

Indiana 21st Century Research & Technology Fund Round Six Awards

Joining of Refractory Materials: Carbon-Carbon Composites

425040717

Dr. Alexander Mukasyan
University of Notre Dame,
Notre Dame

Partners:

University of Notre Dame,
Notre Dame
Honeywell Aircraft Landing
Systems, South Bend
Action Machine, Inc., South Bend
Aloft, Berkeley, CA

21st Century Award: \$337,908.00
Total Budget: \$952,448.00

Summary:

The proposed research is aimed at solving fundamental problems in a joining of carbon-carbon composites. By studying interaction mechanisms between the refractory composites and high temperature reactive melts (e.g. non stoichiometric carbides and borides), which formed during combustion synthesis (CS) of exothermic powder mixtures, we plan to develop novel approaches for joining of such materials.

Along with such attractive features of combustion approach, as low energy consumption ("furnace-free" technology), short process duration (~seconds) and low cost equipment, in the case of materials joining the suggested method leads to the additional advantages. First, the liquid intermediate CS product (e.g. non-stoichiometric metal carbides) interacts with solid refractory materials (e.g. carbon-carbon composite) under extremely high combustion temperature (>3000 C) and forms physically and chemically bonded junctions. Thus the combustion reaction plays role of a heat source and also provides reactive additives. Second, the final joint is also refractory material (e.g. TiC, m.p. ~3320 K), which especially important for high intermediate temperature applications (e.g. aircraft brakes). Third, CS gives unique opportunities to produce functionally graded structures. The latter feature is critical in solving the problem of mismatches between coefficients of thermal expansion for the weld and the joined materials. Finally, this method allows joining of rough surfaces, i.e. does not require careful joining surface preparation.

Besides well-recognized fundamental value the proposed program will directly strengthen the competitive market position of Indiana's industry. Key to the immediate commercialization of this new carbon joining technology is our team member, Honeywell Aircraft Landing Systems (South Bend, IN). This technology will allow Honeywell to pair functionally optimized composite materials for optimum cost to performance relationship.

A substantial economic growth in Northern Indiana would be created representing approximately \$4.8 billion per year in sales. Our conservative estimate is that approximately 1,400 jobs would be needed at Honeywell in South Bend Indiana to support the friction material business opportunities and that approximately \$55M to \$85M per year in salary and tax base would be created.

Biologically Enhanced Self- Lubricating Bearing Materials for Total Joint Implants

427040723

Dr. Herb Schwartz
Schwartz Biomedical, LLC,
Fort Wayne

Partners:

Schwartz Biomedical, LLC,
Fort Wayne
DePuy Orthopaedics, Inc., Warsaw
Colorado State University,
Fort Collins, CO
Northeast Indiana Innovation
Center, Fort Wayne

21st Century Award: \$1,273,778.00
Total Budget: \$2,088,647.00

Summary:

Given the ongoing active lifestyle of the aging population, total joint replacement (TJR) demographics are trending toward younger patients. However, orthopaedic surgeons are extremely reluctant to perform TJR in these younger patients because of limited longevity of the artificial joints. Since the polymer component of total joints is the element that experiences wear, technologies that address reducing wear and, thus, increasing joint longevity, are key to the long-term success of artificial joints, especially in younger patients. This proposal is aimed at developing a biological enhancement of the standard polymer component (ultra-high molecular weight polyethylene or UHMWPE). The biological enhancement is accomplished by chemically combining UHMWPE with a naturally occurring lubricating molecule found in normal joints. Therefore, this new material, Bio-Poly™, is a self-lubricated total joint bearing material with better wear properties than current state-of-the-art materials. Bio-Poly™ will increase market share while expanding the market to the younger patient population; therefore, it will increase revenues and headcount to Indiana orthopaedic companies such as DePuy (Warsaw, IN). The long-term collaboration that this work initiates between three Indiana institutions and an out-of-state University has the potential to not only transfer this technology and subsequent revenue into Indiana, but it also creates a conduit through which other technologies can transfer.

Indiana 21st Century Research & Technology Fund Round Six Awards

Development of Vaccines in Microalgae

428040728

Dr. Richard Wagner
Phycotransgenics, L.L.C.,
Bloomington

Partners:

Phycotransgenics, L.L.C.,
Bloomington
Purdue University, West Lafayette
Indiana University, Bloomington

21st Century Award: \$1,818,855.00
Total Budget: \$4,000,000.00

Summary:

The world food economy is being increasingly driven by the shift in diets and food consumption patterns toward meat products. Along with the increase in meat consumption and demand has been an increasing shift from small-scale and less intensive (pasture feeding) to large-scale intensive commercial operations due to increasing demand on land availability as well as economies of scale. A consequence of intensive production is the increased risk of the spread of infectious diseases. Pathogens spread rapidly in intensive systems causing high mortalities, elevated pathogen levels in the environment, and problems associated with disposal of carcasses. The globalization of trade has increased the potential for new diseases to emerge or previously controlled diseases to reemerge. The continued need for research to address the complex interactions of disease factors, to develop and improve methods for the rapid diagnosis and to control disease is of paramount importance to agriculture industry as it transcends into the 21st century. It is also of paramount importance to human health; intensive systems enable faster evolution and selection of virulent pathogen strains capable of crossing the host-species barrier. Recent examples include SARS and avian influenza viruses that spread from poultry to humans.

Respiratory diseases are a major cause of mortality in the poultry industry. The impetus to raise wholesome food products with limited use of antimicrobial agents has provided new challenges to poultry producers. Vaccination provides an effective, low risk means. However, conventional vaccination using modified live organisms and needles is not practical and safe in large-scale poultry operations. The primary goal of our 21st Century Grant Proposal is to develop microalgal-based oral vaccine(s) for the prevention of infectious diseases in poultry. Our strategy is to use transgenic microalgae to present antigens in drinking water and/or feed to chickens for the control of specific pathogens. Candidate antigens include the VP2 gene of infectious bursal disease virus (IBDV), hemagglutinin and nucleoprotein genes of avian influenza virus, and spike and nucleocapsid genes of turkey coronavirus. Additional genes and host species will be pursued after the establishment of the overall system in poultry. These include: hemagglutinin-neuraminidase and/or fusion protein gene for Newcastle disease of poultry, the protective genes for porcine reproductive and respiratory syndrome virus (PRRSV), antigen 85 and fibronectin-attachment protein (FAP) genes of *Mycobacterium avium* subsp. *paratuberculosis* affecting dairy cattle, and fish pathogens such as *Renibacterium salmoninarum*.

Indiana 21st Century Research & Technology Fund Round Six Awards

Advanced Substrate Design for High-Frequency Systems in a Package

502040736

Dr. William Chappell
Purdue University, West Lafayette

Partners:

Purdue University, West Lafayette
Delphi Electronics and Safety,
Kokomo
CTS Microelectronics,
West Lafayette
Omega Wireless Solutions,
West Lafayette
Nexaura Systems, LLC, Indianapolis
Dupont Microcircuit Materials,
Triangle Park, NC

21st Century Award: \$1,666,249.00

Total Budget: \$9,292,659.00

Summary:

This project is for the commercialization of high frequency, vertically integrated circuits to create ultra-small, low power radios, specifically for the next generation of automotive radios such as satellite radio and communication receivers. The ability to design in three-dimensions relative to the standard two-dimensional PC board approach allows for much more compact, yet better performing communication devices. The ability to create these radios integrated inside of a layer by layer package will maintain Indiana's dominance in the automotive radio market as well as expand the recent developments in broadband mobile services such as satellite radio to newer services. Enabling the automobile as a hub of communication is only possible through the development of multifunctional radios which requires enhancement in the underlying circuit and packaging hardware. The ability to embed many of the functions of the radio internal to the packaging and to design in three-dimensions will provide the necessary enhancements to enable the next generation of high frequency products and allow Indiana to capitalize on the next wave of automotive products such as high frequency automotive radar and satellite TV. High quality embedded components, low loss yet high isolation vertical transitions, ceramic materials development, component characterization, and design library formation are all aspects of research needed to facilitate the next generation of radio products which utilize the advanced packaging concepts.

Silicon Carbide Electronic Devices for Automotive Systems

503040742

Dr. Michael Capano
Purdue University, West Lafayette

Partners:

Purdue University, West Lafayette
Delphi Electronics and Safety,
Kokomo

21st Century Award: \$1,097,873.00

Total Budget: \$8,449,701.00

Summary:

This proposal presents an opportunity to bring together two elements of a new and potentially revolutionary technology that can significantly impact the automotive electronics industry in the state of Indiana. These elements have existed side-by-side in our state for years, but have not interacted until now. The elements are (i) the technical expertise in developing robust electronics for harsh environments, and (ii) the vast commercial markets for robust electronics intended for future automotive products. The technical expertise in robust electronics refers to the expertise in design and fabrication of electronic components made from silicon carbide (SiC), a revolutionary new semiconductor that is superior to silicon in many respects. This expertise resides in the SiC development group at Purdue University in West Lafayette. The vast commercial markets refer to the large markets for robust electronics represented by the automotive industry, exemplified by Delphi Electronics and Safety (DES) in Kokomo.

Indiana 21st Century funds will be used by Delphi and Purdue to conduct a collaborative study into the feasibility of adapting conventional silicon processing equipment to the high-volume fabrication of SiC electronic components for the automotive industry. An existing silicon processing line at Delphi Electronics in Kokomo will be used for this study. The physical proximity of the SiC experts at Purdue and the silicon processing experts at Delphi give Indiana a unique opportunity to bring this technology to market. SiC electronics technology would give Delphi a competitive advantage in the large potential market for electronics that can function in harsh environments, creating new products, and new jobs in Indiana.

Indiana 21st Century Research & Technology Fund Round Six Awards

Direct Structural Health Monitoring of a Blast Furnace Refractory Using Novel Acoustical Technology

504040747

Dr. Yulian Kin
Purdue University Calumet,
Hammond

Partners:

Purdue University Calumet,
Hammond
Stevens Institute of Technology,
Hoboken, NJ
University of Illinois, Chicago, IL
Ispat Inland Inc., East Chicago
US Steel, Gary
Los Alamos National Laboratory,
Los Alamos, NM
Indiana Industries of the Future,
Indianapolis

21st Century Award: \$692,199.00
Total Budget: \$2,851,820.00

Summary:

The U.S. steel industry produces over 100 million tons of steel annually. The blast furnace that converts iron ore to molten iron is an important component in these facilities. The goal of the work is to develop a novel acoustic technology for blast furnace refractory structural health monitoring and provide reliable data for the CFD code. The project will be in direct coordination with the currently funded project by 21st Century Research & Technology Fund (PI: Dr. Zhou of PUC) for the development of CFD code. Currently, there are no methods providing direct structural health monitoring of blast furnace refractory. The objective of this project is to develop a state-of-the-art acoustic method to evaluate blast furnace wall thickness, assess erosion and estimate damage accumulation in the furnace wall. The results of acoustic measurements will be used for inner wall profile assessment, CFD optimization, development of blast furnace lifetime prediction model and modification of preventive maintenance. The project will lay a solid foundation to develop a long-term R&D steel program as well as to expand applications to other industries.

Principal Outcome:

The final products of this project are expected to include a state-of-the-art acoustic technology for direct structural health monitoring of blast furnace refractory. This technology will include detailed procedures, developed sensors, instrumentation and appropriate software.

Center of Excellence for Computational Diagnostics

506040768

Dr. Susanne Ragg
IUPUI, Indianapolis

Partners:

IUPUI, Indianapolis
Indiana University, Bloomington
University of Bielefeld,
Bielefeld, Germany
Technical University of Munich,
Munich, Germany

21st Century Award: \$1,994,091.00
Total Budget: \$5,177,028.00

Summary:

High throughput technologies are rapidly changing the medical field. For Indiana University to remain competitive for research funding, these technologies must be integrated into clinical research at the School of Medicine. The goal of this project is to establish Indiana University as a premier computational medical diagnostic institution by creating a Center of Excellence for Computational Diagnostics. This Center will unite a unique set of existing local expertise in evidence-based medicine, medical informatics, proteomics, database integration, mathematical modeling, and data visualization to produce a fully integrated service with initial applications in diagnosis and therapy of cardiac disease and cancer. The Center will replace the need for individual researchers to piece together their own collaborations with researchers in fields far outside of their own, resulting in application-driven development of new technologies, more efficient use of resources, and increased competitiveness for grant support. The Center will improve cost efficiency of resources such as NIH funding, improve research quality, and improve communication across diverse disciplines. In addition, the services of the Center could be marketed to the pharmaceutical industry and outside investigators. Technologies developed by the Center will be commercialized after market analysis. Thus, the Center of Excellence for Computational Diagnostics will strengthen Indiana's position as a life sciences leader.

Indiana 21st Century Research & Technology Fund Round Six Awards

AMS Center for Biomedical Excellence

507040770

Dr. Marc Caffee
Purdue University, West Lafayette

Partners:

Purdue University, West Lafayette
Bioanalytical Systems, Inc.
West Lafayette
Cook Biotech, Inc., West Lafayette
Eli Lilly and Company, Indianapolis

21st Century Award: \$382,700.00
Total Budget: \$850,351.00

Summary:

The goal of this project is to further develop a unique Purdue University scientific facility known as the Purdue Rare Isotope Measurement Laboratory (PRIME Lab). These enhancements would enable Indiana institutions to perform cutting edge life sciences research. The realization of this goal requires two elements: 1) increasing the sample throughput and decreasing the waiting time for a measurement; and 2) a concerted effort to increase awareness and access to this powerful analytical technique for Indiana institutions.

Accelerator-mass-spectrometry (AMS) is an ultra-sensitive analytical technique for measuring rare nuclides. Using AMS techniques single atoms can be counted in the presence of 10¹⁵ atoms of a neighboring isotope. This powerful technique enables life science investigations to be carried out with physiologically safe and relevant doses for the lifetime of the subject. Possible studies include ADME (absorption, distribution, metabolism, and excretion), pharmacokinetics, and long-term nutritional studies. PRIME Lab has already made measurements for the Purdue/University of Alabama at Birmingham NIH Botanicals Center, Cook Biotech, Eli Lilly, the Fort Wayne State Developmental Center, and investigators at Purdue University. A persistent problem with these investigations though is the cost and perhaps more importantly, the time involved in performing a study that utilizes AMS measurements. While these issues are of concern in all scientific investigations they are key issues for private companies desiring to develop techniques or products for the commercial market place. Increasing the sample throughput capacity and reducing the time between submission of a sample and delivery of results, i.e. the turn-around time, will absolutely alleviate these concerns. We believe these 21st Century Funds will allow us to triple our productivity. Having realized this productivity improvement we will embark on an extensive campaign to educate the life science community of Indiana, making them aware of the potential of this facility and the unique capabilities. We plan to conduct an extensive outreach program for educational purposes. Furthermore, we will catalyze future collaborations by instituting a pilot grant program that will make gratis preliminary measurements available for Indiana entities. This expanded role of AMS in the life sciences will increase the leverage of Indiana researchers in their pursuit of NIH funding. Furthermore, local industry will be able to take full advantage of this resource. This analytical service will bring business from across the country and the world to Indiana.

Indiana 21st Century Research & Technology Fund Round Six Awards

HOTPAK: A CFD Design and Optimization Tool for Curing Ovens

507040774

Dr. Jayathi Murthy
Purdue University, West Lafayette

Partners:

Purdue University, West Lafayette
George Koch Sons, LLC, Evansville
Fluent, Inc., Lebanon, NH

21st Century Award: \$429,456.00
Total Budget: \$967,535.00

Summary:

Curing ovens and furnaces are widely used in a variety of industries including the paint-curing, coatings, food, glass, ceramics, semi-conductors and others. Despite their widespread use, these ovens and furnaces are frequently designed heuristically, following approximate rules of thumb derived from tradition and experience. As a result, it is difficult to rationally modify designs to address new applications, to perform scale-up, or to innovate in order address energy consumption or environmental needs. Improper design not only results in expensive retro-fits paid for by the oven vendor, but also has long-running energy and environmental costs to the user. Since these ovens and furnaces form the back-bone of a vast variety of traditional high-energy consumption, high environmental-impact industries, it is critically important to the United States and to Indiana to improve their design and operation.

The central goal of the proposed work is to substantially modernize the science and knowledge base informing the design and operation of curing ovens and furnaces. To this end, we propose to develop a computer aided design (CAD) tool called HOTPAK using the latest advances in computational fluid dynamics (CFD), flow, reaction and thermal modeling, as well as modern software engineering. The software will be developed jointly by Purdue, Fluent Inc., a leading vendor of CFD software, and George Koch Sons LLC of Evansville, IN, a market leader in the development of paint-curing ovens. HOTPAK will enable the designer and user of curing ovens to rapidly create computational models of ovens and furnaces, to evaluate preliminary furnace designs, and to design and evaluate curing protocols. HOTPAK will provide the user with domain-specific property and reaction databases. HOTPAK will be computationally efficient and easy to use, will speak the language of the oven designer, and will require no specialized knowledge of either CFD, software or hardware. HOTPAK will be introduced to its potential user base through demonstrations and short courses at Purdue and at Fluent.

A Center of Excellence in Medical Informatics to Provide an Advanced Infrastructure for Human Research: A Catalyst for Indiana Research

510040784

Dr. Clement J. McDonald
IUPUI, IUSOM, Indianapolis

Partners:

IUPUI, Indianapolis
Indiana University, Bloomington
Purdue University, West Lafayette
Regenstrief Institute, Inc.,
Indianapolis
Indiana Health Information
Exchange, Inc., Indianapolis

21st Century Award: \$1,905,100.00
Total Budget: \$3,832,196.00

Summary:

The fragmentation of information, both within and across healthcare institutions, hinders quality and productivity in both clinical care and biomedical research. National leaders are now supporting efforts to eliminate this fragmentation. We propose a 21st Century Center of Excellence in biomedical informatics to provide an advanced information infrastructure for medical research in Indiana, based on our existing successful clinical care infrastructure. Regenstrief Institute, with its considerable track record in informatics research, its experience over the last three decades in designing and implementing community-wide networks and infrastructure, and its strong connections with the IU School of Medicine's clinical research community, is uniquely positioned to create this infrastructure. Furthermore, the IU School of Medicine with more than 90 million dollars in research grants and 3,000 active human subject protocols, and our other Indiana collaborators have the research activity base with which to take advantage of such a system.

Our advanced research infrastructure will have four components: 1) Tool building: The creation of the system tools and processes to give researchers easy (but privacy protecting) access to the medical data; 2) Data content: Expand the links to new kinds of data to cover the entire state of Indiana; 3) Biologic utility: Link to large existing archives of human specimens; 4) Process simplification: Expand the scope of research questions that can be answered with de-identified data and reduce the work of recruiting study volunteers and capturing the clinical data needed for study protocols. Under the 21st Century funding, we will create a research infrastructure with rich connections among research relevant computer systems to provide better access to clinical data, and new access to external databases, existing tissue resources, and patient recruitment registries. We will also develop technology and agreements that will expand the availability and utility of de-identified clinical information and specimens for research.

Indiana 21st Century Research & Technology Fund Round Six Awards

**Indiana Center for Insect
Genomics: An International
Center of Excellence**

510040790

Dr. Jeanne Romero-Severson
University of Notre Dame,
Notre Dame

Partners:

University of Notre Dame,
Notre Dame
Indiana University, Bloomington
Purdue University, West Lafayette
State University of Rochester,
Rochester, NY

21st Century Award: \$2,000,000.00

Total Budget: \$3,720,399.00

Summary:

PROJECT SUMMARY AND PARTICIPANT DATA

Title: INDIANA CENTER FOR INSECT GENOMICS
Science and Technology Commercialization, Center of Excellence or Cost-Share
Award

Abstract: Travel, trade and trafficking have carried arthropod vectors of human and animal disease, destructive agricultural and forest insects, and insect pests of stored grain throughout the world. The resources devoted to insect control, including genomics programs, are small indeed relative to the cost of vector-borne disease, crop damage and forest destruction. The Indiana Center for Insect Genomics (ICIG) has already earned international recognition for its leadership of genome projects for the malaria mosquito (*An. gambiae*) and the yellow fever mosquito (*Ae. aegypti*), projects that are already rapidly moving into the post-genomics era. We now propose to bring eight high-impact arthropod taxa into the genomics era: Hessian fly, apple maggot fly, jewel wasp, tobacco hornworm, human head louse and three species of ticks. In addition, we will position two other projects for commercial development. The first of these is characterization of the *An. gambiae* G protein-coupled receptors (GPCRs) to determine their suitability as targets for the development of novel mosquito insecticides. The second is the production of anti-freeze protein (AFP) from genes isolated from the Alaskan beetle *Dendroides canadensis*. The mosquito project could result in a highly efficacious yet environmentally benign control agent, while the second could produce a safe cryopreservative for human tissue and organ transplants.

The three participating Indiana Universities have major arthropod research programs and a significant capacity for genomics research. Existing genomics centers and the VectorBase initiative, headed by Frank Collins, the FlyBase group (Harvard and Indiana University at Bloomington) and the Ensembl developers at the European Bioinformatics Institute group, will provide genomics and bioinformatics services to the research projects fostered with this initiative.

Two Indiana based companies (Dow-Agrosciences and Ely Lilly Elanco) and one international seed and biotechnology company (Pioneer Hi-bred Intl., a division of Dupont) will serve on our advisory board. Ely Lilly Elanco has a specific interest in the GPCR project.

Participating Institutions and ICIG leadership: The Principal Investigator of this proposal and Director of ICIG will be J. Romero-Severson (Department of Biological Sciences, Notre Dame). Co PI of the project will be F. H. Collins, Clark Chair of Biological Sciences, Notre Dame. Assistant directors will be P. Cherbas (Biology Department, IU at Bloomington) and J. Stuart (Entomology Department, Purdue University).

Expected outcomes:

- (i) Expanded access to leveraged Federal, private and international agency funds.
- (ii) Partnerships with the private sector in Indiana and elsewhere.
- (iii) Intellectual property attractive to the biomedical and agricultural private sectors.
- (iv) Retention of scientific professionals within Indiana as postgraduate opportunities in genomic sciences increase.

Submitting Investigator: J. Romero-Severson, Indiana Center for Insect Genomics, 327 Galvin Life Sciences, University of Notre Dame, Notre Dame, IN, 46556

Indiana 21st Century Research & Technology Fund Round Six Awards

Preparative Mass Spectrometry Using Ion Soft-Landing

510040797

Dr. John Campbell
Prosolia, Inc., Indianapolis

Partners:

Prosolia, Inc., Indianapolis
Purdue University, West Lafayette
Detector Technologies, Inc.,
Palmer, MA
Bioanalytical Systems, Inc.,
West Lafayette
INCAPS, Indianapolis
Inproteo, Indianapolis

Summary:

A new family of mass spectrometers for protein separation, identification and collection based on ion soft-landing will be developed. The resultant products will meet critical needs in the areas of proteomic research and drug discovery. The results of the commercialization of the technology will lead to increased efficiency and purity in the preparation of biological species that are similar in chemical nature, while maintaining the molecules' bioactivity.

The current proposal will result in the development of a proprietary, fully validated, single channel, prototype of a high efficiency preparative mass spectrometer which will later be multiplexed into a device capable of rapidly and efficiently producing protein microarrays (chips). The commercialization of this revolutionary technology will result in the availability of preparative mass spectrometers necessary for the production of substantial amounts of "absolutely pure" protein and ultimately in the cost effective generation of protein microarrays (protein chips), which will continue to transform the way biological research and testing is conducted and expectations for the purity of materials.

21st Century Award: \$1,773,347.00
Total Budget: \$5,670,325.00

Concurrently with meeting market needs, new employment opportunities will be created for scientists, engineers, and high-tech manufacturing specialists in the state of Indiana. Partnerships initiated and catalyzed by the 21st Century Research and Development Fund will assist greatly in the development, validation, and commercialization of the technology and contribute to establishing Indiana as a center of excellence in the life sciences.

FolateChemo: Novel, Non-Toxic Delivery of Chemotherapeutics

511040805

Mr. Christopher Leamon
Endocyte, Inc., West Lafayette

Partners:

Endocyte, Inc., West Lafayette
Purdue University, West Lafayette
IUSOM, Indianapolis
Mayo Clinic College of Medicine,
Rochester, MN
National Cancer Institute,
Bethesda, MD
Bioanalytical Systems, Inc.,
West Lafayette

Summary:

This proposal requests funds to develop a proprietary targeted chemotherapeutic by supporting the pre-clinical and Phase I clinical development of folate-targeted chemotherapy drugs. Chemotherapy remains the primary method of treatment for metastasized or disseminated cancers, but it is plagued by toxicity resulting from the non-discriminate targeting of proliferating cells. Thus, specific targeting of drugs to cancer cells remains one of the major challenges in cancer treatment today.

In collaboration with Purdue University, researchers at Endocyte, Inc. will develop a new drug targeting system using the vitamin folic acid to greatly enhance the selectivity of chemotherapeutic drugs for cancer cells versus normal cells. The development efforts will be lead by Endocyte and include Purdue University, Indiana University School of medicine, the Mayo Clinic, and the National Cancer Institute. This project will have an immediate and long-term economic impact on Indiana's high technology industry. Through investment in this sector, high paying life science jobs will be created, and academic and industry interactions/collaborations will be supported. The final result will be the launch of marketable products that improve the length and quality of cancer patient's lives. Accordingly, this project's most important benefit is its potential to improve the lives and health of millions of people that suffer from cancer.

21st Century Award: \$1,950,000.00
Total Budget: \$10,000,000.00

Indiana 21st Century Research & Technology Fund Round Six Awards

Center of Excellence in Studies of Posttranslational Modification Proteomics

511040812

Dr. Milos Novotny
Indiana University, Bloomington

Partners:
Indiana University, Bloomington
IUSOM, Indianapolis

21st Century Award: \$1,994,338.00
Total Budget: \$6,909,874.00

Summary:

Funds are being requested to sustain and further develop a Center of Excellence in the area of detecting and structurally characterizing various posttranslational modification of proteins. Whereas the funds were provided through Indiana University to establish the Proteomics Research and Development Facility three years ago (providing the initial instrumentation and infrastructural resources) as part of Indiana Genomic Initiative (INGEN), there is a need to maintain this facility for the benefit of the science departments at IU Bloomington and collaborating biomedical scientists at the School of Medicine. While the facility has been very successful in developing the cutting-edge tools for proteomics and glycomics and initiating a number of fruitful collaborations, its very unique focus has been to study posttranslational modifications (particularly, the most methodologically challenging glycosylation modifications), done very often with minute quantities of samples. Another very useful angle of investigations has been in analyzing very complex biological mixtures. These attributes provide unique methodological opportunities for other investigators in the State of Indiana. The proposal concerns research activities of Professors Clemmer, Jacobson, Novotny and Reilly at IU Bloomington: development of new separation technologies involving microcolumn separation techniques, new types of monolithic separation media, lectin preconcentration columns for glycoconjugates, microfabricated analytical systems, and ion-mobility spectrometry; new mass-spectrometric techniques used in a tandem arrangement; and the use of photofragmentation to elucidate the sites of posttranslational modification. The collaborating scientists include Professor William McBride (molecular aspects of alcohol addiction in animal models) and Professors Linda Malkas and Meei-Huey Jeng (breast cancer research), all faculty members with the IU School of Medicine. Together with these investigators, we are in the process of identifying disease markers that have been glycosylated and phosphorylated. As an important regional knowledge resource, this Center of Excellence proposal is being supported by the scientists at Dow Agrosiences and Eli Lilly Company in Indianapolis.

A Novel Pulp Molding Apparatus for Advanced Composite Preforms

511040815

Mr. Neal Baitcher
Industrial Composites Inc.,
Fort Wayne

Partners:
Industrial Composites Inc.,
Fort Wayne
Purdue University, West Lafayette
Raytech, Crawfordsville
Porvair Fuel Cell Technology,
Hendersonville, NC

21st Century Award: \$759,250.00
Total Budget: \$1,530,832.00

Summary:

This proposal describes a highly innovative pulp molding process applied to producing preforms for carbon/carbon and carbon fiber/epoxy composite shapes. Current composite technology produces parts of exceptional strength, but its cost and limitations of part geometry confine its use to a few specialized areas. ICI, a leader in the pulp-molding field, has already begun to expand its technology in this direction. This project would greatly leverage its existing technology, increase flexibility and control, and open up significant new markets to ICI and its customers.

This advanced manufacturing concept is seen as an enabling technology, playing an important role in bringing carbon fiber technology out of its specialized role in space and defense applications and into a host of new practical applications including both existing (automotive) and emerging (alternative energy) markets.

ICI will team with the Materials Engineering Department at Purdue University for their advanced testing and analysis capability. We would utilize Purdue's experience gained from a previous 21st. Century funded program on carbon/carbon composites. We are also in contact with several potential customers who are eager for components made from this technology. For example Raytech (the research and development group of Raybestos, Crawfordsville, IN) has initiated a Joint Development Agreement with ICI to net shape mold friction components using the ICI process. We have had initial discussions with the Air Force Research Laboratory and they have identified a number of projects and components that would be candidates for this development.

Indiana 21st Century Research & Technology Fund Round Six Awards

Detection and Control of Combined Sewer Overflow Events Using Embedded Sensor Network Technology

512040817

Dr. Jeffrey Talley, P.E.
University of Notre Dame,
Notre Dame

Partners:

University of Notre Dame,
Notre Dame
Purdue University, West Lafayette
Greeley and Hansen, LLC,
Indianapolis
Environmental Health Laboratories,
South Bend
EmNet, LLC, South Bend
City of South Bend
City of Elkhart
City of Mishawaka
The CSO Partnership,
Richmond, VA

21st Century Award: \$1,000,000.00
Total Budget: \$4,649,628.00

Summary:

A Science and Technology Development and Commercialization Project

The combined sewer overflow (CSO) problem is an important challenge facing most major cities in the Midwest, Westcoast and Northeastern United States. In these cities, storm and sanitary sewers are connected so that storm runoff and raw sewage can mix together. This mixing often occurs when the sewer system is surcharged (overloaded) due to a storm event. To prevent raw sewage from backing up into homes and businesses, municipalities often divert the excess sewage directly into an open stream or river, thereby creating a CSO event. Because this diverted sewage is untreated, it has adverse effects on water quality and poses a significant public health threat. All municipalities with a CSO problem are under federal mandate by the U.S. EPA to take corrective action. South Bend is one of 105 cities in Indiana and 772 cities nationwide that have a CSO problem. Like most CSO cities, South Bend has a "passive" physical system where existing weirs or diversion structures divert the combined flow of storm water and sewage when water levels exceed historical levels. In South Bend, these historical levels are very conservative so that there is a potential CSO event every time it rains. Current solutions to the CSO problem mainly involve large and expensive civil engineering projects to enhance the sewer infrastructure of metropolitan areas. The American Society of Civil Engineers estimates that it may cost up to \$45 billion to solve this problem. South Bend estimates spending \$200 million dollars over twenty years to fix the problem. This proposed embedded sensor network (EmNet) project offers a cost-effective solution to this important national problem by providing new means to monitor and control CSO events, along with data that can be used to design additional remediation strategies.

This project proposes addressing the CSO problem through the use of EmNet technologies. EmNet consist of sensors that are controlled by embedded micro-processors. The micro-processors exchange information over a wireless communication network. EmNet allow for real-time in-situ monitoring and control of environmental systems at an unprecedented spatial and temporal resolution. The network becomes an intelligent sensor, a distributed memory, and ultimately a distributed database system that users can access interactively to study the system being monitored and make real-time decisions concerning control. The aim of this project is to develop, deploy, and test EmNet that can be used to monitor and control CSO events in South Bend; a tributary of the St. Joseph River called Clyde Creek Basin. The network will consist of 45 sensor and approximately 150 communication nodes. Sensor nodes will be designed to accommodate commercial-off-the-shelf sensors and novel sensors currently under development at Notre Dame. Communication nodes will be used to route information between sensors and smart valves. They will be designed to capitalize on existing infrastructure including telephonic and fiber optics connections. The data from such monitoring will be automatically routed to in-situ "smart valves" which will make real time adjustments on the in-line storage minimizing or preventing CSO events. The network will convert the existing "passive" system into a "smart active" system. Using the EmNet system, this project will link distributed rain gage data and sewer surcharging in wet weather conditions in real-time allowing for continuous calibration and adjustment of a CSO model developed by project member Greeley and Hansen. This active control allows for the reduction of CSO events while minimizing the need to make expensive modifications to existing sewer infrastructure; an approach that market analysis estimates could bring over \$14 million and 300 new jobs to Indiana per year as Indiana becomes the national CSO service and manufacturing products solution center. The technologies developed herein will open the door for a host of spin-offs such as monitoring of biochemical agents essential for national security.

Indiana 21st Century Research & Technology Fund Round Six Awards

Extending the Application Space for a Novel Anisotropic Conductive Adhesive Technology

512040819

Mr. Tim Bruemmer
Nexaura Systems, LLC, Carmel

Partners:

Nexaura Systems, LLC, Carmel
Rose-Hulman Institute of
Technology, Terre Haute
Purdue University, West Lafayette

21st Century Award: \$444,887.00
Total Budget: \$941,267.00

Summary:

Packaging engineers are having to consider alternatives to standard lead based soldering technology due to a variety of factors including the increasing use of cheaper glass or flexible substrates, general temperature sensitivity of materials and devices coupled with smaller package sizes and the push towards elimination of lead as a component of solder. Anisotropic conductive adhesives (ACAs) are one such solution that dominate applications such as making fine pitch interconnects on glass or flexible substrates for LCD manufacture for which there are no reasonable alternatives.

However, processing requirements for these adhesives are difficult to implement and often require additional material preparation steps and as a consequence have limited a broader use of the approach.

Nexaura Systems has developed a novel ACA that requires no raised surfaces (bumping) or pressure application to create conductive paths eliminating expensive processing steps from many existing packaging solutions. The technology already has a customer in the production and packaging of detector arrays and has generated both industrial and academic interest in many other existing and emerging applications including flip chip, BGA, face-to-face chip interconnects, three dimensional stacking of electronics (3-D electronics) or general fine pitch interconnects on glass and flexible substrates. This project will explore the commercial opportunities by identifying capabilities and limits of the technology through characterization and modeling of conductive path formation as a function of formulation and processing parameters.

Advanced Manufacturing of Carbon-Carbon Friction Materials

513040829

Dr. Thomas Siegmund
Purdue University, West Lafayette

Partners:

Purdue University, West Lafayette
University of Notre Dame
Notre Dame
Indiana University, Bloomington
Honeywell Aircraft Landing
Systems, South Bend
Action Machine, Inc., South Bend
Koppers, Inc., Harmarville, PA
Plenco, Green Bay, WI
Zoltek, Inc., St. Louis, MO
Asbury Carbons., Asbury, NJ

21st Century Award: \$898,959.00
Total Budget: \$6,805,098.00

Summary:

The proposal seeks funding for the development of low cost manufacturing processes for carbon-carbon (C-C) friction materials. IN Phase I the proposing team has made significant progress on developing novel C-C friction materials. We have demonstrated the production of these materials by combing dry powders and chopped carbonized fibers. The approach enabled a reduction in material cost by 80%, thus reducing the total product cost by 20%. The attractive properties of the new materials open opportunities in the friction materials market. In Phase II our objective is to bring the novel friction materials to the commercial marketplace. Through a novel manufacturing approach we aim to achieve a 50% reduction in manufacturing cost, an in cycle time from 130 to 60 days. These goals will be achieved by development and scale up of advanced manufacturing technology in pre-forming and thermo-chemical processing. We propose to develop two commercially viable pre-forming processes. Pre-forms subsequently will be processed through novel thermo-chemical processing route consisting of a vacuum pitch infiltration step combined with a novel direct carbonization process. This approach will lower the time needed to densify a pre-form by 70% and eliminate most of the time and energy intensive chemical vapor deposition. With the new manufacturing process implemented these products will be the lowest cost-best performance C-C friction material in the industry. Beyond strengthening and expanding the position in the area of wide-body airplanes and military applications, the cost advantages will allow Honeywell to successfully compete in the markets of C-C friction materials for regional jet and for high end automotive applications.