program Manager: Cheryl F. Albus

Start Date: August 1, 2001
Expires: July 31, 2004
Total Amount: $400,000
Investigator: Devon J. Renock, drenock@tjtechnologies.com
Company: T/J Technologies, Inc
PO Box 2150
Ann Arbor, MI 48106-2150
Phone: (313)213-1637

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop platinum-transition metal alloy catalysts that are supported on high area carbon for oxygen cathodes in proton exchange membrane fuel cells. The Phase II project will build on the success of Phase I by optimizing the alloy composition and particle size of supported Platinum (Pt) alloy catalysts for efficient oxygen reduction. Low temperature synthesis methods allow T/J Technologies to produce supported Pt alloys with minimal Pt aggregation. Alloy compositions that reduce the over potential toward oxygen reduction by >50 mV versus Pt alone and will be produced with particles sizes (3-5 nm) that maximize Pt utilization and oxygen reduction efficiency. Performance will be demonstrated in half-cell and full fuel cell experiments. Catalysts resulting from this project will enable PEM fuel cells to operate more efficiently.

The potential commercial applications from this project would be improved oxygen reduction catalysts for proton exchange membrane fuel cells for vehicle propulsion and kilowatt-scale off-grid electric power generation. These are potentially large markets with beneficial impacts on energy efficiency, international competitiveness, and emissions reductions.

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

Award Number: 0548636
Program Manager: Rosemarie Wesson

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

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

Abstract:

This Small Business Innovation Research (SBIR) Phase II project aims to develop a practical, cost-effective solid-acid catalyst alkylation technology, which will be an economically viable replacement for current alkylation processes, which use toxic liquid acids such as HF and H2SO4. The new technology will significantly reduce capital cost and operating expenses by using a novel multifunctional solid-acid catalyst that produces high-octane ultra-clean gasoline in a simple fixed-bed reactor. The multifunctional solid-acid catalyst significantly outperforms conventional solid-acid catalyst both in terms of catalyst activity and long-term stability. The octane number of the alkylate product obtained using this new catalyst is substantially higher than that obtained using a conventional solid-acid catalyst.

Fifty refineries in the US use hydrofluoric acid (HF) in their alkylation units. The new "green" iso-paraffin alkylation technology is an economically viable alternative to HF catalyzed processes, which would eliminate such risks posed by toxic liquid acids. The multifunctional catalyst promises significantly improves yields and selectivities, minimizing waste by-products and disposal problems associated with liquid acids, and reduces CO2 emissions.

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: 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: 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.

Photo/Electrochemical Applications

Title: SBIR Phase II: Electrochemical Chlorine Purification

Award Number: 0091596
Program Manager: T. James Rudd

Start Date: January 15, 2001
Expires: July 31, 2003
Total Amount: $499,999

Investigator: Srinivasan Sarangapani, icetinc@attglobal.net
Company: ICET Inc
916 Pleasant Street
Norwood, MA 02062-4640
Phone: (781)769-6064

Abstract:

This Small Business Innovative Research Phase II project will further the development of the electrochemical chlorine purification process and conduct a pilot trial with a 0.5 square meter cell at a chlor-alkali plant. During the Phase I phase, densities as high as 0.5 A/cm2 (at room temperature) were demonstrated for this process, with a potential of less than 300 mV at the highest current density. A pilot scale MP-cell with 100 cm2-electrode area was successfully demonstrated to purify chlorine in the flow through electrode mode using anion exchange membranes. Chlorine purity at the outlet was 100%. A complete mass balance was carried out for the chlorine gas and the chloride ion. The objectives of the Phase II program include (a) study and understanding of the mechanism of chlorine reduction in concentrated hydrochloric acid, (b) investigation of catalysis of both the chloride oxidation and chlorine reduction processes in concentrated HCl, (c) building a 0.5 square meter pilot cell, and (d) conducting field trials in a chlor-alkali plant with the pilot cell. At the end of Phase II, a detailed economic analysis would have been completed to enable commercialization efforts.

The world chlor-alkali industry is projected to grow from the current production capacity of 42.1 million tons to 49 million metric tons in the year 2002. The total amount of tail gas to be processed is 562 million dollars through the year 2007 for a technology that replaces third stage liquefaction. The market for the second stage liquefaction is approximately 1.7 billion dollars. The U. S. market size for a low cost, energy efficient technology such as electrochemical purification is approximately 160 million dollars through 2007.

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.

Title: SBIR Phase II: An Economical Continuous Metal Coating Method for Electronic and Other Applications

Award Number: 0078622
Program Manager: T. James Rudd

Start Date: August 1, 2000
Expires: July 31, 2002
Total Amount: $400,000
Investigator: Mandar Sunthankar, mandar@ionedge.com
Company: IonEdge Corporation
513 B N. Link Lane
Fort Collins, CO 80524
Phone: (970)491-9942

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will conduct research to develop a new approach to coating metals continuously and rapidly on large areas of moving substrates. Currently, these types of coatings are electrochemically plated resulting in higher operating costs due to environmental regulations in the U.S. This has added to the declining share of the world market for the U.S. electronic metal-coating industry. Consequently, the Phase I results on the technique have generated interest in the commercial sector and a prototype demonstration is needed for the identified customers. The proposed method is suitable for coating conductive as well as nonconductive substrates, and rigid as well as flexible substrates. In this Phase II project, a prototype will be developed for continuously coating nonconductive substrates used in electronic applications. Then metal coatings will be deposited at a rate better than that of the conventional methods. Further research will be conducted to meet customer's expectations of the coating quality and process economics. In addition, process repeatability will be assured by running the equipment for the identified customers. Finally, the coating price will be determined and a cost benefit analysis will be performed.

The proposed method has the potential to reduce operating costs in the intended coating operations substantially. Copper, nickel and other metal coatings are widely plated on nonconductive substrates in several electronic and automotive applications. Typical application include EMI/RFI shielding in cellular phones, conductor lines in printed wiring boards used in computers and flat panel displays, and decorative trims in automobiles. The method to be developed could provide a lower-cost alternative to the conventional methods in use today and make the US. coating industry more competitive in the international market.

Title: SBIR Phase II: Dynamic, Variable Area, Rechargeable Zinc-Air Fuel Cells as Small Power Sources for Cold Regions

Award Number: 9983433
Program Manager: Winslow L. Sargeant

Start Date: June 1, 2000
Expires: May 31, 2002
Total Amount: $391,325
Investigator: Tsepin Tsai, tsai@reveo.com
Company: Reveo Incorporated
3 Westchester Plaza
Elmsford, NY 10523
Phone: (914)345-9555

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will develop a zinc-air fuel cell for replacement of internal combustion engines in polar and other cold climates. Phase I examined the electrochemistry of the zinc-air fuel cell's anode, cathode, electrolyte, and system designs to identify and optimize critical low-temperature performance characteristics. This power source has inherently high energy- and power-density as well as exceptional reliability at start-up temperatures as low as -40 degrees Centigrade. Phase II will develop 500-watt prototypes, capable of internal and external recharging, for low-temperature, low-maintenance remote use.

Potential commercial applications include portable rechargeable power supplies, materials handling equipment, personal mobility vehicles, and cellular telephones operated in polar and other cold regions.

Title: SBIR Phase II: Improved Electrodes for Capacitive Deionization for Purifying Ocean/Well Water

Award Number: 0216299
Program Manager: Rosemarie D. Wesson

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

Investigator: Steven D. Dietz, sdietz@tda.com
Company: TDA Research, Inc
12345 West 52nd Avenue
Wheat Ridge, CO 80033-1917
Phone: (303)940-2301

Abstract:

This Small Business Innovation Research (SBIR) Phase II Project will develop improved monolithic carbon electrodes for capacitive deionization. Capacitive deionization technology (CDT) is a new method for purifying ocean and brackish well water. In this process, a constant voltage is applied between two porous carbon electrodes, and soluble salts are collected on their surface, thus purifying the water. The operating costs of CDT are roughly half those of reverse osmosis, the current system of choice.

Obtaining a reliable and plentiful supply of clean water is becoming a worldwide problem. From this work, society (both in the U.S. and worldwide) will benefit from an inexpensive method of producing potable water from large existing reserves of brackish (saline) water. Inexpensive mesoporous carbon electrodes could also be used in capacitive deionization for industrial processes such as boiler feed, as well as in electrical energy storage, such as in capacitive energy storage.

Title: SBIR Phase II: Electrochemical Disinfectant Generator for Multiple In-Situ Applications

Award Number: 0239197
Program Manager: Rosemarie D. Wesson

Start Date: February 1, 2003
Expires: January 31, 2005
Total Amount: $499,979

Investigator: Charles L. Tennakoon, charles.tennakoon@lynntech.com
Company: Lynntech, Inc
7610 Eastmark Drive, Suite 202
College Station, TX 77840-4024
Phone: (979)693-0017

Abstract:

This Small Business Research (SBIR) Phase II project is concerned with the development and commercialization of electrochemically operated devices that will revolutionize the disinfectant industry by providing on-site, on-demand generation of extremely potent dual disinfectants. Peroxyacids are well known disinfectants that remove even resistant microorganisms (i.e. spores) by attacking S-S and S-H bonds on cell walls. The conventional method of manufacturing peroxy acids involves mixing concentrated hydrogen peroxide, an organic acid, and a catalyst (usually concentrated sulfuric acid), and involves the transportation and storage of hazardous chemicals. During the Phase I, the feasibility of a novel approach for the generation of the dual disinfectant was amply demonstrated. In this process, reactants for converting organic acids to dual disinfectants are generated within the device, avoiding problems associated with storage. All the criteria of success specified have been successfully accomplished and a well-known industrial partner has shown a keen interest in commercializing the novel devices. In Phase II, further optimization of the electrochemical devices will be followed by fabrication of prototypes of three devices for demonstrating their efficacy for a variety of disinfection applications.

There is a considerable need for devices that produce potent disinfectants that are biocidal against a broad spectrum of microbes including spores and viruses. These devices that produce potent disinfectants on-demand have commercial potential in domestic health care and food service establishments as well as in infection control applications in hospitals and nursing homes. It is estimated that revenues of the entire cleaning/sanitizing industry will be $31 billion in 2007.

Separations Technology

Title: SBIR Phase II: Novel Facilitated Transport Membranes for Olefin Separations

Award Number: 0110193
Program Manager: Rosemarie D. Wesson

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

Investigator: Tim C. Merkel, tcmerkel@mtrinc.com
Company: Membrane Tech & Res Inc
1360 Willow Road Suite 103
Menlo Park, CA 94025-1516
Phone: (415)328-2228

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on olefin/paraffin separations. In the USA, ethylene and propylene are produced in larger quantities than any other organic chemical. Currently, olefin/paraffin separation is done by distillation, an extremely energy-intensive process because of their low relative volatility. Selectivities of polymeric membranes are inadequate for these separations, but selectivities of facilitated transport membranes are higher. However, membrane instability, low gas fluxes, and a required water-saturated feed limit their industrial application. To overcome these problems a new type of facilitated transport membrane is being developed. The membrane has high gas fluxes, dramatically improved olefin/paraffin selectivities over conventional facilitated transport membranes, operates with a dry feed, and is stable for several weeks.

The commercial applications from this project will be membranes that will significantly lower cost and energy consumption of industrial olefin/paraffin separations. Other applications include by product/vent gas streams in polyethylene/polypropylene, cumene, isopropanol and acrylonitrile plants. Subsequent applications are propylene recovery from FCCU off-gas and from large processes (propane dehydrogenation and steam crackers).

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 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 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 multifunctionality, 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: 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.

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: Investigation of Novel, Low-Cost Materials and Manufacturing Methods for Polymer Electrolyte Membrane (PEM) Fuel Cell Bipolar Plates

Award Number: 9983456
Program Manager: Rosemarie D. Wesson

Start Date: May 15, 2000
Expires: April 30, 2002
Total Amount: $399,924
Investigator: Holly Grammer, hgrammer@vt.edu
Company: Directed Technologies, Inc.
3601Wilson Blvd., Ste 650
Arlington, VA 22201
Phone: (703)243-3383

Abstract:

This Small Business Innovation Research Phase II project will continue the development of inherently low cost, mass-producable conductive composite materials and novel manufacturing processes for Polymer Electrolyte Membrane (PEM, also called Proton Exchange Membrane) fuel cells. Current PEM fuel cell bipolar plates often achieve good overall technical performance, but have some combination of high materials, manufacturing and assembly cost. This high cost is a barrier to market penetration of fuel cells. In order to develop a fuel cellbipolar plate which has acceptable technical performance, as well as, low cost, novel composite materials amenable to low cost manufacture will be developed. Three novel manufacturing processes identified during Phase I will be used to fabricate small and large format bipolar plates from composite materials identified in Phase I. These bipolar plates will be tested for electrical conductivity and will be operated in both short-term, performance-oriented testing and longer-term, lifetime testing. Additionally, the materials development work of Phase I will be continued in order to further optimize the novel composite materials for performance and cost.

Successful completion of the project will lead to low cost, mass-manufacturable fuel cell stacks, thereby enhancing U.S. competitiveness in the emerging markets for fuel cells. This will further lead to a greatly accelerated market penetration of fuel cells especially in low cost applications such as light duty vehicles

Title: SBIR Phase II: Carbon Nano Composite Filtration Media

Award Number: 0078865
Program Manager: T. James Rudd

Start Date: September 15, 2000
Expires: August 31, 2002
Total Amount: $400,000
Investigator: Stephen Jaffe, smjaffe@materialmethods.com
Company: Material Methods
21571 Via Del Angel
Lake Forest, CA 92630
Phone: (949)707-1829

Abstract:

This Small Business Innovation Research Phase II project will make self-assembled, nanocomposite building blocks, composed of carbon nanotubes on a macroscopic support. Phase I demonstrated the growth of high quality, long nanotubes, adhered to a metal mesh. The support catalyzes the growth of a dispersed uniform structure of sootfree nanotubes. Additional processing is not required. Traditional manufacturing processes can convert the composite into filters, electrodes, and structures that transport mass, charge, and stress on nanometer scales. The nanotubes remain organized and connected electrically and mechanically. Intimate solid-gas and solid-liquid contact accompanied by high transport rates result. Unlike porous nanoscale media, the pore size can be independent of the nanotube diameter, allowing rapid access to their surface.

The Phase II product will be microfiltration media with unprecedented filtration efficiency and low energy cost. Carbon nanotubes have enhanced single-collector efficiencies and substantially high surface to volume ratios. These advantages produce enormous, pound-for-pound value. The industrial partner has committed Phase III funding based on initial testing and market pull for low-energy, cost-effective separation technology. The industrial partner is committed to nanoscale technologies and the tremendous physical properties of the supported nanocomposites.

Title: SBIR Phase II: Surface Enhanced Dry Magnetic Separation

Award Number: 9983422
Program Manager: Rosemarie D. Wesson

Start Date: May 1, 2000
Expires: January 31, 2003
Total Amount: $399,995
Investigator: Robin Oder, roder@magneticseparation.com
Company: EXPORTech Company Inc
P.O. Box 588
New Kensington, PA 15068
Phone: (412)337-4415

Abstract:

This Small Business Innovation Research Phase II project will apply the ElectriMag (tm) concept to separation of unburned carbon from coal combustion fly ash. A proprietary add-on reactor will be tested for separation of ammonia from fly ash particles at plants using catalytic nitrogen oxide separators. The ElectriMag (tm) separator (patent pending) combines triboelectric forces with magnetic forces to allow the separation of particles which have similar magnetic properties but differing surface electrical charging characteristics, or vice versa. An alpha prototype built and tested in Phase I showed the feasibility of the concept. A beta prototype will be designed, built, and tested on fly ash from coal fired power plants in Phase II; this model will incorporate changes suggested by the work of Phase I. A conceptual level engineering evaluation will be done and a conceptual design of a 2000 Lb/Hr pilot unit will be made.

Potential commercial applications include separation of unburned carbon from fly ash, recovery of activated carbon from municipal incinerator fly ash, and dry coal cleaning.

Title: SBIR Phase II: Membrane Hydrogen Dissolution for Bioremediation of High Strength Nitrate Waste

Award Number: 9983421
Program Manager: Om P. Sahai

Start Date: June 1, 2000
Expires: December 31, 2004
Total Amount: $411,500

Investigator: Stuart Nemser, snemser@compactmembrane.com
Company: Compact Membrane Systems, Inc.
325 Water Street
Wilmington, DE 19804
Phone: (302)999-7996

Abstract:

This Small Business Innovation Research Phase II project will expand the Phase I study, examine the effect of high nitrate loading and demonstrate the technology at a drinking water treatment site, by treating the brine regenerant stream from an ion exchange water treatment system. This would broaden utilization base of the technology and allow increased market penetration since the technology will supplement the existing technology base and reduce the operating costs of the currently practiced technologies for NO3 removal. This will lead to both high probability of commercial success plus a large sales base to allow for lower pricing in remediation markets. Across the United States there are a number of drinking water facilities that are wrestling with the problem of high concentrations of dissolved nitrates in their influent water streams. The present methods of removal resort to concentrating the NO3 into a small volume by means of reverse osmosis or ion exchange and then disposing off this concentrated stream, appropriately. The recovered NO3 in such a waste stream can be destroyed biologically using dissolved hydrogen gas as the electron donor. Hydrogen offers several economic and operational advantages over other organic electron donors in denitrification. The factor limiting hydrogen use is its low solubility, i.e. existing commercial gas-dissolution technologies cannot dissolve sufficient hydrogen in a safe, cost effective manner. Membrane-based gas-dissolution technologies can potentially supply the hydrogen required for these processes safely, but commercially available membrane suitable for bubble-free gas-dissolution have poor performance, biological fouling, or both.

Compact Membrane Systems, Inc., has developed a highly gas permeable perfluoropolymer coating for microporous membranes. The smooth, non-porous nature of the perfluoropolymer coating is highly resistant to biological fouling, especially compared to microporous hydrophobic membranes. This coating could remove the performance, fouling, and cost barriers that preclude the use of membrane-based gas dissolution technologies in continuous biological processes. The Phase I study established concept feasibility and demonstrated that nitrates could effectively remediate without the formation of nitrites in a continuous mode.

Title: SBIR Phase II: Chemically Resistant Gas Separation Perfluoromembranes

Award Number: 0078470
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2000
Expires: July 31, 2004
Total Amount: $686,048
Investigator: John Bowser, jbowser@compactmembrane.com
Company: Compact Membrane Systems, Inc.
325 Water Street
Wilmington, DE 19804
Phone: (302)999-7996

Abstract:

This Small Business Innovative Research Phase II project will optimize and scale up the system developed in Phase I (a nonporous perfluoromembrane system for harsh gas separations). These nonporous perfluoromembrane systems provide industry for the first time with a system (membrane module, glue lines, potting, valves, etc.) that has good gas transport rates and separation capabilities composed totally of perfluorocomponents. In Phase I, laboratory testing and economic evaluations showed these membranes could economically remove hydrogen, carbon dioxide, and key non-condensable gases from chlor-alkali tail gases and in so doing dramatically enhance the recovery of chlorine. Analysis comparing the Compact Membrane Systems, Inc. (CMS) technology to alternative membrane and other unit operations (e.g. absorption) technologies, indicated the CMS technology is significantly superior. Large sheet nonporous perfluoromembrane fabrication has been demonstrated in Phase I. All the key components are in place for large scale module fabrication in Phase II. In Phase II we will optimize and scale up the system. Detailed and representative (-20oC) end use testing and long term testing will be conducted in the laboratory prior to field testing. While the focus of this program is chlor-alkali harsh chemical separations, other harsh chemical processes (e.g. fluorochemical synthesis) will be considered.

A close working relationship with a number of large membrane manufacturers and end users allows us to rapidly and effectively drive this program. Phase I testing was done using both single gas testing and mixed gas testing. Materials evaluated include chlorine, Cl2CF2, SF6, hydrogen, oxygen, nitrogen, carbon dioxide, and helium. Results showed mixed gas results were equal or superior to single gas results. This suggests that minimal plasticization or other anomalies are occurring within the system. This would suggest we can project actual end use performance accurately.

Title: SBIR Phase II: Fabrication of Low-Cost Modules Incorporating Microporous Silica Membranes for Natural Gas Purification

Award Number: 0078474
Program Manager: Rosemarie D. Wesson

Start Date: August 1, 2000
Expires: July 31, 2003
Total Amount: $400,000

Investigator: Richard Higgins, higgins@ceramem.com
Company: CeraMem Corporation
12 Clematis Avenue
Waltham, MA 02453
Phone: (617)899-4495

Abstract:

This Small Business Innovation Research Phase II project addresses development of economical membrane-based devices primarily suitable for: (a) purification of sub-quality raw natural gas to pipeline quality and (b) carbon dioxide recovery from enhanced oil recovery operations. A large fraction of domestic natural gas reserves are uneconomical for recovery based on current market conditions because they contain significant amounts of non-methane gas. Membrane-based devices are currently commercially employed to purify sub-quality natural gas, but membranes with improved productivity compared to now state-of-the-art devices are required to allow economic use of currently unrecoverable natural gas. The overall objective of this program is to develop an innovative fabrication approach to incorporate microporous silica membranes within low-cost, highly compact modules. Microporous silica membranes exhibit combinations of carbon dioxide permeance and CO2/CH4 selectivity that are unrivaled by conventional organic gas separation membranes, but have not yet been incorporated in low-cost modules to allow their commercialization. Commercial availability of such modules would greatly reduce costs associated with upgrading sub-quality natural gas reserves. In Phase I, the feasibility of the novel module fabrication approach was demonstrated. In Phase II, the separation properties of very small modules will be improved through systematic optimization of processing. Modules with ca. 0.1 m2 membrane area will be fabricated and tested for extended duration for separation of simulated raw natural gas, and a detailed manufacturing scheme with related costs will be developed in preparation for commercialization of the technology.

The devices to be developed in this program would significantly reduce costs associated with purification of gas streams in the following applications: natural gas upgrading, carbon dioxide recovery from enhanced oil recovery operations, and biogas processing.

Title: SBIR/STTR Phase II: Development of Stable Membrane-Based Gas-Liquid Contactors for SO2 Removal from Flue Gas

Award Number: 0078527
Program Manager: Om P. Sahai

Start Date: January 1, 2001
Expires: December 31, 2004
Total Amount: $403,656

Investigator: Sudipto Majumdar, sudipto.majumdar@compactmembrane.com
Company: Compact Membrane Systems, Inc.
325 Water Street
Wilmington, DE 19804
Phone: (302)999-7996

Abstract:

This Small Business Innovation Research Phase II project will demonstrate the enhanced performance of membrane-based gas-liquid contactors to abate SO2 emissions from flue gas. SO2 present in flue gas streams leads to deforestation and damage to crops and property as a result of its participation in the formation of acid rain. In Phase I, Compact Membrane Systems, Inc. (CMS) developed a nonporous perfluorocopolymer composite membrane designed for use in membrane-based gas liquid contactors to scrub flue gas of SO2 using an aqueous absorbent solution. This membrane is designed to overcome the major drawbacks of conventional microporous supports, i.e. progressive wetting out of the microporous substrate by the (typically) aqueous absorbent and in some instances salt precipitation at the liquid-gas interface. In addition to all the operational advantages of membrane contactors, CMS membranes result in sustained improved SO2 removal efficiencies. During Phase I it was demonstrated that this membrane permeated SO2, scrubbed a flue gas simulant gas stream of SO2 as well as if not better than a conventional microporous membrane contactor under identical conditions, and showed no loss in performance despite exposure to an acidified silica suspension. Phase II will scale-up the process to employ large pilot-scale contactors, study absorbent regeneration technologies, demonstrate the whole process on a pilot-scale combustor, and demonstrate that the CMS system offers better efficiencies and economics of flue gas removal compared to existing systems.

The enhanced performance of membrane-based gas-liquid contactors to abate SO2 emissions from flue gas is of considerable interest to ore processors, pulp and paper industries, many oil and natural gas processors (particularly those which have to treat tail gases from gas sweetening processes), power plants employing coal as a fossil fuel, etc.

Title: SBIR Phase II: Segmented Proton Exchange Membranes with Edge Seals for Compact Fuel Cell Electrode Structures

Award Number: 0239174
Program Manager: Rosemarie D. Wesson

Start Date: January 15, 2003
Expires: December 31, 2004
Total Amount: $499,926
Investigator: Robert C. McDonald, rmcdonald@ginerinc.com
Company: Giner EC Systems, LLC
89 Rumford Avenue
Newton, MA 02466-1311
Phone: (781)529-0500

Abstract:

This Small Business Innovative Research Phase II project will demonstrate practical and cost-effective designs for a high energy density Proton Exchange Membrane (PEM) Fuel Cell. The approach taken will utilize the treatment of membranes with Interpenetrating Polymer Networks (IPN), as demonstrated in Phase I, to create regions with enhanced strength and the desired ionic, reactant and water transport properties for a viable Segmented Fuel capable of operating with ambient diffused oxygen for portable applications. A systematic modeling procedure will be developed to generate optimal, thermally and hydraulically stable segmented fuel cell designs, with specific electrode arrays, given voltage, and power requirements. Size/weight trade-offs will be considered.

The work supports the effort to develop fuel cells for portable consumer and industrial power, which is safe, durable and energy efficient. PEM based fuel cells are a mature technology which takes advantage of very simple chemistry and the introduction of the GES IPN-improved membranes will permit designers greater flexibility in producing fuel cells which meet the needs for portable computers, tools, communication, medical and industrial equipment.

Title: SBIR Phase II: The ResonantSonic Enhanced Mixer and Coalescer (RSEMC) as an Advanced Solvent Extraction Technology

Award Number: 0321499
Program Manager: Rosemarie D. Wesson

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

Investigator: Joel Pierce, jpierce@resodyn.com
Company: Montec Research
1901 South Franklin
Butte, MT 59701
Phone: (406)723-2222

Abstract:

This Small Business Innovation Research Phase II (SBIR) project will develop and demonstrate a novel prototype solvent extraction (SX) device, which, by virtue of its highly uniform shear and mixing intensity, has the potential to supplant existing SX units in terms of extraction and phase separation rates. The technical approach of the Phase II project is as follows: Develop performance and scale-up principles for the SX device, optimize the hardware configuration and process conditions; 2.) Apply the results to the design of a reliable prototype SX system that demonstrates improved mass transfer and phase separation, and decreased entrainment at power consumption levels equivalent to existing equipment. The Phase I copper extraction work showed a 3-5 fold improvement in extraction and phase separation rates over existing mixer-settlers that are used in the minerals industry for the recovery of copper.

The commercial benefits of the ResonantSonic solvent extraction device to the minerals industry are reduced equipment size and footprint, reduced solvent loss, and improved electrowinning efficiency. Reducing the solvent loss to the environment has great societal benefit as losses can exceed 100,000 gallons per year per mine site. Other potential applications are metals separation, and the recovery of vitamins, antibiotics, and other pharmaceuticals

Title: SBIR Phase II: Concentration of Thermally Labile Solutes

Award Number: 0110267
Program Manager: Rosemarie D. Wesson

Start Date: July 15, 2001
Expires: June 30, 2004
Total Amount: $500,000

Investigator: John J. Bowser, jbowser@compactmembrane.com
Company: Compact Membrane Systems
325 Water Street
Wilmington, DE 19804-2410
Phone: (302)999-7996

Abstract:

This Small Business Innovation Research (SBIR) Phase II project will demonstrate in actual field tests the novel room temperature dewatering process. In the Phase I project, Compact Membrane Systems, Inc. (CMS) demonstrated a stable osmotic distillation (OD) process on orange juice, grape juice, and coffee. In typical applications, solids levels were increased from approximately 10% sugar to approximately 70% sugar. Taste tests showed no significant difference between original juice and re-diluted OD product. Process stability was demonstrated by obtaining equivalent product when operating temperature was increased to 40C and maintaining performance after multiple juice dewatering and cleaning cycles. Product stability was demonstrated by leaving OD juice concentrate open to air with no microbiological growth due to very low water activity in the juice concentrate. In the OD process the solution to be dewatered is placed on one side of the hydrophobic membrane and a high salinity feed is placed on the other side. Water vapor then moves from the solution to the high salinity side. While OD has been around for 15 years, no significant commercial products have been developed due to these hydrophobic microporous membranes rapidly wetting out. This project will demonstrate a novel, non-porous perfluoromembrane that eliminates wet-out while maintaining high water vapor transport.

Potential commercial applications include beverages, pharmaceuticals, neutraceuticals, and industrial chemicals.

Title: SBIR Phase II: Reactive Nanoparticles as Destructive Adsorbents

Award Number: 0091369
Program Manager: Rosemarie D. Wesson

Start Date: March 15, 2001
Expires: February 29, 2004
Total Amount: $499,995

Investigator: Kenneth J. Klabunde, kenjk@ksu.edu
Company: Nanoscale Materials, Inc.
1310 Research Park Dr.
Manhattan, KS 66502
Phone: (913)532-0179

Abstract:

This Small Business Innovation Research (SBIR) Phase II project focuses on the development and optimization of a continuous, easily scalable and economical synthesis of reactive nanoparticles (RNPs); characterization and control of physical and chemical properties of these materials; development of flexible synthesis approaches for production of complex nanoparticle metal oxides; and identification and establishment of quality control procedures. This effort is critically needed in order to develop commercially viable nanomaterials for applications in both civilian and military markets. As demonstrated during the Phase I research, nanomaterials, produced using the proprietary continuous process, possess the same chemical and physical properties as those prepared in a batchwise mode.

The research is broad and spans a number of significant markets including decontamination technologies for military and civilian applications, improved catalysts and catalytic supports, industrial gas scrubbing, and active ingredients for high efficiency air and water purification systems. Each of these market applications represents an initial subset of the market opportunities for these highly reactive nanomaterials.

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: 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.