Indiana 21st Century Research & Technology Fund
Round One Grant Awards

Minimally Invasive Orthopedic Implant Development

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Steven R. Schmid
University of Notre Dame, Notre Dame

PARTNERS:
IUSOM, Indianapolis
Purdue University, West Lafayette
Zimmer, Warsaw

Funds Requested: $1,967,958.00
Total Project Budget: $4,048,976.00

Summary:

This proposal addresses the development of new orthopedic implants that allow simpler, less-invasive surgical procedures, and development of tribological interfaces that are more durable. Currently, many orthopedic procedures require large incisions, long operating times, and prolonged patient recovery. The direct costs of surgical procedures are great, and this is compounded indirectly by time required for recovery, pain associated with the procedure, and medication needed to suppress pain and treat ancillary symptoms. The Minimally Invasive Orthopedic Implants (MIOIs) that we will develop will require less-invasive surgical procedures for initially implanting the device, and the tribological interfaces will be more durable, thus obviating the need for later surgeries. This effort will be carried out at each of the three major Indiana research universities and at Zimmer, Inc., a world leader in the orthopedic implant industry. The research is multidisciplinary, and personnel at Zimmer will support all aspects of the research and product development. It is intended that this research result in MIOIs that are ready or nearly ready to be marketed and sold. For many types of orthopedic implants significant competition is from foreign-based companies. MIOIs promise to give Zimmer the opportunity to be more competitive in these markets, resulting in significant economic and employment growth for Zimmer and its suppliers, all based in the Warsaw area.

Novel Simulated Moving Bed Adsorption Technologies for Purification of Multi-component Biochemical Mixtures

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N.-H. Linda Wang
Purdue University, West Lafayette

PARTNERS:
Eli Lilly, Indianapolis
Dow Agrosciences, Indianapolis
Abbott Labs, Abbott Park, IL

Funds Requested: $386,311.00
Total Project Budget: $527,623.00

Summary:

Novel simulated moving bed (SMB) processes with spatial or temporal gradients of desorbent strength can produce high purity (>99%) biochemicals at high yield (>99%). They have an order of magnitude higher throughput and an order of magnitude less solvent usage than conventional chromatography. We propose in this project to demonstrate the novel SMBs using two multi-component systems of industrial significance: a paclitaxel (an anticancer drug) system and an amino acid system. Specific goals are the following: (1) Develop theoretical analysis and dynamic simulations for innovative designs. (2) Design and construct a small scale SMB which can implement spatial and temporal gradients, novel configurations, and novel start-up conditions. (3) Test the new designs by obtaining SMB data for the two model systems and compare the data with theoretical and simulation results. (4) Develop a systematic model-based SMB design program for multi-component purification and incorporate the program into the dynamic simulation package. (5) Transfer the new technologies to industry. This new technology can increase yield by 10% or more and significantly reduce the purification cost of insulin, high fructose corn syrup, antibiotics, amino acids, amino acid derivatives, paclitaxel, and many other biochemicals derived from corn, soybeans, and natural products.

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Combustion Synthesis of Orthopedic Implant Materials

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Arvind Varma
University of Notre Dame, Notre Dame

PARTNERS:
Zimmer, Inc., Warsaw

Funds Requested: $188,672.00
Total Project Budget: $602,638.00

Summary:

The orthopedics industry in the State of Indiana currently employs approximately 4,000 personnel. The proposed work will contribute towards improving the future growth as well as competitiveness of this industry that is vital to the economy of our state. The partners in this project are the University of Notre Dame, which includes a laboratory known worldwide for its fundamental works in the field of Combustion Synthesis (CS) of Advanced Materials, and Zimmer Inc., the world leader in production of orthopedic implants. Combustion synthesis is a novel advanced technique to synthesize a wide variety of materials including alloys and near-net shape articles. In terms of operation, CS offers several advantages. The foremost is that solely the heat of chemical reaction, instead of an external source supplies the energy of the synthesis. At the same time, it utilizes relatively simple equipment. These characteristics of CS lead to the possibility of producing advanced materials rapidly and efficiently. We propose to study the CS of a wide range of orthopedic implant materials, with the main goal to develop new advanced technology of their production. Itemized details of the expected results are: (i) Use advantages of CS to enhance the characteristics of currently used materials; (ii) Based on the specific conditions of CS, synthesize materials with unique properties; (iii) Develop new CS technology for direct net-shape casting of the synthesized materials.

Indiana Telemedicine Incubator: A Multidisciplinary Consortium for the Development of Distributed, Multimedia Database Technology for the Health Care Industry

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Ahmed K. Elmagarmid
Purdue University, West Lafayette

PARTNERS:
IU School of Medicine, West Lafayette
University of Notre Dame, Notre Dame
Med Institute Incorporated, West Lafayette
Micro Database Systems, Inc., West Lafayette
Methodist Hospital/Methodist Research Institute, Indianapolis
Indiana Health Industry Forum, Indianapolis

Funds Requested: $1,698,880.00
Total Project Budget: $2,895,495.00

Summary:

This Consortium: The Indiana Telemedicine Incubator (ITI) is a consortium in formation that will develop technologies for which there are critical needs in all major areas of telemedicine: consultation, diagnosis, and administration. The ITI will leverage the latest research and technologies to create a world-class telemedicine research, development, and delivery infrastructure; and to foster economic development opportunities through an aggressive technology commercialization program. Challenges remain in managing medical data because they exist in many formats, some are not compatible with traditional database systems, and they present serious security and privacy requirements. The Project: The initial idea for incubation will be a system called InterMed, a distributed, multimedia database system and network infrastructure to support health care delivery, clinical trial management, and medical education. InterMed will address a critical set of patient and market needs; it is a project that best leverages the collective expertise and resources of consortium members; and it offers the widest range of economic development opportunities for telemedicine in Indiana at this time.

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The ICERT Consortium for Tissue Engineering of Living Replacement Vessels and Organs Starting from Natural Scaffold Biotechnology

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Michael Hiles, Ph.D.
Cook Biotech Incorporated, West Lafayette

PARTNERS:
Purdue University, West Lafayette
Indiana University, Bloomington
IUPUI, Indianapolis
Clarian Health Partners, Indianapolis
MED Institute, West Lafayette
Cook, Incorporated, Bloomington

Funds Requested: $1,950,000.00
Total Project Budget: $2,450,000.00

Summary:

Healthcare has a strong and growing need for living replacement organs and tissue components. A recent breakthrough in the key mechanisms of cellular interactions with growth factors and the 3-D microstructure of extracellular matrices now promises to make tissue engineering of replacement organs and vessels possible. A new biotechnology consortium of Indiana entities with expertise in: 1) tissue scaffolding technology, 2) cell biology, 3) tissue engineering, 4) clinical medicine, 5) regulatory science, 6) sales and marketing, and 7) research management will highly leverage university research and business expertise with grant funding to address this market. Each entity has an established record in its respective field but only in concert through this consortium can the expertise be combined and focused toward commercialization of engineered living replacement organs or components. The consortiums mission will be to address major diseases, the first being cardiovascular disease with the creation of a family of replacement blood vessels. University research has established feasibility and identified six specific goals of research yet needed. Data from this research will be developed to attract NIH federal funding. The associated business entities to make organ products available to the public will create an immediate need for Indiana high-tech college graduates and skilled production workers, as well as require byproducts of the Indiana swine industry.

Industry University Consortium of Mid-infrared Sensing, Diagnostics and Control Clusters

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Jay P. Gore
Purdue University, West Lafayette

PARTNERS:
University of Notre Dame, Notre Dame
IUPUI, Indianapolis
En'Urga, West Lafayette
HemoCleanse, Inc., West Lafayette
Bioanalytical Systems, Inc., Lafayette

Funds Requested: $1,106,765.00
Total Project Budget: $2,325,035.00

Summary:

The goals of this project are: (1) To establish a consortium of clusters for applications of mid infrared sensing in Biomedical and other areas; (2) To prove the feasibility of eleven mid infrared sensing products including glucose, calcium, and magnesium sensors; live tissue thermal property calorimeter; food composition sensors, aluminum and silicon temperature sensors, fire detector, and an overheat sensor; and (3) to create a data base of mid infrared spectra. Projects in the biomedical engineering cluster will collect mid infrared absorption spectra of the microfiltrate, obtained from wearable probes, to measuring glucose, calcium, and magnesium. These sensors have applications in diabetes and heart and vascular disorders. Another project will involve measurement of thermal diffusivity of live tissue with applications to breast cancer diagnosis. Work in food science will involve collection of mid infrared spectra of many food products. These spectra are useful for online food quality sensors. Catalyst technology work involves measurements of species using mid infrared and design methods for new catalysts. Material processing work involves collection of mid infrared spectra of hot aluminum and silicon. Engineering safety work involves collection of fire signatures for a mid-infrared fire detector and development of overheat-sensors for machine parts. The clusters in diverse areas are tied together by the need for the core mid-infrared technology developed in Indiana.

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Program of Comparative Medicine

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Mervin Yoder, M.D.
IUSOM, Indianapolis

PARTNERS:
Indiana University, Bloomington
Purdue University, West Lafayette

Funds Requested: $1,999,965.00
Total Project Budget: $4,000,000.00

Summary:

The overall goal of this application is to develop a Program of Comparative Medicine At the Indiana University School of Medicine. Comparative medicine may be defined as the inestigation of disease at the whole animal, organ, tissue, cellular, or molecular level across species lines in an attempt to improve the diagnosis and treatment of disorders of both man and animals. This program will focus on the development of animal models of human disease and comparative analysis of normal and abnormal stem cell differentiation in cells isolated from rodents, pigs, and humans. This program will be comprised of investigators from Purdue University and Indiana University. Matching support for this program will be derived from the Departmen of Pediatrics of the Indiana University School of Medicine and in part from the Departments of Animal Sciences in the Purdue School of Agriculture and Vetrinary Pathobiology in the Purdue University School of Veterinary Medicine.

Advanced Imaging Technology for Disease Detection and Control

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George K. Stookey, Ph.D.
IUPUI, Indianapolis

PARTNERS:
IU School of Optometry, Bloomington
Purdue University, West Lafayette
Inspektor Research Systems, Inc., Amsterdam, The Netherlands
Panoramic Corporation, Fort Wayne
Therametric Technologies, Inc., Indianapolis
Midwest Orthodontic Manufacturing, Columbus

Funds Requested: $1,652,431.00
Total Project Budget: $2,461,480.00

Summary:

Goal 1. Introduction of Early Caries Detection Technology into Clinical Dental Practice. Refine, for clinical practice, a new Quantified Light Fluorescence (QLF) technology developed for very early detection of dental caries. Modify hardware/software to make system more user friendly. Initiate marketing technology to practicing dentists in Indiana and U.S. through Panoramic Corporation, Fort Wayne. Goal 2. Multispectral Imaging for Tissue Characterization and Lesion/Disease Detection. Complete development and validation of a new instrument for accurate assessment of multispectral color images using our school expertise and Purdue School of Electrical Engineering and IU School of Optometry scientists. Evaluate the instrument for utility in cancer detection (malignant melanoma, etc.) in IU School of Medicine. Evaluate color changes in oral soft and hard tissues and fabrication of restorative materials and appliances in IU School of Dentistry. Market the instrumentation to practicing physicians, dentists and dental laboratories through Therametric Technologies, Indianapolis. Goal 3. Development of New, More Effective Preventive Measures for Dental Practitioners. Use QLF imaging technology we developed to clinically evaluate promising systems for prevention and control of primary and secondary dental caries. Subsequent marketing of the most effective systems for over-the-counter use by The Procter & Gamble Company and for professional use by Midwest Orthodontic Mfg., Columbus

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Center for Medical Genomics

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Howard J. Edenberg, Ph.D.
IUSOM, Indianapolis

PARTNERS:
Indiana University, Bloomington
Eli Lilly, Indianapolis

Funds Requested: $1,274,202.00
Total Project Budget: $2,167,725.00

Summary:

This project will establish a Center for Medical Genomics at Indiana University School of Medicine to provide infrastructure that allows researchers to use array-based technology in studies of diseases, in clinical trials, and in other biomedical research. Health and disease are influenced both by our genes and by the environments to which we are exposed; progress in understanding these influences will require studies of thousands of genes. For example, knowing differences between tumor cells and the normal cells from which they arose will be of tremendous value for prevention, early diagnosis, clearer prognosis, treatment monitoring, and drug design and validation. For the Indiana University School of Medicine to be a leader in this new era, and be competitive for increased research funding, it will require microarray technology. The Center will be a core technology facility. Equipment will be purchased and microarrays will be fabricated, tested, and provided to researchers so they can generate the data necessary to secure further funding. Expertise will be provided to collaborators from many departments and universities. We will educate Indiana scientists to the opportunities that array technology provides. The proposed Center for Medical Genomics will position Indiana University for the future by providing infrastructure that can be leveraged into funding from national agencies and drug companies, and thereby improve the health and economy of the citizens of Indiana.

Semiconductor Spintronics:Fundamental Studies of Growth and Materials Properties

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David V. Baxter
Indiana University, Bloomington

PARTNERS:
University of Notre Dame, Notre Dame

Funds Requested: $511,634.00
Total Project Budget: $1,059,077.00

Summary:

The proposed research will investigate fundamental aspects of the growth and magneto-opto-electronic properties of new ferromagnetic semiconductors and related materials. These materials will form the foundation of a major new segment of the Information Technology field over the next 10 years known as "Spintronics". Spintronic devices could also give birth to new high-technology markets that will exploit the unique properties of these materials. Our primary goal will be to publish high-profile results and to establish Indiana as a state in which the most significant research in this field is being conducted. We will determine how specific aspects of film growth influence the properties that control spintronic effects in these materials. Spintronic devices making use of the unique magnetic, electronic, and optical properties of these materials will be created, and understanding these properties will be our primary focus. A variety of experimental and theoretical techniques will be employed to advance the present (still very limited) understanding of these new materials. Achieving such understanding in related, non-magnetic, materials (e.g. GaAs) over the last decade produced familiar advances in electronics such as cellular phones and fiber-optic communications. This project will create the “infrastructure” needed to allow the state to attract the companies that will be established to take advantage of these new developments in high technology.

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Design of Low Emission Regional Aircraft Engines for the 21st Century

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M.S. Anand
Rolls-Royce

PARNTERS:
Purdue University, West Lafayette

Funds Requested: $1,073,674.00
Total Project Budget: $2,463,674.00

Summary:

Growing environmental and health concerns and market pressures to reduce emissions including oxides of nitrogen (Nox) into the atmosphere dictate the development of ultra clean gas turbine engines for aircraft propulsion and land-based power generation. Based in Indianapolis, Rolls-Royce Allison is a leading manufacturer of gas turbines for the fast-growing regional aircraft market and for military and power generation applications. The 20-year market-value forecast for engines for business and regional jets alone is about $67 billion. Rolls-Royce Allison is aggressively pursuing advanced technologies, under both company and federal sponsorships to meet the emissions standards of the 21st century. Developments of these technologies are expensive, especially since they involve several design iterations and extensive testing to meet stringent and often conflicting requirements. The leading design concepts for low emissions involve premixed combustion, in which fuel and air are uniformly mixed in lean proportions prior to combustion to achieve uniform and low temperature burning, resulting in low NOx emissions. However, the low temperatures can cause incomplete combustion, resulting in higher levels of carbon monoxide (CO). IN addition to such inevitable trade-offs, there are some serious barriers to designing robust low emission gas turbine combustors. One of the less understood phenomena in lean premixed combustors requiring serious attention is that of combustion instability. The amplitudes and energy of the pressure oscillations, resulting from and acoustic coupling of the unsteady combustion process, can be so great as to disintegrate the engine hardware. Another phenomenon is "flashback," which refers to the unintended travel of the flame upstream of the combustion zone that could lead to burning-up of the hardware. The current approach to overcoming these barriers is mainly trial and error with extensive and expensive design iterations and testing. Often the solutions fail to be effective over the entire range of engine operation conditions. The main technical barrier is the lack of sound analytical/computational design tools that can accurately simulate the underlying physics of these phenomena; such tools would result in a robust design of low emission gas turbines. To address this need, Rolls-Royce Allison is proposing this program in collaboration with Purdue University. The specific aims of the proposed program are (1) to understand the basic mechanisms of combustion instability and (2) to develop design tools based on advanced and emerging analytical methodologies, such as large eddy simulation (LES) for unsteady flow phenomena and the probability density function (PDF) stochastic combustion model, and to incorporate them in the Rolls-Royce Allison computer based combustor design codes. The program is proposed to be two years in duration. The development and application of the proposed first-of-its-kind computer based design tools for combustion instability and flashback predictions will be invaluable in optimizing, in a cost and time-effective manner, low emission gas turbine engine designs for robust operation while meeting stringent performance3 and emission requirements. An investment from the 21st Century Research Fund for this research and development (R&D) project will pay off in terms of continued success of Indianapolis built Rolls-Royce Allison engines in the world regional aircraft and land-based power regeneration marketplace.