TIP Project Brief – 080011 / 9H9007

Civil Infrastructure

Self Powered Wireless Sensor Network For Structural Bridge Health Prognosis

Develop a novel system for continuously monitoring the structural health of bridges using wireless sensors that "harvest" power from structural vibration/wind energy and assembles data from a variety of sensors for interpretation through damage assessment/reliability algorithms.

Sponsor: Mistras Group, Inc.,DBA Physical Acoustics Corporation
195 Clarksville Road
Princeton Junction, NJ 08550

- Project Performance Period: 2/1/2009 - 1/31/2014
- Total project (est.): $13,899 K
- Requested TIP funds: $6,930 K

A joint venture led by Physical Acoustics Corporation (PAC, Princeton Junction, N.J.) plans to develop a suite of new technologies that will enable an easily deployed, self-powered network of wireless sensors, together with analysis tools, to provide continuous monitoring of the structural integrity of bridges. The Federal Highway Administration estimates that more than 70,000 bridges in the United States are structurally deficient. While about 10,000 bridges are built, replaced or rehabilitated annually, there is a significant need for a system to provide continuously updated information on the structural health of bridges to better prioritize repair operations and to notify bridge owners of extreme events such as collisions. The system proposed by PAC and research partners Virginia Tech (Blacksburg, Va.), the University of South Carolina (Columbia, S.C.) and the University of Miami (Coral Gables, Fla.) will include an innovative system for "harvesting" its own power from ambient motions and vibrations in the bridge using piezoelectric materials. The instrument package itself will utilize acoustic emission (AE) sensing; a passive, non-destructive monitoring technique that detects acoustic waves emitted by active flaws such as cracks. The AE sensors will be complemented with active piezoelectric sensors that "ping" the structure to detect echoes from cracks and other flaws, and sensors for strain, acidity, temperature, humidity and similar factors. The exact sensor combination will depend on the nature of the bridge construction. The research targets both steel and concrete bridges. The sensor data, transmitted through a wireless system, will feed computer models of the structure and a data interpretation system that will make assessments and predictions of the bridge's structural integrity on the basis of continuously updated information. Built-in self-check capabilities will eliminate the need for routine sensor maintenance. The power harvesting feature will eliminate the need for either a hard-wired power source for the hundreds of sensor nodes required or a reliance on batteries that would have to be regularly replaced. This aspect greatly reduces both installation and maintenance costs for the monitoring system. TIP support is needed to offset the several high-risk elements of the proposal. These elements include development of the energy harvesting system, the sensors themselves, and the data interpretation, damage assessment and health prognosis software.

For project information:
Dr. Didem Ozevin, (609) 716-4050
didem.ozevin@mistrasgroup.com

Active Project Members

- Mistras Group, Inc., DBA Physical Acoustics Corporation (Princeton Junction, NJ)
  [Original, Active JV Member]
- University of Miami (Coral Gables, FL)
  [Original, Active JV Member]
- University of South Carolina Research Foundation (Columbia, SC)
  [Original, Active JV Member]
- Virginia Polytechnic Institute and State University (Blacksburg, VA)
  [Original, Active JV Member]

TIP Project Brief – 080012/9H9008

Civil Infrastructure
Cyber-Enabled Wireless Monitoring Systems for the Protection of Deteriorating National Infrastructure Systems

Develop a comprehensive system for monitoring and assessing the structural health and integrity of major infrastructure elements such as bridges on a regional basis, with innovations ranging in scale from "smart material"-based sensors at the level of individual structural components up through structure-level data integration and interpretation to a Web-based system for information aggregation and decision support at the regional level.

Sponsor: University of Michigan
3003 South State Street
1064 Wolverine Tower
Ann Arbor, MI 48109-1274

- Project Performance Period: 2/1/2009 - 1/31/2014
- Total project (est.): $19,162 K
- Requested TIP funds: $8,998 K

A joint venture led by the University of Michigan (Ann Arbor, Mich.) plans to develop a comprehensive system for monitoring the structural integrity of major elements of the nation's infrastructure—systems of bridges in particular—by combining innovations at length scales ranging from individual structural components of a single bridge up to the regional management of a collection of bridges. Together with research partners Weidlinger Associates (New York, N.Y.), SC Solutions (Santa Clara, Calif.) LFL Associates (Ann Arbor, Mich.), Monarch Antenna (Ann Arbor, Mich.) and Prospect Solutions (Albany, N.Y.), the team will develop a suite of technologies to identify fatigue and corrosion in bridges, two closely related degradation mechanisms that if left unchecked lead to brittle structural failures. At the most basic level, these focus on self-sensing "smart materials" that can be incorporated into the structure of the bridge and that are better suited than discrete sensors for detecting purely localized failures, like cracks. An example would be cement composites where the electrical or magnetic properties of the cement change in response to strain or cracking. Power "harvesting" technologies based on electromagnetic and micro-electromechanical (MEMS) devices that derive power from vibrations in the bridge structure—including a unique technique that employs normally useless low-frequency vibrations—will power the system. Data will be transmitted to base stations using a new ultra-low-power wireless telemetry system. Other innovative elements of the plan include a low-level data management that handles initial data processing in the sensor nodes to reduce the load on the transmission network and the higher level monitors, an additional sensor system that correlates structural changes with vehicular traffic loads, an internet-based system that links data streams from the sensor network with net-based structural models and analysis tools and decision-making tools that allow managers to make informed and optimal decisions on maintenance and upkeep without sacrificing safety and performance. Michigan and California have agreed to provide the research team with access to operational bridges and bridge models that will serve as testbeds for the proposed technologies. The technology could easily be adapted to other large infrastructure systems such as roads, pipelines and tunnels. TIP support is needed because of the high aggregate risk of developing and intergrating a complex set of new, multidisciplinary technologies.

For project information:
Prof. Jerome P. Lynch, (734) 615-5290
jerlynch@umich.edu

Active Project Members

- Li, Fischer, Lepech & Associates LLC (Ann Arbor, MI)
  [Original, Active JV Member]
- Monarch Antenna, Inc. (Ann Arbor, MI)
  [Original, Active JV Member]
- Prospect Solutions, LLC (Loudonville, NY)
  [Original, Active JV Member]
- SC Solutions (Sunnyvale, CA)
  [Original, Active JV Member]

- University of Michigan (Ann Arbor, MI)
  [Original, Active JV Member]
- Weidlinger Associates, Inc (New York City, NY)
  [Original, Active JV Member]

TIP Project Brief – 080014/9H9009

Civil Infrastructure
Infrastructure Defect Recognition, Visualization, and Failure Prediction System utilizing Ultra Wide Band Pulsed Radar Profilometry

Develop a novel, deep-penetrating scanning system based on ultrawideband radar for inspecting buried infrastructure such as pipelines, tunnels, and culverts that can detect fractures, quantify corrosion and determine the presence of voids in the surrounding soil to ¿see¿ beyond the structure to prevent accidents. The technology provides analysis which cannot be detected by current pipe inspection techniques.

Sponsor: ELXSI
3600 Rio Vista Avenue
Orlando, FL 32805-6605

- Project Performance Period: 2/1/2009 - 4/30/2013
- Total project (est.): $6,747 K
- Requested TIP funds: $3,119 K

The United States has over one million miles of buried pipes carrying water to cities, towns and homes. The consequences of pipeline failure range from disease-causing water pollution to sometimes fatal highway accidents due to sinkholes created by soil erosion around leaky pipes. Current practice is to inspect buried pipes with closed-circuit video cameras mounted on pipe-crawling robots, but the cameras can see only surface damage, not corrosion hidden by pipe liners or dangerous voids in the soil around the pipes. A joint research venture led by Elxsi Corporation (Orlando, Fla.) and including UltraScan, LLC. (Ruston, La.) and Louisiana Tech University (Ruston, La.) plans to develop an entirely novel approach to the problem using a technology called ultrawideband (UWB) pulsed radar that only became available in the past few years. The project, FutureScan, incorporates leading-edge simulation, electronics, robotics, signal processing and three dimensional (3-D) rendering technologies in a package that could be mounted on existing pipe-inspection robots. Using extremely narrow electromagnetic pulses and special signal-processing algorithms derived from mine and bomb detection technology, the technique can “see” through solid, non-ferrous objects with extremely high spatial resolution and measure both surface and internal structural integrity. 3-D visualization software will be used to render the results in a convenient format to allow for ease of assessment by civil engineers and rehabilitation experts. In addition to soil voids, the proposed system will be able to measure the current wall thickness of the pipe, the dimensions and depth of circumferential cracks and defects in the pipe wall, the integrity of internal reinforcement rods and the amount of deformation of the pipe. The proposed system should be compatible with many of the estimated 17,000 pipeline inspection robots in use today, allowing for rapid and economical deployment. TIP support is needed for this project because it involves several challenging technology development components, particularly the signal-processing software.

For project information:
Joseph Purtell, (800) 327-7791
joep@cuesinc.com

Active Project Members

- ELXSI (Orlando, FL)
  [Original, Active JV Member]
- Louisiana Technical University (Ruston, LA)
  [Original, Active JV Member]
- UltraScan, LLC (Ruston, LA)
  [Original, Active JV Member]

Project Brief – 080019 / 9H9010

Civil Infrastructure
Fiber Sensing System for Civil Infrastructure Health Monitoring

Develop an economical, fiber-optics-based system for monitoring the structural health of large infrastructure elements such as bridges or pipelines utilizing light pulses traveling down-cable to provide high-resolution, localized identification of both static and dynamic conditions without the need for installing large networks of discrete sensors.

Sponsor: Distributed Sensor Technologies, Inc.
3350 Scott Boulevard
Bldg#62
Santa Clara, CA 95054

- Project Performance Period: 2/1/2009 - 6/25/2012
- Total project (est.): $8,548 K
- Requested TIP funds: $4,030 K

Distributed Sensor Technologies, Inc. (Santa Clara, Calif.) and joint venture partners Optiphase, Inc., (Van Nuys, Calif.); Redfern Integrated Optics, Inc., (Santa Clara, Calif.) and the University of Illinois at Chicago plan an innovative monitoring system for large structures such as bridges or pipelines that substitutes a single optical fiber sensing cable for potentially hundreds of discrete, local strain or fracture sensors. Sophisticated analysis of backscattered light from short pulses of laser light sent down the fiber turns the entire length of the fiber into a sensor, registering both static conditions—strains and their variations over time in the structure, for example—and dynamic conditions—structural breaks, cracks or vibrations, for example. If successful, the project would enable an economical method to instrument large structures for continuous, high-resolution monitoring and detection of crack initiation, deformation and other critical structural conditions. The system will be continuously evaluated and tested in laboratory size structures as in bridges in order to develop efficient solutions for monitoring and inspection. By replacing local discrete sensors with lengths of optical fiber, the system would mitigate initial deployment cost of the discrete sensors and a variety of bandwidth and transmission problems associated with collecting data from a large number of discrete sensors, while potentially offering more precise location of faults and problems. To achieve this, the research team must overcome several challenging technical obstacles. At the heart of the proposal is the ability to simultaneously apply two different optical sensing and analysis techniques—coherent Rayleigh and Brillouin scattering—using common opto-electronics and a single sensor cable. Both techniques will require interrogation and processing enhancements over the current state of the art to achieve the resolution and fidelity needed for the monitoring system. This also includes the development of improved laser sources, a precision laser control module, and a novel fiber-optic sensor cable which optimizes fiber mechanics for the two measurement techniques, can be economically manufactured in long lengths and is sufficiently rugged for deployment and bonding to large, exposed structures. TIP support is required to pursue this project because the several technology development targets require a mix of both basic and applied research that is not addressed by other federal funding programs and that involves too much risk for private funding.

For project information:
Michael Jansen, (408) 970-3500
mitch.jansen@rio-inc.com

Active Project Members

- Distributed Sensor Technologies, Inc. (Santa Clara, CA)
  [Original, Active JV Member]
- Optiphase, Inc. (Van Nuys, CA)
  [Original, Active JV Member]
- Redfern Integrated Optics, Inc. (Santa Clara, CA)
  [Original, Active JV Member]
- University of Illinois, Chicago (Chicago, IL)
  [Original, Active JV Member]

TIP Project Brief – 080024/9H9011

Civil Infrastructure
Development of Rapid, Reliable, and Economical Methods for Inspection and Monitoring of Highway Bridges

Develop a pair of complementary sensor networks for bridge inspection, including an active, self-powered system for continuous monitoring for cracks or defects in fracture critical bridges and a passive system for monitoring corrosion in reinforced concrete bridge decks.

Sponsor: University of Texas at Austin
PO Box 7726
Austin, TX 78713-7726

- Project Performance Period: 2/1/2009 - 1/31/2014
- Total project (est.): $6,842 K
- Requested TIP funds: $3,421 K

The joint research venture led by the University of Texas at Austin and including National Instruments Corporation (Austin, Texas) and Wiss, Janney, Elstner Associates, Inc., (Northbrook, Ill.) plans to develop two related wireless network systems that together address a critical issue for bridge safety, the monitoring of cracks or defects and corrosion in key structural components. One will be a network of low-power, wireless sensors designed to continuously monitor fracture-critical bridges—those susceptible to collapse from the failure of a single critical component—over a 10-year service life. The sensor nodes will be powered by one of several possible “energy harvesting” techniques that derive power from solar or wind energy or vibrations in the bridge structure, making them independent of the electric power grid. The nodes will be capable of supporting multiple sensors and will have sufficient computing power to process raw sensor data, detect important events and send notifications off-site when a threshold level of damage occurs. A second network of passive sensors will be designed to detect early signs of corrosion in reinforced concrete bridge decks. These sensors will be read using a wireless connection during regular bridge inspections. The robust sensors are inexpensive to produce, require no power source other than the wireless signal, and could easily be dispersed throughout the entire structure during construction and will function for the lifetime of the bridge. The proposed research involves several major challenges that require TIP support, particularly the extremely long target service life of the sensors and data acquisition systems. The research in this proposal will not only transform the inspection practices used for highway bridges today, but also will dramatically advance the state of the art in wireless sensing technology.

For project information:
Sharon Wood, (512) 471-4558
swood@mail.utexas.edu

Active Project Members

- National Instruments Corporation (Austin, TX)
  [Original, Active JV Member]
- University of Texas at Austin (Austin, TX)
  [Original, Active JV Member]
- Wiss, Janney, Elstner Associates, Inc. (Northbrook, IL)
  [Original, Active JV Member]

TIP Project Brief – 080046/9H9012

Civil Infrastructure
VOTERS: Versatile Onboard Traffic Embedded Roaming Sensors

Develop a novel system based on instrument packages that can be installed on a wide variety of private and public vehicles to assess the conditions of bridges and roadways through several different and complimenting methods at regular driving speeds during the course of ordinary use of the vehicles.

Sponsor: Northeastern University
360 Huntington Avenue
405 Lake Hall
Boston, MA 02115-5000

- Project Performance Period: 3/1/2009 - 3/24/2014
- Total project (est.): $18,802 K
- Requested TIP funds: $9,000 K

A research team headed by Northeastern University (Boston, Mass.) and including the University of Massachusetts at Lowell, the University of Vermont and State Agricultural College (Burlington, Vt.) and Witten Technologies, Inc., (Somerville, Mass.) plans to eliminate the need for setting up hazardous and congestion-prone highway work zones to conduct roadway inspections with an automated "drive-by" inspection system that uses ordinary vehicles in the course of their regular driving. The VOTERS (Versatile Onboard Traffic Embedded Roaming Sensors) project proposes to gather accurate, up-to-date condition information on roadways and bridges using compact instrument packages that would be installed in cars and trucks. The packages will include several novel and sophisticated sensor developments, including an acoustic system that listens to the noise made by the vehicle's tires on the roadbed and from that determines possible defects such as cracks or poor bonding between the concrete roadbed and asphalt overlay; a small, high-frequency ground-penetrating radar array to detect delamination, trapped moisture, rebar corrosion and similar faults that would be invisible from the surface; and an advanced millimeter-wave radar to determine the surface condition of the roadway including the detection of potholes, embedded moisture, and thin ice layers. An onboard computer will control the instruments, check its location using GPS, and report data back to base stations using the cellular phone system—all without involving the vehicle's driver, who just needs to follow his or her regular driving routine. Installed in a diverse fleet of vehicles, VOTERS will provide a constant stream of information on road and bridge deck conditions gathered under real, daily driving conditions at operational speeds that will not congest traffic. The information will allow planners to schedule needed repairs at the right place and at the right time. The project involves several significant research challenges requiring TIP support, in particular the development of inexpensive, non-contact sensors able to gather the needed data at regular driving speeds.

For project information:
Dr. Ming L. Wang, (617) 373-3900
mi.wang@neu.edu

Active Project Members

- Earth Science Systems LLC (WheatRidge, CO)
  [New JV Member since original JV was formed]
- Northeastern University (Boston, MA)
  [Original, Active JV Member]
- Trilion Quality Systems, LLC (Plymouth Meeting, PA)
  [New JV Member since original JV was formed]
- University of Massachusetts Lowell (Lowell, MA)
  [Original, Active JV Member]
- University of Vermont and State Agricultural College (Burlington, VT)
  [Original, Active JV Member]

TIP Project Brief – 080058/9H9013

Civil Infrastructure
Next Generation SCADA for Prevention and Mitigation of Water System Infrastructure Disaster

Develop a novel monitoring and inspection system for pipes and pipe networks in water and wastewater infrastructure systems using wireless sensor nodes incorporated in an advanced Supervisory Control And Data Acquisition (SCADA) system.

Sponsor: The Regents of the University of California (Irvine)
Office of Research Admin.
300 University Tower
Irvine, CA 92697-7600

- Project Performance Period: 4/1/2009 - 3/31/2012
- Total project (est.): $5,685 K
- Requested TIP funds: $2,800 K

A research team led by the University of California at Irvine and including Earth Mechanics, Inc. (Fountain Valley, Calif.), the Irvine Ranch Water District (Irvine, Calif.), the Orange County Sanitation District (Fountain Valley, Calif.), the Santa Ana Watershed Project Authority (Riverside, Calif.) plans to develop a novel monitoring and inspection system for large water pipe networks. This advanced SCADA (Supervisory Control And Data Acquisition) system will incorporate several novel features to monitor both networks of pressurized pipes, commonly used for water supply, and un-pressurized gravity pipes generally used for wastewater. The former will use noninvasive external sensors to monitor vibrations at the pipe surface, listening for the sharp transient jolts caused by a sudden local change in pressure or other hydraulic conditions. The latter will use highly innovative data fusion techniques that incorporate any sound or vibration in the pipe from a fracture, the vibrations caused by the fracture wave propagating along the pipe and any transient flow induced pipe vibrations. The new system being developed will use the experience from a previously developed advanced wireless network of compact, low-power devices called DuraNodes. This system developed at UCI uses MEMS (micro-electromechanical system) devices to measure a variety of dynamic factors such as acceleration and displacement as well as collecting images and measuring temperature. Development of the wireless control and data integration system will be the third major research area. A particular feature of the proposed system is the ability not only to detect a fracture or failure in a pipeline but also to evaluate in real time the remaining useful life at the original design capacity in the damaged system, enabling more effective and strategic planning of repair operations and maintenance. The project involves several major research challenges that need TIP support, including developing the necessary understanding of the correlation between pressure drops and pipe vibrations, differentiating important vibration data caused by fractures or breaks from background “noise,” and developing techniques to monitor otherwise inaccessible installed pipes by mounting sensors on exposed connecting features such as hydrants or air release valves. The project success will aid in extending the useful life and reliability of the water systems infrastructure.

For project information:
Dr. Masanobu Shinozuka, (949) 824-9379
shino@uci.edu

Active Project Members
- Earth Mechanics, Inc. (Fountain Valley, CA)
  [Original, Active JV Member]
- Irvine Ranch Water District (Irvine, CA)
  [Original, Active JV Member]
- Orange County Sanitation District (Fountain Valley, CA)
  [Original, Active JV Member]
- Santa Ana Watershed Project Authority (Riverside, CA)
  [Original, Active JV Member]
- University of California at Irvine (Irvine, CA)
  [Original, Active JV Member]

TIP Project Brief – 080059/9H9014

Civil Infrastructure
Microwave Thermoelectric Imager for Corrosion Detection and Monitoring in Reinforced Concrete

Develop a novel nondestructive technology for early detection of corrosion in reinforced concrete structures.

Sponsor: Newport Sensors, Inc.
7 Murasaki Street
Irvine, CA 92617

- Project Performance Period: 2/1/2009 - 1/31/2012
- Total project (est.): $2,498 K
- Requested TIP funds: $1,249 K

Deterioration and failure of civil engineering structures due to rebar corrosion in reinforced concrete costs the nation tens of billions of dollars annually. Newport Sensors, Inc., (Irvine, Calif.) plans a novel microwave "camera" for *in situ*, real time nondestructive detection of rebar corrosion at an early stage. The proposed system exploits the fact that even a small degree of corrosion around a steel rebar or tendon acts as a thermal insulator, so corroded steel cools more slowly than un-corroded steel. The Newport Sensor device will use inductive heating as a "flash unit" to selectively heat the steel reinforcing bars within a concrete structure and microwave reflectance to measure the cooling rate of the steel. The project entails several significant research challenges that require TIP support, including developing optimal techniques for induction heating of steel rebar that can be buried two to six inches deep in concrete, and obtaining an accurate measure of temperature from microwave reflectance. Because the optimal microwave frequencies for deep penetration of concrete are significantly different from the optimal frequencies for high-resolution imaging of the rebar, a key element of the proposed research is an advanced microwave imaging system to enhance sensitivity and penetration depth. If successful the project innovations will enable direct visualization of rebar corrosion in its early stages, something not possible with any existing nondestructive evaluation technology.

For project information:
Dr. Richard Livingston, (949) 378-8666
info@newportsensors.com

TIP Project Brief – 080060/9H9015

Civil Infrastructure
Development of SCANS^n for Advanced Health Management of Civil Infrastructures

Develop an extensible and self-powered sensor network using a peer-to-peer communication protocol for nondestructive evaluation (NDE) and health monitoring of bridges, buildings, pipelines and other major infrastructure components.

Sponsor: Acellent Technologies Inc.
835 Stewart Drive
Sunnyvale , CA 94085-4514

- Project Performance Period: 2/1/2009 - 8/30/2012
- Total project (est.): $5,990 K
- Requested TIP funds: $2,995 K

Acellent Technologies, Inc. (Sunnyvale, Calif.) plans an advanced intelligent sensor network using NDE techniques to monitor the structural health of entire bridges, buildings and other major structures down to the level of individual components. A key feature of the planned Scalable Cognitive Autonomous Nondestructive Sensing network (SCANS^n) is the relative ease with which the network could be extended to cover larger and larger structures. Individual nodes in the network will communicate with each other in a "peer-to-peer" network scheme that will allow the system to grow exponentially (hence the superscript 'n'). Each individual SCANS^n node will be a self contained entity that includes an embedded array of multi-frequency piezoelectric actuators and sensors for NDE detection and evaluation of cracks, along with sensors to detect mechanical parameters such as strain, displacement and acceleration, and environmental factors such as temperature and humidity. The system will exploit advanced flexible electronics packaging to facilitate applying the SCANS^n node to curved surfaces and other difficult shapes. The SCANS^n node will use energy harvesting through photoelectric cells or piezoelectric systems to derive power from sunlight or mechanical strain and vibrations in the structure. On-board data processing elements will create 3-D representations of local damages and use wireless communications to link with nearby nodes in a distributed system. At higher levels the SCANS^n network will link into a Global Integrity Monitoring (GIM) data system that will be able to evaluate the overall health of the entire structure and feed into higher level systems that will monitor collections of SCANS^n instrumented structures of a regional basis. SCANS^n entails several difficult technical challenges that require TIP support. The hardware will require integrating both active and passive sensors—together with a power source and a wireless communications system—into a miniaturized, flexible package, requiring significant advances in materials and design. The signal processing algorithms at the individual node level and data mining algorithms at higher levels also will require research advances. If successful, SCANS^n will offer a relatively inexpensive, adaptable and easily extensible network solution for monitoring the structural health of bridges, buildings, pipelines and other major infrastructure components.

For project information:
Dr. Shawn Beard, (408) 745-1188
sjb@acellent.com

TIP Project Brief – 090021/10H001

Manufacturing
Production of Low-Cost, High-Quality Metallic and Semiconducting Single Wall Carbon Nanotube Inks

Develop technologies for the cost-effective production of high-purity, high-quality, metallic and semiconducting carbon nanotube 'inks' to enable commercial production of a wide variety of high-performing electronic devices for energy, flexible electronic and sensor applications.

Sponsor: Brewer Science, Inc.
Rolla, MO

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $13,910 K
- Requested TIP funds: $6,527 K

Brewer Science, in conjunction with SouthWest NanoTechnologies (SWeNT), is developing a set of technologies for the cost-effective, commercial production of high-purity, high-quality single-walled carbon nanotube (SWCNT) ink solutions. After many years of research, carbon nanotubes have emerged as one of the most promising classes of 'nanomaterials'—advanced materials that exhibit unique, functional properties in nanoscale structures. In the case of single-walled carbon nanotubes, the long, cylindrical carbon macromolecules possess unique physical, electrical, optical and mechanical properties. These properties make them suitable for a wide array of applications including high-performance optical devices, photovoltaic cells, batteries, supercapacitors, lighting products, flexible electronic devices, sensors and high-performing specialty materials (such as high mechanical strength nanocomposites). However, a major obstacle to commercializing products from these carbon nanotube materials is the lack of affordable high-purity, high-quality single-walled carbon nanotubes. Conventional methods produce carbon nanotubes that are not readily suitable for enabling these high-performance applications. Brewer Science, which has a long history in commercializing high-performance materials for the semiconductor industry, has developed processes to purify, separate, disperse and manufacture metallic and semiconducting carbon nanotube ink solutions. Applying these processes to the raw carbon nanotubes manufactured by SWeNT yields a new generation of commercial-scale single-walled carbon nanotube inks that can be applied with a variety of deposition techniques. These conductive and semiconducting carbon nanotube inks will enable domestic leadership in a wide variety of applications, including photovoltaics, supercapacitors, solid-state lighting, energy storage, printed electronics and sensors. The demand shown for such a solution makes the work from this project valuable to the successful production, separation, purification, dispersion and scale-up technologies that are cost-effective and required to address the needs satisfied by these high-performance carbon nanotube inks.

For project information:
Kevin Edwards, (573) 364-0300
kedwards@brewerscience.com

Active Project Members

- Brewer Science, Inc. (Rolla, MO)
  [Original, Active JV Member]
- Southwest Nanotechnologies, Inc. (Norman , OK)
  [Original, Active JV Member]

TIP Project Brief – 090023/10H013

Civil Infrastructure
Civil Infrastructure Inspection and Monitoring Using Unmanned Air Vehicles

Develop the technologies required to create small, hovering, Unmanned Air Vehicles (UAVs) for use in the inspection and monitoring of large-scale civil infrastructure elements such as bridges and dams.

Sponsor: CyPhy Works, Inc. (formerly The Droid Works, Inc.)
Framingham, MA

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $4,996 K
- Requested TIP funds: $2,453 K

A number of research efforts are under way to develop "smart" sensor technologies to improve the monitoring of large, critical structures like bridges and dams, but few offer significant improvement over the current state of the practice that relies on visual inspection. CyPhy Works, together with the Georgia Institute of Technology Research Corporation, is attempting to develop a novel and potentially revolutionary inspection system based on small, unmanned, hovering robots fitted with video cameras and other sensors. The proposed Unmanned Air Vehicle (UAV) would slowly move along the sides or undersides of bridges and similar structures while relaying close-up, high-fidelity images and other data to engineers for "Robotic Assisted Inspection" (RAI). Because the robots could work without the need to shut down bridge lanes or to rig safety harnesses and other equipment for human inspectors, they would greatly increase both the speed and safety of bridge and dam inspections. For particularly critical or at-risk structures, inspectors could use a more advanced technology, "Autonomous Robotic Monitoring" (ARM)—one or more dedicated inspection robots that would be stationed at the structure and make periodic flights to detect potentially dangerous changes. Both approaches will require major advances in the current state of the art of small UAVs to allow them to fly and hover safely in potentially gusty winds for long periods with precise positioning. Current UAV technology, for example, uses GPS signals for maintaining position, but the technique is nowhere near precise enough to maintain position within extreme close proximity of a large structure. Moreover this technique becomes impossible to employ when the structure blocks the GPS signal. CyPhy Works envisions an optics-based close-in navigation system that allows the robot to maintain a position and navigate by observing visual cues such as corners or edges of the structure. If successful, the project will produce an advanced class of UAVs that would enable entirely novel, efficient and relatively low-cost techniques for monitoring the health of the nation's existing civil infrastructure. ARM, in particular would monitor our civil infrastructure without the need for an inspector on-site. This capability is critically needed for bridges and dams that are rated as substandard to warn of impending catastrophic failure. ARM requires the technologies developed for RAI, but has even higher technical risks and rewards associated with it.

For project information:
Helen Greiner, (617) 669-6665
helen@cyphyworks.com

TIP Project Brief – 090027/10H002

Manufacturing
Functionalized Nano Graphene for Next-Generation Nano-Enhanced Products

Develop processes for mass-producing chemically modified ("functionalized") nano graphene for next-generation products, particularly for the energy industries.

Sponsor: Angstron Materials, LLC
Dayton, OH

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $2,988 K
- Requested TIP funds: $1,494 K

Angstron Materials, a world leader in the production of nano graphene platelets (NGPs), is developing a process for modifying the tiny flakes of graphene by attaching tailored molecules to their surfaces to match them to specific applications, a process called chemical functionalization. Despite the press carbon nanotubes tend to receive, graphene may prove to be even more important. Graphene, carbon in the form of a flat sheet of hexagonally arranged atoms, has been shown to have striking material properties; among other things, it has the highest intrinsic strength and the highest thermal conductivity of all existing materials as well as exceptional in-plane electrical conductivity and electron mobility that is 100 times faster than silicon. In addition, it is far cheaper to make than nanotubes. Nano graphene platelets are being investigated as critical ingredients in several energy storage and conversion products, such as high-capacity lithium-ion batteries, high-capacity supercapacitors, fuel cells, wind turbine blades, lubricants and solar cells. The ability to modify graphene platelets in a continuous, cost-effective manner is the next step to broad implementation of this high performing material in next-generation nano-enhanced products. To realize this capability and explore other exciting possibilities for new manufacturing solutions, Angstron's project goals will focus on two primary objectives at the leading edge of graphene science and technology. The company will develop methods for mass-producing functionalized nano graphene platelets through the development of scalable surface treatment procedures for both pristine graphene and graphene oxide platelets. Angstron will also develop an in-depth understanding of the relationships between processing, shape and structure changes and performance in nano graphene platelets and devices or composites that include them for both functional and load-bearing applications. Angstron's work will also support the use of nano graphene platelets in thin films or coatings (for EMI shielding, electrostatic spray painting, and conductive adhesive),composites and thermal management applications.

For project information:
Lynn Stanley, (972) 409-9044
Stanleymedia@tx.rr.com

TIP Project Brief – 090029/10H014

Civil Infrastructure
Automated Nondestructive Evaluation and Rehabilitation System (ANDERS)for Bridge Decks

Develop a mobile integrated system for nondestructive evaluation and repair of bridge decks, including human-operated and robotic systems that merge novel imaging and NDE techniques together with innovative intervention approaches to arrest deterioration processes.

Sponsor: Rutgers, The State University of New Jersey
Piscataway, NJ

- Project Performance Period: 2/1/2010 - 1/31/2015
- Total project (est.): $17,923 K
- Requested TIP funds: $8,810 K

This university-industry joint venture led by Rutgers' Center for Advanced Infrastructure and Transportation (CAIT) is developing a suite of technologies that together will provide a comprehensive solution to bridge deck maintenance—from monitoring and assessment to remediation—as well as overall bridge inspection. The other members in the joint venture include Drexel University, PD-LD, Inc., Mala GeoSciences USA, Inc., and Pennoni Associates, Inc. The goal is to develop the Automated Nondestructive Evaluation and Rehabilitation System (ANDERS) for bridge decks, which will use a combination of human-operated and robotic vehicles that allow rapid, comprehensive application across a large number of bridge types. The basic ANDERS technologies, however, could be applied to many other infrastructure maintenance problems as well. ANDERS will be composed of four systems that merge novel imaging and nondestructive evaluation (NDE) techniques with innovative intervention approaches to arrest deterioration processes in bridges. The planned system focuses on identification and mitigation of bridge deck deterioration, which bridge engineers and owners have identified as one of their most acute problems. Between 50 and 85 percent of bridge maintenance funds are spent on repair or replacement of bridge decks. To assess deck conditions ANDERS will use two complementary nondestructive evaluation systems. A Multi-Modal Nondestructive Evaluation (MM-NDE) System will combine ground-penetrating radar, impact echo, and ultrasonic probes to identify and characterize localized deterioration. In tandem, a Global Structural Assessment (GSA) System will use modal analysis (i.e., observation of how a structure vibrates in response to a mechanical stimulus) to assess global structural characteristics, identify any appreciable effects of deterioration on the bridge structure as a whole, and shed light on how local deterioration effects global performance of the structure. Output from these two methods will be merged using an automated analysis system that will construct and calibrate mathematical simulation models to assess overall structural vulnerability and capacity. Based on the outcome of these assessments, a Nondestructive Rehabilitation (NDR) System will use robotic repair equipment to deposit specially formulated repair materials to fill and bond hairline crevasses and repair delamination. Developing and testing the NDR repair materials is also part of this project. If successful, the ANDERS project will provide unique tools that enable the sustainable management of repairs to our nation's aging bridges. ANDERS will provide much more detailed and comprehensive detection of early onset deterioration and result in both time and cost savings compared to traditional approaches. ANDERS will incorporate comprehensive condition and structural assessment at all stages of deterioration, integrated assessment, and prudent rehabilitation that will be rapid, cost-effective, and implementable at all stages of deterioration.

For project information:
Allison Thomas, (732) 445-0579
a.thomas@rutgers.edu

Active Project Members

- Drexel University (Philadelphia, PA)
  [Original, Active JV Member]
- Mala GeoScience USA, Inc. (Charleston, SC)
  [Original, Active JV Member]
- PD-LD, Inc. (Pennington, NJ)
  [Original, Active JV Member]
- Pennoni Associates Inc. (Philadelphia, PA)
  [Original, Active JV Member]
- Rutgers, The State University of New Jersey (Piscataway, NJ)
  [Original, Active JV Member]

TIP Project Brief – 090033/10H003

Manufacturing
Transformational Casting Technology for Fabrication of Ultra-High Performance Lightweight Aluminum and Magnesium Nanocomposites

Develop a novel casting technology, based on ultrasonic cavitation dispersion of nanoparticles in metal melts, for large-scale production of aluminum and magnesium matrix nanocomposites.

Sponsor: The Board of Regents of the University of Wisconsin System
Madison, WI

- Project Performance Period: 2/1/2010 - 1/31/2015
- Total project (est.): $10,092 K
- Requested TIP funds: $4,863 K

This multidisciplinary joint venture team led by the University of Wisconsin-Madison is attempting to develop a commercial-scale method for thoroughly mixing and dispersing nanoparticles in molten metals to enable the manufacture of large and complex metal castings with greatly enhanced performance characteristics. The joint-venture team includes Eck Industries, Inc., Nanostructured & Amorphous Materials, Inc., the Oshkosh Corporation, and Wisconsin Alumni Research Foundation. To improve performance and energy efficiency, engineers increasingly are turning from iron and steel to lightweight alloys of aluminum and magnesium. The properties of these alloys can be enhanced considerably if nanoparticles, usually ceramics, are used as a reinforcement to form so-called metal matrix nanocomposites (MMNCs). To date, the use of these nanocomposites has been limited to relatively small and uncomplicated shapes because of the difficulty of evenly dispersing the nanoparticles. With relatively high surface-to-volume ratios and poor wettability, conventional mechanical stirring tends to leave the nanoparticles clumped together like a poorly mixed cake batter. Powder metallurgy techniques—the metals and nanoparticles are premixed as powders before sintering—works better, but it's costly, time-consuming and doesn't scale well to large, complex parts like engine blocks. To meet the need for a large-scale mixing and dispersing technology, the joint venture plans to scale up an experimental technique developed at the University of Wisconsin-Madison that uses high intensity ultrasonic waves to disperse the nanoparticles through molten metal. The high intensity ultrasonic waves induce acoustic cavitation in the liquid metal, causing the transient formation, growth and collapse of microbubbles. The collapse of the bubbles produces microscopic hot spots that can reach temperatures above 5000 degrees Celsius and create severe microscale shock waves at a very short time. The sum result is a violent stirring and dispersing that in laboratory tests leads to effective dispersion of the nanoparticles. The University of Wisconsin-Madison based this proposal on a laboratory-scale, trial-and-error process on small samples. While the laboratory tests at Wisconsin are very promising, there are significant and fundamental challenges and risks in scaling up the system to mass produce premium-quality aluminum and magnesium MMNC components for practical applications. If successful, however, commercial scale production of these metal nanocomposites will enable transformative changes in multiple industries, directly addressing the critical national needs of reducing oil dependency, lowering greenhouse gas emission, and maintaining U.S. leadership in manufacturing. Along the way the project will build an unprecedented knowledge base for design, processing, and properties of MMNCs. The project plan calls for an industrial consortium to be established at the end of the project to disseminate and implement the research results.

For project information:
Brian Mattmiller, (608) 890-3004
bsmattmi@engr.wisc.edu

Active Project Members

- Eck Industries, Inc. (Manitowoc, WI)
  [Original, Active JV Member]
- Oshkosh Corporation (Oshkosh, WI)
  [Original, Active JV Member]
- The Board of Regents of the University of Wisconsin System (Madison, WI)
  [Original, Active JV Member]
- Wisconsin Alumni Research Foundation (WARF) (Madison, WI)
  [Original, Active JV Member]

TIP Project Brief - 90038/10H015

Civil Infrastructure
Distributed Fiber-Optic Sensing Technology For Civil Infrastructure Management

Develop a distributed fiber-optic sensing technology to enable real-time monitoring, identifying and locating disturbances and changes over long stretches of pipelines.

Sponsor: Optellios, Inc.
Newtown, PA

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $3,917 K
- Requested TIP funds: $1,930 K

Optellios, Inc., is attempting to develop a novel and potentially widely deployable technology for monitoring the status and integrity of water pipelines and other similar structures using fiber-optic cables. Instead of using a large number of individual sensors that would be required to monitor a lengthy stretch of pipelines, the optical fiber would act as a continuous sensor providing real-time data about the location and nature of acoustical and temperature changes in the sensor's surroundings over distances of tens of miles. At present there is no single sensor system that is capable of providing such detailed real-time monitoring capability. Monitoring for thermal and acoustic anomalies along water pipelines will help detect water loss due to leaks, while simultaneously detecting structural changes associated with aging infrastructure by monitoring acoustic emissions. Acoustic monitoring would further enable early detection of third-party interference, particularly accidental and intentional excavations, a constant source of concern for in-ground utility operators. The key innovation, and most difficult challenge, is the use of a complex analysis of how specially tailored light signals, sent down the fiber, are scattered and reflected back from various points along the path. The specific character of the returned light—changing with time depending on how far it traveled—will reflect local conditions of the optical fiber at each point along its run, including both transient effects such as vibrations and more static conditions such as temperature and strain. Although the current research targets the in-ground water infrastructure, including water mains and wastewater systems, potential applications exist across many other critical infrastructure sectors. If such a monitoring system were successfully developed, it is expected to become a valuable tool for infrastructure management, because it could assist the operators in prioritizing maintenance schedules and prevent costly repairs and accidents.

For project information:
Jay Patel, (215) 741-5850
jpatel@optellios.com

TIP Project Brief – 090045/10H004

Manufacturing
High-Speed, Continuous Manufacturing of Nano-Doped Magnesium Diboride Superconductors for Next-Generation MRI Systems

Develop a practical, industrial scale continuous manufacturing process for magnesium diboride superconducting wires and other wire products requiring a hollow metal tube around a powder-based core.

Sponsor: Hyper Tech Research, Inc
Columbus, OH

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $6,050 K
- Requested TIP funds: $3,000 K

Hyper Tech Research, Inc., is attempting to develop an industrial-scale process for the continuous manufacture of superconducting wires using a relatively new high-temperature superconductor, magnesium diboride. A relatively simple metallic compound, magnesium diboride becomes superconducting below 39 degrees Kelvin, one of the higher transition temperatures for known metallic superconductors. In practice this means that--unlike ordinary metal wire-present day superconducting wires currently used in MRI's are manufactured using a relatively expensive and labor-intensive batch process, which limits the maximum possible length of a single wire, thus the desire for a continuous manufacturing process to reduce manufacturing costs, and increase piece lengths. Since magnesium diboride superconductor starts out as a powder mixture, the powder will be placed in a continuous formed and filled tube with an outer metallic sheath such as iron or niobium, to distribute the powder along the wire. Then several monofilament wires will then be continuously restacked into another copper or copper-nickel formed tube to manufacture a multifilament superconductor wire. Hyper Tech Research, which has been working on improving the performance of magnesium diboride superconductors using nanopowder additives, is scaling up an experimental Continuous Tube Forming and Filling Process (CTFF) to convert magnesium diboride wire from batch processing to high-speed, continuous manufacturing, demonstrating uniform mixing of nano-sized additives and micro-sized powders, continuously monitoring and dispensing the powders at high speeds, and demonstrating process modeling and adaptive control for both monofilament and multifilament wires. The scientific and technical research program falls across several disciplines: superconductors, metal forming, laser welding, process modeling, adaptive controls, sensors and the uniform mixing and dispensing of nano and micron powders. If successful, the project will enable relatively low-cost high-temperature superconducting wires for magnetic resonance imaging (MRI) and electric power applications, but the basic technology will have application in the production of flux-cored welding wire, specialty alloys and the small diameter tubing market as well.

For project information:
Michael Tomsic, (614) 481-8050
mtomsic@hypertechresearch.com

TIP Project Brief – 090049/10H005

Manufacturing
PRINT® Nanomanufacturing: Enabling Rationally Designed Nanoparticles for Next-Generation Therapeutics

Scale up to practical commercial volumes a novel nanoparticle manufacturing process based on nanoscale molding to produce engineered nanoparticles of specific sizes, shapes and materials for therapeutic applications.

Sponsor: Liquidia Technologies, Inc.
Durham, NC

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $5,942 K
- Requested TIP funds: $2,971 K

Liquidia Technologies is developing a novel, top-down approach to nanoparticle fabrication that uniquely enables simultaneous and precise control over nanoparticle size, shape and composition as well as surface functionalization to adapt the nanoparticles to specific tasks for medicine. Nanoparticle drug delivery systems have the potential for transformational results in healthcare, with the unique ability to access and target specific tissues, cell types, and biological systems. Advances in the technology can enable superior efficacy with novel therapeutics and minimize toxicity by specifically targeting certain cell types. Liquidia's Particle Replication in Non-wetting Templates (PRINT®) technology brings the precision and uniformity of the semiconductor industry together with the scale and cost structure of the films industries to create novel, complex particles with simultaneous control over structure and function. Widespread, practical use, however, will require much higher manufacturing efficiencies than currently possible. This project aims to increase the current nanoparticle manufacturing capability by 1000-fold. To achieve this, the company is attempting to simultaneously increase the scale of the process, improve its performance and reduce the process time. This requires exploring and balancing the design requirements for all three goals, including modeling the physical/chemical parameters of the process components to facilitate predictive manufacturing parameters. Unlike other nanoparticle manufacturing techniques, PRINT nanomanufacturing lends itself to a continuous "roll to roll" process of the sort used to make paper, films, and tapes. If successful, the project will enable both new, continuous manufacturing capabilities to create engineered nanoparticle products in clinically relevant quantities and potentially entirely new clinical products based on that capability.

For project information:
Elle Pishny, (919) 328-4361
elle.pishny@liquidia.com

TIP Project Brief – 090052/10H006

Manufacturing
Silicon Nanowire Production for Advanced Lithium-Ion Batteries

Develop a unique, high-throughput, continuous manufacturing process for producing a novel, nanostructured silicon-based anode material for lithium batteries.

Sponsor: Amprius, Inc.
Menlo Park, CA

- Project Performance Period: 2/1/2010 - 1/31/2012
- Total project (est.): $6,000 K
- Requested TIP funds: $3,000 K

Amprius, Inc., is working to develop a unique, high-throughput, continuous manufacturing process for producing a novel, nanostructured silicon-based anode material for lithium batteries. Higher energy density batteries would have a major impact on the development of electric vehicles by extending driving range and lowering costs. Over the 20 years since the introduction of the lithium ion battery, improvements in energy density have been largely driven by increasing utilization of the electrochemically active materials from which they are made. The materials themselves, however, have remained largely unchanged. Today, current active materials are utilized nearly to their theoretical limits; this means that new, higher energy density materials are required if we are to push the limits of energy density much further. Silicon offers more than 10 times the theoretical energy storage capacity of carbon, today's state of the art anode material, suggesting that batteries built with silicon-based anodes could offer significant increases in energy density, corresponding to better driving range and run-time in consumer electronics. Conventional approaches to utilize silicon in batteries, however, have been unsuccessful. Specifically, lithium-ion insertion causes silicon to swell up to 400% when charged. This swelling causes bulk silicon structures to fracture, diminishing battery life after just a few cycles. Structured as nanowires, however, Silicon is able to swell without breaking. Amprius has demonstrated anodes made of silicon nanowires that are tolerant of strains and can expand and contract without breaking for hundreds of cycles. A practical battery with a silicon nanowire anode could increase the energy density of today's lithium batteries by 40 percent, even at realistic levels of material utilization. Amprius currently makes silicon nanowires in a small-scale batch process using chemical vapor deposition (CVD), a process borrowed from the semiconductor industry. Mass consumer applications would require a far more efficient and low-cost manufacturing technique. The company hopes for a 1000-fold scale up of manufacturing capability, and the current project will explore two potential paths towards a large-scale process to produce silicon nanowire anodes "by the mile." After initial feasibility studies, the most promising approach will be developed. If successful, the process will represent the first continuous "roll to roll" process to deposit three-dimensional silicon-based nanostructures. In addition to the manufacture of advanced batteries, this continuous throughput technology would very likely benefit other industries including solar photovoltaic, energy storage and solid-state lighting industries.

For project information:

Ryan Kottenstette, (800) 425-8803
ryan@amprius.com

TIP Project Brief – 090060/10H016

Civil Infrastructure
Robotic Rehabilitation of Aging Water Pipelines

Develop a prototype robot to apply carbon fiber reinforcement inside water transmission pipes, allowing trenchless repair and rehabilitation, even in smaller pipes, as much as eleven times faster than human crews.

Sponsor: Fibrwrap Construction, Inc.
Ontario, CA

- Project Performance Period: 2/1/2010 - 1/31/2015
- Total project (est.): $17,582 K
- Requested TIP funds: $8,462 K

This joint research venture led by Fibrwrap Construction is working to design and build a prototype robot to repair and retrofit aging water mains by applying a tough, carbon fiber reinforcement material to the insides of the pipes without the need for costly excavation or replacement. Other members of the joint venture include Fyfe Company, a pioneer in the development of fiber-reinforced polymer composites, and the University of California, Irvine. The United States is served by a sophisticated water infrastructure consisting of two million miles of water transmission pipelines, most of which, unfortunately, are aging and in some cases failing prematurely. Recent catastrophic breaks of water pipes highlight the urgent needs for cost-effective solutions to address this societal challenge. At present, broken or failing pipes must be dug up, segment by segment, to repair or replace them, which is costly. This project aims to construct a prototype robot able to apply high-strength, high-stiffness, low-cost carbon fiber internally to strengthen underground pipelines and prevent their bursting and collapsing. Simple robots have been used for some time to crawl through pipes for inspection, but the task of evenly and thoroughly applying a carbon fiber coating to the insides of old pipes with unpredictable flaws, imperfect shapes and uneven surfaces is a far bigger technical challenge. The proposed robot would employ advanced sensor systems to monitor the contact pressure against the pipe wall and synchronize the application process with the motion of the robot. Able to lay carbon fiber eleven times faster than human crews, the pipe-repair robot will be able to adapt to variable sized pipes and conditions. The multidisciplinary research team includes Fibrwrap Construction, a pioneer in automated trenchless carbon fiber installation systems; Fyfe Company, a world leader in developing and applying fiber-reinforced polymers for civil infrastructure rehabilitation; the University of California, Irvine, with extensive knowledge and experience in advanced robotics, pipeline modeling and analysis, sensing and non-destructive evaluation of pipelines. In additional to formal members of the joint venture, the project is supported by the East Bay Municipal Utility District; the San Diego County Water Authority; the District of Columbia Water and Sewer Authority; and construction engineers Simpson, Gumpertz & Heger. If successful, the project will develop and commercialize the robotic system which potentially could save the U.S. economy an estimated $245 billion in lost benefits and give the nation a lead in a growing world market for water infrastructure technology.

For project information:
Heath A. Carr, (909) 390-4363
heath@fibrwrapconstruction.com

Active Project Members

- Fibrwrap Construction, Inc. (Ontario, CA)
  [Original, Active JV Member]
- Fyfe Company, LLC (San Diego, CA)
  [Original, Active JV Member]
- The Regents of University of California, (UCI) (Irvine, CA)
  [Original, Active JV Member]

TIP Project Brief – 090062/10H007

Manufacturing
Integrated Multiscale Modeling for Development of Machinable Advanced Alloys and Corresponding Component Machining Processes

Develop and demonstrate integrated multiscale physics-based predictive modeling for developing more machinable advanced alloys and the corresponding component machining processing data needed by manufacturers.

Sponsor: Third Wave Systems, Inc.
Minneapolis, MN

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $3,170 K
- Requested TIP funds: $1,564 K

Third Wave Systems is working to develop a complex, physics-based predictive modeling system for developing advanced alloys that would incorporate data on how best to machine the planned alloy. This would close a major gap that currently exists in the development and application of new, high-performance metal alloys. Advanced alloy development is an active area of research with pervasive impact within the national economy. Industries benefiting from new alloy development include aerospace (airframes and jet engines), defense and the automotive sector. However, a disconnect exists between alloy developers and the manufacturing base of industries who want to machine advanced alloy components in a fast and affordable manner. Each new alloy presents a new combination of toughness, ductility, heat sensitivity and a variety of other characteristics that need to be considered when the material is machined. Time-to-market advantages are lost while manufacturers struggle with determining machining and other manufacturing factors needed to employ these new, unfamiliar alloys. This project will extend the capabilities of computational alloy design, an emerging approach to alloy development. In current computational design, structure-property models are used to predict an optimal alloy microstructure for a specific set of desired final properties, and process-structure models determine an optimal processing scheme to arrive at that microstructure. What is missing is the incorporation, on the one hand, of machinability considerations into the process plan—an intermediate annealing step, for example, that would make the alloy more workable—and on the other hand, physics-based models that could predict optimum machining parameters like tool speeds and feed rates based on the alloy's microstructure. The project will create a high performance computing environment enabling rapid turnaround for cutting tool design and toolpath development for machined advanced alloy component. If successful, it will enable U.S. manufacturers to produce highly machinable, advanced alloys through the coupling of micromechanical models with physics-based machining models. The results will be applicable not only to machining of advanced alloys, but also to general metal machining.

For project information:
Kate Burke, (952) 832-5515
kate.burke@thirdwavesys.com

TIP Project Brief – 090072/10H017

Civil Infrastructure
A Rapid Underground Pipe Rehabilitation Technology

Develop an advanced trenchless technology to rehabilitate the nation's network of underground pipes by employing a novel dynamic resin-injection, molded-in-place pipe (MIPP) process, which can incorporate nanomaterials.

Sponsor: LMK Enterprises, Inc.
Ottawa, IL

- Project Performance Period: 2/1/2010 - 7/31/2012
- Total project (est.): $3,411 K
- Requested TIP funds: $1,701 K

LMK Enterprises is developing a novel technology for repairing and rehabilitating underground pipes from the inside, without the need to dig trenches to expose the damaged pipe. There are a handful of existing or proposed technologies that attempt the same feat. Three basic approaches involve either pulling a new liner, impregnated with a quick-setting resin, through the old pipe in a collapsed form and expanding it with air or water pressure; wrapping the inside of the old pipe with a new, solid lining material like a spiral layer of tape; or spraying the inside of the old pipe with some form of quick-curing coating. These current technologies have various drawbacks. In the case of pre-formed liners, for example, it's necessary to know the diameters and lengths of the old pipe section in advance, so as to manufacture custom tailored liner tubes. Current technologies also do not capitalize on the latest advances, such as nanomaterials, and suffer from other limitations, such as lack of cost-effectiveness and versatility of applications. LMK Enterprises proposes to develop an advanced trenchless technology to rehabilitate the nation's ever deteriorating network of underground pipes by employing a novel dynamic resin-injection, molded-in-place pipe (MIPP) process, which can incorporate nanomaterials. A quick-curing composite resin that could include recently developed nanomaterials for additional strength is mixed in place by an extruding device that applies the mixture between an inflatable bladder and pipe wall providing a smooth and even surface. The proposed LMK technology is novel and offers several advantages over current technologies such as increased productivity by significantly reducing installation time; reduced cost by eliminating the need for a custom tailored resin-impregnated liner tube; improved mechanical properties by employing nanomaterials; and enhanced performance by yielding smooth and uniform wall thickness. According to the Environmental Protection Agency, the annual market for rehabilitation of waste water infrastructure in the United States is approximately $7 billion, and the annual market for potable water infrastructure repair is about $10 billion. The proposed technology has a broad application potential, since it is applicable for rehabilitating all types of pipes including potable water, sewer, gas, oil, steam, and compressed air, and these markets offer a significant opportunity.

For project information:
Larry Kiest, Jr., (815) 433-1275
lmkliner@aol.com

TIP Project Brief – 090099/10H018

Civil Infrastructure
Development of a Multiscale Monitoring and Health Assessment Framework for Effective Management of Levees and Flood-Control Infrastructure Systems

Develop a new health assessment framework, ranging from a satellite-based radar system to local sensor arrays to monitor, assess the health, and ensure the safety of levees and other distributed systems of a flood-control infrastructure.

Sponsor: Rensselaer Polytechnic Institute
Troy, NY

- Project Performance Period: 2/1/2010 - 1/31/2014
- Total project (est.): $6,928 K
- Requested TIP funds: $3,462 K

This joint venture led by Rensselaer Polytechnic Institute partnering with Geocomp Corporation is developing a new health assessment framework with the potential to revolutionize our ability to monitor, manage, and ensure the safety of levees and other systems of a flood-control infrastructure. The integrity and reliability of levees, earthen dams, and flood-control infrastructure are essential components of homeland safety. The failure of such systems due to a natural or manmade hazard such as a hurricane storm surge, flood, earthquake, deterioration, or terrorist attack can have monumental repercussions, sometimes with dramatic and unanticipated consequences on human life, property, and the country's economy. Levees, earthen dams and similar structures are difficult structures to assess not only because of their sheer size but also because they are constructed of complex geological materials, somewhat random in composition, with intricate degradation mechanisms. The planned framework provides a comprehensive multiscale monitoring and analysis for real-time health assessment of this infrastructure. This framework relies on long-term continuous monitoring techniques that are minimally-intrusive and inexpensive, and include satellite-based interferometric synthetic aperture radar (InSAR) measurements and a new high resolution shape-acceleration-pore pressure (SAPP) array able to measure soil displacements and movements over local areas for tens of meters. Novel high resolution GPS sensors with millimeter level accuracy tie the local SAPP arrays to the InSAR measurement system. The planned system would provide for the first time a long term, continuous assessment of the health of levee systems on both local and global scales, allowing federal, state and local governments to prioritize repairs and rehabilitation efforts, and assess the effectiveness of those efforts before a serious failure. The new health assessment framework will be implemented and benchmarked through an ambitious field test in the New Orleans area. The benchmark plan will include a $5,000,000 full-scale test of a levee that will be loaded until failure (i.e., a levee breach). This test will be conducted by the U.S. Army Corps of Engineers and fully funded by the Department of Homeland Security. If successful, the project innovations will transform the field of geohazard mitigation to enable more global and holistic approaches, and thereby enable a better management and more reliable flood-control infrastructure.

For project information:
Michael Mullaney, (518) 276-6161
mullam@rpi.edu

Active Project Members

- Geocomp Corporation (Boxborough, MA)
  [Original, Active JV Member]
- Rensselaer Polytechnic Institute (Troy, NY)
  [Original, Active JV Member]

TIP Project Brief – 090114/10H019

Civil Infrastructure
Development of High-Toughness, Low-Viscosity Resin for Reinforcing Pothole Patching Materials

Develop an innovative pothole repair technology for asphalt pavement in both warm and cold weather using an ultra-high toughness, nano-molecular resin as a reinforcement or binder for the asphalt-aggregate pothole repair material.

Sponsor: The Regents of the University of California (UCLA)
Los Angeles, CA

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $3,051 K
- Requested TIP funds: $1,499 K

A joint research team led by the University of California at Los Angeles in partnership with Materia, Inc., together with the Department of General Services of the City of Los Angeles as a subcontractor, is developing an innovative pothole repair technology for asphalt pavement in both warm and cold weather. Pothole repair is not a glamorous issue, but it's an important one. The potholes in the asphalt pavement of our country's roadways have become an annoying part of our daily life and no innovative technologies have been advanced sufficiently to improve the safety of US drivers, reduce the traffic congestions and cost of road maintenance, and lower the vehicle damages which are in the range of billions of dollars annually. Thus far, most technical approaches to pothole repair have focused on improving the processing and deployment of the asphalt patches. This project takes a radically different approach, infiltrating the compacted asphalt-aggregate mixture with an ultra-high toughness, nano-molecular resin. After the resin is infiltrated, cured, and hardened, it will form a continuous network of mechanical "cages" that will provide mechanical locking of the aggregates in the asphalt mixture, serve as a load-bearing component under repeated traffic stresses, provide compressive shear-load strength, anchor patches to the original pavement walls and sub-bases, prevent water infusion and serve as barrier for the initiation and propagation of alligator cracks. The project involves several major challenges, including material development, compatibility studies, interfacial chemistry and adhesion, performance evaluation and durability testing, durability modeling and life prediction, deployment, road testing and nondestructive monitoring. The Department of Public Works of the City of Los Angeles and the California Department of Transportation will support the deployment of the new repair materials and technology to street test sites. If the project is successful, it will fundamentally revolutionize the asphalt pavement preservation and pothole patching repair methodology, dramatically enhance the strength, durability and service life of the asphalt pavement and pothole repair patching practices.

For project information:
Wileen Wong Kromhout, (310) 206-0540
wwkromhout@support.ucla.edu

Active Project Members

- Materia Inc (Pasadena, CA)
  [Original, Active JV Member]
- The Regents of the University of California, (UCLA) (Los Angeles, CA)
  [Original, Active JV Member]

TIP Project Brief – 090121/10H020

Civil Infrastructure
Advanced Coating Technology for Infrastructure

Develop a novel coating technology using a high-intensity infrared light source to fuse and bond nanocomposite metal coatings and claddings to large steel structures such as bridges, oil rigs and pipelines.

Sponsor: MesoCoat, Inc.
Euclid, OH

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $3,956 K
- Requested TIP funds: $1,792 K

This joint research venture led by MesoCoat, together with The Edison Materials Technology Center (EMTEC) and Polythermics, LLC, is developing a novel coating technology to change the way large steel and steel alloy structures are protected from corrosion. Steel structures, including bridges, pipelines, and support structures, are subject to corrosion and attack from the atmosphere, acid rain, salt, and chloride ions, among others. Current protection systems rely on often hazardous primer materials such as heavy metals coated with an organic polymer paint as a moisture barrier. The organic coatings are subject to ultra violet degradation over time and must be repaired or replaced regularly, a process that involves stripping with volatile organic compounds (VOCs). Many of the materials, such as lead, cadmium and chromium as well as the VOCs have been phased out or are subject to increasingly strict environmental regulations. This project is developing large area nanocomposite, corrosion-resistant coating materials and a high-rate, low-cost application technology. Novel, high-intensity infrared light sources will be used to fuse nanocomposite metal-ceramic and polymer coatings onto steel surfaces of large structures, replacing electroplating, chromate primers, hot-dip galvanizing and fusion-bonded epoxy coatings. If successful, the application system, which relies on a scalable high intensity white light optical source, will be able to rapidly heat a surface to remove old paint or polymer coatings with minimal hazardous waste or volatile organic emissions. The same application system can also be used for removal of damaged concrete as well as for repair and reinforcement of metallic pipe at rates ten to hundred times that of weld cladding. The metal finishing industry, according to MesoCoat, is currently a $16 billion market (inorganics only) and one of the largest users of hazardous and carcinogenic chemicals in industry. This project's technology would provide a complete, portable system to strip coatings, apply high-performance metal primers and zero VOC polymer topcoats with improved performance at lower cost.

For project information:
Mr. Andrew Sherman, (216) 453-0866
asherman@mesocoat.com

Active Project Members

- EMTEC (Dayton, OH)
  [Original, Active JV Member]
- MesoCoat, Inc. (Euclid, OH)
  [Original, Active JV Member]
- Polythermics (Kirkland, WA)
  [Original, Active JV Member]

TIP Project Brief – 090163/10H008

Manufacturing
High Volume Production of Nanocomposite Electrode Materials for Lithium-Ion Batteries

Develop a new composite nanomaterial for lithium-ion battery cathodes for significantly increased battery performance together with improved manufacturing techniques to lower overall costs.

Sponsor: A123Systems, Inc.
Ann Arbor, MI

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $6,000 K
- Requested TIP funds: $2,864 K

A123Systems, Inc. is developing a new nanocomposite material for lithium ion battery electrodes together with improved manufacturing process technologies to enable both significantly improved battery performance and lower manufacturing costs. With their high energy-to-weight ratios, lithium ion batteries are an important enabling technology for electric vehicles, upgrading the electric utility grid, and increasing the use of variable renewable energy sources such as wind and solar power. The highest barrier to adoption of lithium ion batteries in the transportation market is cost, and the largest cost component of the battery is the positive (cathode) electrode material. Technology innovations that either improve the efficiency or lower manufacturing costs of cathode materials, therefore, can have a major impact on the lithium ion battery market. A123Systems has an existing iron-phosphate nanocomposite electrode material that has enjoyed commercial success and is commonly used in batteries for cordless power tools, among other applications. The current project pursues a novel second generation nanomaterial that would replace some or all of the iron with manganese, increasing the battery's energy density and therefore reducing cost per watt-hour. This project also will develop a number of improvements to the manufacturing process used to make the nanoparticles which should result in a threefold increase in manufacturing throughput. Since capital equipment and facilities are primary factors in the cost of electrode materials, increasing throughput offers the best leverage for cost reduction. The ultimate goal of the project is to scale up from 10 grams per lab batch to more than 10 kilograms per day production in a quasi-continuous pilot demonstration.

For project information:
Dr. Mike Wixom, (734) 213-1623
mwixom@a123systems.com

TIP Project Brief – 090165/10H009

Manufacturing
Building U.S. Strategic Metals Competitiveness Through Integration of Advanced Sensor Technologies

Develop and scale-up to commercial levels a suite of novel, optoelectronic inspection technologies to accurately identify and sort aerospace metals such as titanium and nickel/cobalt superalloys at ultra-high speeds so they can be recycled more cost effectively and also to enhance melting capacity for existing furnaces by measuring composition in-situ, in real time.

Sponsor: wTe Corporation
Bedford, MA

- Project Performance Period: 2/1/2010 - 1/31/2014
- Total project (est.): $11,532 K
- Requested TIP funds: $5,670 K

This joint research venture led by wTe Corporation together with National Recovery Technologies, Inc., and Energy Research Co., is working to combine and scale up a suite of technologies to build an efficient, integrated recycling system for high-value alloy scrap in the aerospace industry. The aerospace industry is one of the nation's most advanced and successful manufacturing sectors. It also has an extraordinarily high scrap rate because high-performance jet engines, airframes, and similar aerospace products require extremely tough and tight quality control. According to industry statistics, out of the 949 million pounds of raw materials consumed by the aerospace industry in 2008, only about 19 percent actually makes it into an aircraft. This project focuses on recycling two high-performance specialty alloys used by the aerospace industry, titanium-based alloys and the nickel- or cobalt-based "superalloys." These are extremely high-performance and costly alloys, but the scrap often cannot be reused in aerospace applications either because it is too expensive to recycle given current practices or because it is too contaminated to recycle as the original high-grade alloy. As a result it must be downgraded to inferior product uses and applications. The joint venture team is scaling up a group of novel optical technologies to first, automate the sorting of scrap metal at high speeds and volumes, sorting each piece by composition, and second, provide real-time, continuous analysis of the composition of molten metal in high-temperature alloy furnaces to allow furnace operators to make changes to the melt while it is being processed. The novel technologies, based on optical and x-ray spectroscopy, would both significantly refine the waste metal stream and enable alloy producers to accommodate changing scrap metal input and furnace conditions to produce precise alloy chemistries. Such tight control of alloy chemistry not only would enable the production of better alloys but also would reduce production time and eliminate "bad heats," saving energy and raw materials. If successful, the project would lessen U.S. dependence on supplies of strategic virgin metals recovered at primary refineries from ore (most of which are purchased abroad), and enable substantial energy savings from use of scrap rather than ore and virgin metals. There would also be greatly reduced emissions because secondary smelting consumes much less energy than primary production followed by remelting.

For project information:
M. Scott Mellon, (781) 275-6400
msmwte@aol.com

Active Project Members

- Energy Research Company (Staten Island, NY)
  [Original, Active JV Member]
- National Recovery Technology, Inc. (Nashville, TN)
  [Original, Active JV Member]
- wTe Corporation (Bedford , MA)
  [Original, Active JV Member]

TIP Project Brief – 090169/10H010

Manufacturing
Homogeneous Three-Dimensional Pultruded Processing of PEEK, PEI, and PPS High Temperature Thermoplastic Composite Profiles

Develop a state-of-the-art manufacturing process to automate, on a large scale, the production of three-dimensional fiber composites with high temperature thermoplastics.

Sponsor: Ebert Composites Corporation
Chula Vista , CA

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $4,018 K
- Requested TIP funds: $1,866 K

Ebert Composites Corporation is developing a novel manufacturing process to produce large, three-dimensional, fiber-composite components from a variety of high-temperature thermoplastics. Thermoplastics are strong, flexible materials than turn liquid when heated above a critical temperature. They have several valuable properties; they can be resistant to chemical attack or shock and some are able to withstand quite high temperatures. Very strong composite materials can be made with thermoplastics. Unlike thermoset plastics, thermoplastics are relatively easy to recycle because they can be melted and reformed again and again. (PET beverage bottles, for example.) Handling thermoplastic resins in the molten state to achieve adequate wet-out of large or complex reinforcement profiles is a challenge. Current high-temperature thermoplastic composites are essentially two-dimensional. They are manufactured as a thin tape of the composite material, such as carbon fibers, impregnated with the thermoplastic. Manufacturers buy this "prepreg" tape and cut, braid and form it into more complex shapes which are then heated and formed in a mold to produce the finished part. In addition to requiring several steps and much labor, the process limits the size and complexity of the shapes that can be made. Ebert has pioneered the production of continuously formed, three-dimensional shapes from thermoset composites using the "pultrusion" process. In this project, the company is developing a radically different manufacturing process to achieve the same thing with high-temperature thermoplastics. The process will produce components that can be larger than any existing thermoplastic mold and that are equally strong in all three dimensions (a problem with today's prepreg-based components). If successful, the project could revolutionize the composites industry, enabling larger and stronger thermoplastic composite components at a quarter the cost of the current state of the art.

For project information:
Mr. Todd E. Johnson, (619) 423-9360
todd.johnson@ebertcomposites.com

TIP Project Brief – 090174/10H011

Manufacturing
High-risk, Low-Cost Carbon Nanofiber Manufacturing Process Scale-Up

Develop a commercial-scale manufacturing process for producing self-supporting, non-woven fabrics of both natural and activated carbon nanofibers.

Sponsor: eSpin Technologies, Inc.
Chattanooga, TN

- Project Performance Period: 2/1/2010 - 4/2/2013
- Total project (est.): $6,006 K
- Requested TIP funds: $3,000 K

eSpin Technologies, Inc. is conducting research to scale-up a manufacturing process for producing commercial quantities of self-supporting, non-woven fabrics of both natural and activated carbon nanofibers. These fabrics have a wide range of potential applications. The current focus is on the development of low-pressure-drop, high-performance molecular air filter media. Molecular air filtration provides protection against chemical and biological weapons, toxic vapors from industrial processes and volatile organic chemicals (VOCs) emitted from new carpets and paints in offices and homes. eSpin has already innovated the manufacture of non-woven nanofiber materials with a polymer nanofiber fabric used for particulate air filters. Carbon fibers and/or activated carbon nanofibers with diameters of a few hundred to less than a hundred nanometers have very high ratios of surface-area to mass, which produces extremely lightweight and high-performance materials. Very little pressure drop occurs when non-woven mats of these nanofibers are used for air filtration thus resulting in significant energy savings. Manufacturing these innovative carbon nanofiber products on a commercial scale requires solving several major technical challenges. The fabrics are initially produced by fabricating a non-woven nanofiber web from an organic polymer. The web is then carbonized by a high-temperature thermal process. Nanofiber materials are extremely fragile and customarily are made on a substrate that provides support. However a substrate cannot be used for the thermal processing stage. Therefore a major challenge will be to produce a free-standing self-supporting nanofiber web. Additional engineering challenges include managing heat flow, removing off-gases and residual solvent, web transport and controlling the carbon structure within the nanofibers. eSpin estimates that molecular air filters—their target application—if widely utilized could save the Nation trillions of Joules of energy annually. In addition, the fundamental technology for producing free-standing non-woven carbon nanofiber materials would have a wide variety of applications in carbon-fiber composite materials because of their high strength-to-weight ratio and their relatively low cost, whereas activated carbon nanofibers are expected to have applications in energy storage devices among many other uses.

For project information:
Renee Ford, (423) 267-6266
rford@espintechnologies.com

TIP Project Brief – 090175/10H012

Manufacturing
Development and Scale-Up of Nanocomposites with Sub-10nm Particles

Develop new processes and technologies for scaling up the production of high quality nanocomposites, by incorporating nanocrystals with precisely controlled size, shape, and surface chemistry into a polymer matrix for demanding and high-volume industrial applications.

Sponsor: Pixelligent Technologies, LLC
College Park , MD

- Project Performance Period: 2/1/2010 - 1/31/2013
- Total project (est.): $8,178 K
- Requested TIP funds: $4,089 K

A research joint venture led by Pixelligent Technologies, LLC, partnered with Brewer Science, Inc., is developing new processes and technologies to scale up the production of high-quality nanocomposites—nanocrystals dispersed in polymers—to create materials with enhanced performance and new functionality that cannot be provided by polymers or traditional composites. Their initial target applications are new materials for the optoelectronics and semiconductor industries. Adding tailored nanocrystals to polymers can result in materials with a broad range of enhanced properties, depending on the combination. Polymer nanocomposites can be designed that are tougher, stronger, stiffer, more heat resistant, better conducting, more fire-resistant, more chemical resistant and more biocompatible. Although many nanocomposites have shown great promise at the laboratory scale, commercialization has lagged, in part because of the inability to produce these materials on an industrial scale while maintaining their quality and functionality. Working with Brewer Science, a company with expertise in polymers for industrial applications, Pixelligent aims to scale their production of high-quality metal oxide nanoparticles from grams to kilograms while maintaining their ability to control the size and shape of the particles within narrow ranges, and prevent them from clumping together, a common problem with nanoparticles. Their two target applications are novel polymer nanocomposites, one with a high index of light refraction and other necessary properties for use in high-efficiency light-emitting diodes (LEDs), and the other a novel microlithographic layer for semiconductor processing that can be used in thinner coatings to support next-generation levels of microcircuit lithography. If successful, the basic nanocomposite processing advances developed in this project should extend to a wide range of nanocomposite materials.

For project information:
Gregory Cooper, (301) 405-9284
gcooper@pixelligent.com

Active Project Members

- Brewer Science, Inc. (Rolla , MO)
  [Original, Active JV Member]
- Pixelligent Technologies, LLC (College Park , MD)
  [Original, Active JV Member]

TIP Project Brief – 100002/11H001

Manufacturing
Production of Fully Deleted Helper-Virus Independent Adenoviral Vectors

Develop and optimize standardized manufacturing systems for a novel type of pharmaceutical-grade gene transfer vehicle for vaccination, gene therapy and tissue transplantation applications.

Sponsor: Isogenis, Inc.
12635 East Montview Boulevard
Suite 370
Aurora, CO 80045-7336

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $5,511 K
- Requested TIP funds: $2,756 K

Since viruses are designed by nature to transport genetic material into an infected host cell, biotechnology researchers have developed various ways to adapt viruses as “vectors” to transfer genes for therapeutic purposes. Isogenis, Inc. has developed a versatile gene transfer vector based on the adenovirus, a family of common viruses. In this project Isogenis hopes to develop improved manufacturing technologies for commercial-scale production of modified versions of their adenovirus (Ad) vector, intended for a variety of medical uses, including vaccines, organ and tissue transplants, and gene therapy.

The Isogenis Ad vector is “fully deleted,” meaning that it is essentially an empty icosahedral shell stripped of all the original virus genes. It is believed to be highly safe; it is not infectious and does not integrate into the target cell chromosomes. Isogenis is exploring the use of the Ad vector to create safe vaccines that can be developed rapidly for diseases ranging from influenza to dengue hemorrhagic fever. It also could be used to protect transplanted tissue from the body’s immune system without the need for immune suppression drugs, and as a gene therapy vehicle to treat diseases such as hemophilia and cystic fibrosis.

Producing Isogenis’s Ad vector is complicated because the deletion of all the Ad genes means that the biochemical “information” needed to assemble the vector, together with its biopharmaceutical payload, must be provided separately. Other “helper” viruses could be enlisted to do this, but the Food and Drug Administration has expressed concerns that this runs the risk of contaminating the final product. With TIP support, the company plans to develop and optimize standardized manufacturing systems for fully deleted, helper virus-independent Ad (fdhiAd) vectors that would enable mid- and large-sized batch manufacture of pharmaceutical-grade vectors for vaccination, gene therapy and tissue transplantation applications. If successful, the technology would provide valuable new capabilities to the nation’s healthcare system. The vaccine applications alone would be important in combating emerging infectious threats and bioterrorism because the fdhiAd-based vaccines could be developed more quickly and at lower cost than traditional vaccines.

For project information:
John R. Price, MPA, (303) 886-0700
jprice@isogenis.com

TIP Project Brief – 100006/11H002

Manufacturing
Volume Production of Nanocomposite Alloy Anode Materials for Lithium-Ion Batteries

Develop technology necessary to scale up production of the company's novel nanocomposite material for high-performance lithium batteries by a factor of a thousand, potentially enabling safe, powerful and economical batteries for electric vehicles and other demanding applications.

Sponsor: ActaCell, Inc.
2105 Donley Drive
Suite 200
Austin, TX 78758-4510

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $6,197 K
- Requested TIP funds: $3,000 K

ActaCell, Inc., a start-up company based in Austin, Texas, plans to develop technology necessary to scale up production of the company's novel nanocomposite material for high-performance lithium batteries by a factor of a thousand, potentially enabling safe, powerful and economical batteries for electric vehicles and other demanding applications.

Lithium-ion batteries could be an excellent choice for large energy storage applications such as plug-in hybrid (PHEV) and electric vehicles (EV), because they can store far more energy in a smaller space than other types of batteries—which translates to lighter, more efficient vehicles with greater range. However, lithium batteries face several technical challenges, principally related to achieving a high level of safety while maintaining a low cost. One of the primary safety issues in current lithium-ion batteries is related to the use of graphite as the battery's anode and the electrochemical interaction between the graphite anode and the electrolyte. ActaCell has developed a novel nanocomposite anode material, based on research at the University of Texas at Austin, which greatly reduces the reactivity of the anode under abusive conditions. The ActaCell anode material also is, in principle, significantly less expensive to produce.

To be commercially viable, ActaCell must be able to scale up the production of its nanocomposite anode material from the current laboratory batches of about 5 grams to 5 kilograms economically. To achieve this, the company proposes to use a technique called Reactive High Energy Milling (RHEM) that drives a chemical reaction via the use of a high energy reactive milling in one single reaction scheme. Commercial scale use of RHEM is untried in the lithium battery industry, and is complicated by a number of process variables that are not expected to scale uniformly, but is critical to keep the processing and overall materials cost low. The scale-up of this synthesis process will be a key innovation not only in the lithium-ion battery industry, but also as a low-cost manufacturing technique for other related materials. These combined innovations are key to advancing adoption of large-scale energy storage, offering potential transformation of both the automotive and electric utility sectors.

For project information:
Marc Kohler, (512) 834-8600
mkholer@actacell.com

TIP Project Brief – 100019/11H003

Manufacturing
Atmospheric Spray Freeze Dried Powder Process Advancement and Scale-Up

Scale up and demonstrate a commercially viable production line employing a novel freeze drying process to prepare complex biomolecules in powder forms that simplifies the storage and delivery of emerging, protein-based pharmaceuticals.

Sponsor: Engineered BioPharmaceuticals, Inc.
71 Utopia Road
Manchester, CT 06042-2192

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $5,977 K
- Requested TIP funds: $2,988 K

Engineered BioPharmaceuticals, Inc., a small start-up company, plans to scale up and demonstrate a commercially viable process for freeze drying protein-based pharmaceuticals in aseptic, powder forms. If successful, the company's technology could significantly simplify the use of emerging, protein-based therapies by stabilizing the drugs, extending their shelf life, and making them amenable to a variety of simple, reliable delivery mechanisms such as low cost inhalers and point-of-use devices.

Advances in biotechnology have opened up a new class of pharmaceuticals based on engineered proteins that can selectively target specific disease mechanisms with relatively few side-effects. The field, still in its infancy, has great potential to prevent or combat many diseases and provide an arsenal of therapies to counteract pandemic and bioterrorism agents. Biomolecular-based drugs, however, are large and complicated molecules that must be handled carefully to preserve their effectiveness. They generally cannot be delivered as pills or otherwise ingested because the digestive mechanism is specifically designed to break down proteins. Currently, most are injected as liquids by a less than enthusiastic patient-base. Due to the relatively short shelf life stability of liquid biomolecular-based drugs, they often require special handling, such as maintaining cold chain storage and/or clinician administration, both adding to increased cost and limiting distribution. Establishing a long shelf life through aseptic processing into dry powders is a cost effective and essential process for efficient storage of stockpiles required for epidemics and pandemics.

Engineered BioPharmaceuticals has pioneered an atmospheric spray freeze drying (ASFD) process to create high performance dry powders in controlled sizes for biomolecular pharmaceuticals. Freeze drying has been used to preserve things such as blood serum since World War II, but existing commercial processes produce either solid cakes or poorly defined powders that are unsuitable for aerosol delivery and can be difficult to dissolve while maintaining therapeutic value. The project entails significant technical challenges in creating a hybrid manufacturing process that combines the characteristics of spray drying and freeze drying while maintaining a fine control over particle shape. Technical barriers to be overcome include preventing stresses on the biomolecules that damage their therapeutic value; handling aerosol distributions with particle dimensions ranging from the micron scale to the sub-micron scale without loss of expensive product (much like catching smoke and placing it in a small bottle without losing any); and performing all operations in aseptic environments.

The company proposes to build and demonstrate an integrated production line capable of manufacturing aseptic dry powders and filling them aseptically into delivery devices. A non-pharmaceutical test material will be used to demonstrate the production and packaging of aseptic powder batches at a variety of size scales, including nanoscale particles, and particles suitable for pulmonary delivery, nasal delivery, and reconstitution. The company also will produce a recombinant protective antigen vaccine powder to demonstrate the process' potential with actual proteins.

For project information:
Carl Sahi, (860) 803-7437
crsahi@engbiopharm.com

TIP Project Brief – 100030/11H004

Manufacturing
Critical process advance to transform production rates of core-sheath electrospun fibers enables manufacturing of micro- and nanofibrous devices in practical commercial volumes

Develop processes to increase production of drug-filled, hollow fibers to rates necessary to enable commercially viable use of these fibers in devices and products for drug delivery, tissue engineering, nanoscale sensors and other applications.

Sponsor: Arsenal Medical, Inc
480 Arsenal Street
Watertown, MA 02472-2891

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $4,706 K
- Requested TIP funds: $2,279 K

Good things often come in small packages—like the ultrathin core-sheath fibers now being eyed for applications ranging from controlled drug delivery systems and tissue regeneration to self-healing coatings and self-cleaning filters. Core-sheath fibers are fibers with a concentric structure, one material surrounding another. (Think of an insulated copper wire, but much smaller.) Arsenal Medical intends to develop a high-throughput, core-sheath electrospinning technology that greatly increases the rate of producing these slender cylindrical packages. The anticipated jump in processing speed would move promising—but unaffordable—prospective products requiring high-throughput manufacture of core-sheath fibers into the realm of the commercially viable.

Ranging in diameter from about 100 nanometers to 20 micrometers, core-sheath fibers are among the most promising members of a growing family of electrospun materials. In electrospinning, a high-voltage electrical field is used to charge and stretch a droplet of a polymeric solution while on its way to a grounded collector plate or screen. Depending on the composition of the starting materials, operating conditions, and other factors, the process outputs can take the form of a range of shapes and textures including meshes, tubes, or structures that look like yarns.

A major challenge is to develop methods that yield fibers of uniform quality in volumes sufficient for commercial production. This is especially true for core-sheath fibers because of their concentric design, which encapsulates one material within another. Production yields with the current state-of-the-art method—a pump-driven needle with low flow rates—are a fraction of a gram per hour, according to Arsenal Medical.

Extending a newly introduced technology, the company will leverage the physics of electrospinning to devise a process that generates multiple fiber-forming jets composed of two materials in the desired arrangement. In addition to revving up production rates by more than 500-fold, the nascent process does not require multiple nozzles, as would an alternative option. Arsenal Medical says its approach can overcome logistical, quality-control, and cost issues that impede other approaches to scaling up production of core-sheath fibers for marketplace applications.

For project information:
Toby Freyman, Ph.D., (617) 393-4609
tfreyman@arsenalmedical.com

TIP Project Brief – 100032/11H005

Manufacturing
Process Innovation for High Technology Manufacturing of Flexible Liquid Crystal Displays

Develop a suite of integrated processes for efficient, roll-to-roll manufacturing of flexible, reflective displays for high-volume product markets.

Sponsor: Kent Displays, Inc.
343 Portage Boulevard
Kent, OH 44240-7284

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $6,005 K
- Requested TIP funds: $2,996 K

With the vast majority of liquid crystal displays (LCDs) now manufactured in Asia, Kent Displays proposes to develop a suite of processes for high-volume production of flexible, low-power displays—an emerging technology that can help U.S. businesses establish a solid foothold in the growing flat-panel market, now totaling about $150 billion globally. If successful, the project will result in the first U.S. facility for commercial scale manufacturing of high-resolution digital displays of any type. The displays will be made from thin flexible, plastic films, as opposed to the thin-film transistor LCDs made of breakable glass. Used in flat screen TVs, laptop computers, cell phones, and other devices, these glass LCDs account for most of the global market. Rather than challenge the entrenched technology, Kent Displays plans to open new markets by introducing its low-power, high-resolution Reflex™ displays for use on credit cards; as electronic paper for broad-scale applications, such as advertising; in low-cost writing tablets, and for other mass-market offerings. Because they reflect ambient light, Reflex displays do not require backlighting; nor do they require constant refreshing. Both attributes greatly reduce power consumption.

The company recently progressed from batch processing to continuous roll-to-roll manufacturing of Reflex flexible displays, enabling it to produce a first-generation electronic writing tablet in volume for the mass market—the popular Boogie Board™ LCD Writing Tablet. Now it aims to increase production capabilities and lower costs for Reflex flexible displays by developing seven new manufacturing processes. These processes are expected to provide the framework for attaining the high-yield, high-volume production capacity necessary to expand markets for the Boogie Board tablet as well as capture markets for new LCD products that exploit the attributes of Kent Display's flexible technology, including low power, low cost, and high resolution. Kent Displays will maximize the effectiveness of the processes by integrating them into an on-line system where each process rests on the capabilities of the others. Collaborators contributing to the project include the University of Akron and the Manufacturing and Growth Network (MAGNET), as well as a host of other close partners and strategic suppliers.

For project information:
Kevin Oswald, (330) 673-8784
KOswald@kentdisplays.com

TIP Project Brief – 100044/11H006

Manufacturing
Genetic Engineering of Elite Bioproduction Cell Lines

Create new tools for modifying the chemical structure of proteins that are produced by current biomanufacturing technologies to improve the therapeutic action of the manufactured protein.

Sponsor: Precision BioSciences, Inc.
104 TW Alexander Drive
Building 7
Research Triangle Park, NC 27709-2292

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $5,453 K
- Requested TIP funds: $2,712 K

Precision BioSciences aims to develop a genomic engineering tool kit for reprogramming a key biological process that largely determines the yield, quality, safety and cost of monoclonal antibodies and other therapeutic proteins produced with Chinese hamster ovary (CHO) cells. The industry standard cell line, CHO cells are used to make about two-thirds of all glycosylated biopharmaceuticals, which in turn account for about a quarter of all new drugs approved for clinical use. The complex process—known as glycosylation—involves dozens of enzymes and other biomolecules. These enzymes are engaged in linking sugar molecules (saccharides) to various amino acids that make up a protein. The final arrangement of sugars affects the properties of the resultant glycoprotein, including its safety, effectiveness, availability and longevity in the body. Because of challenges in optimizing glycosylation, production of glycoproteins is time-consuming and costly. Achieving precise control of the process in CHO cells would make it far easier to optimize therapeutic proteins so that dosage requirements for some biopharmaceuticals now in the markets could be reduced by as much as 80 percent, according to Precision BioSciences.

Using its technology for cleaving strands of DNA at specific points and inserting new genetic instructions, the company will edit and reprogram multiple genes in a single CHO cell and modify reaction pathways involved in glycosylation to target specific sugars. The novelty and challenge of the project lie in its scope and in manipulating multiple genes in the same CHO cell line without negatively affecting its growth or capacity to produce biopharmaceuticals. Because it is difficult to manipulate the genomes of living mammalian cells, previous attempts to modify glycosylation have been limited to a single gene. In this TIP project, Precision BioSciences aims to optimize a large ensemble of genes and their products. Because CHO cells already are integral to a large segment of the biomanufacturing industry, implementation of process technologies resulting from the project would not require a major overhaul of the industry's existing infrastructure. More efficient processes also would help to foster the emergence of a competitive generics market for biopharmaceuticals. Knowledge gained in this project is expected to advance the state-of-the art in genomic engineering and synthetic biology.

For project information:
Derek Jantz, Ph.D., (919) 314-5512
derek.jantz@precisionbiosciences.com

TIP Project Brief – 100067/11H008

Manufacturing
Volatile Reporters for Biomanufacturing of Protein Therapeutics

Develop genetically engineered measurement technologies for real-time monitoring of cellular health and production capacity during the manufacturing of therapeutic proteins.

Sponsor: Ginkgo BioWorks, Inc.
7 Tide Street
Unit 2B
Boston, MA 02127-0000

- Project Performance Period: 2/1/2011 - 7/31/2013
- Total project (est.): $2,300 K
- Requested TIP funds: $1,000 K

Ginkgo BioWorks aims to develop genetically-engineered tools for in-line, real-time monitoring of the fermentation processes used in the production of pharmaceutical proteins. The company's novel "reporter technology," intended for integration and use with analytic equipment already in place in biomanufacturing operations, will facilitate the monitoring, control, and optimization of fermentation processes used to produce monoclonal antibodies, vaccines, and other biologic compounds for medical and industrial applications.

Made in cells, biologics constitute one of the fastest growing segments of the pharmaceutical industry. Yet, determining and maintaining fermentation process conditions that yield acceptable levels of these compounds can be exceedingly challenging. Slight variations in process conditions can stress cells, suppress expression of genes that code for desired proteins, or interfere with the folding and post-translational modification of proteins as they are being assembled inside cells. Existing process-monitoring methods only make periodic measurements of many sample variables—akin to taking multiple photographs. With the tools of synthetic biology, Ginkgo BioWorks proposes to fashion the biomanufacturing equivalent of real-time video monitoring. By inserting so-called reporter genes at strategically located sites in the production cell's genome (the cell's hereditary information) the company will create the means to continuously track the health of cells and the growth conditions in fermentors. Changes will trigger the reporter genes to initiate production of volatile reporter compounds that can be detected with gas chromatography-mass spectrometry instruments, which are standard in biomanufacturing. With this capability, manufacturers could make real-time adjustments to maintain optimal production conditions. In-line monitoring would also simplify steps required to demonstrate conformance with regulatory requirements, thereby facilitating further innovation in manufacturing practices.

For project information:
Joseph Davis, (510) 517-2731
joey@ginkgobioworks.com

TIP Project Brief – 100071/11H009

Manufacturing
Low cost, scalable manufacturing of surface-engineered super-hard (SESH) substrates for next generation electronic and photonic devices

Develop the means to fabricate high-quality, super-hard substrates in a rapid, reliable, scalable, and cost-effective manner.

Sponsor: Sinmat Inc.
2153 SE Hawthorne Road
Box 2, Suite 124
Gainesville, FL 32641-7553

- Project Performance Period: 2/1/2011 - 1/31/2014
- Total project (est.): $4,801 K
- Requested TIP funds: $2,398 K

Sinmat is pursuing a practical, cost-effective solution to a hard technological problem impeding progress toward next-generation integrated circuits, advanced power electronic devices, and enhanced solid-state-lighting technology. The company plans to develop commercial-scale methods for making super hard, low-defect substrate materials and engineering the surfaces of these advanced technology platforms to eliminate roughness and optimize properties for particular applications. Success could pave the way for silicon-on-diamond (SOD) substrates to meet the need to rapidly dissipate heat on future generation integrated circuits. By 2016, according to the semiconductor industry's technology roadmap, the thermal properties of the current substrate material—silicon on insulator—will fall short of what is needed.

However, SOD technology is not ready to fill the void because methods currently available cannot smooth diamond surfaces to the required level—less than 1 nanometer in variation. Near perfect surfaces on super hard substrates also are required for improving brightness of light emitting diodes, eliminating defects that impede the performance of high-power devices, and creating large sheets of graphene of the desired thickness to enable commercial applications of this promising, but still experimental nanoscale material.

Sinmat's surface-engineered super-hard substrates are designed to greatly reduce surface roughness, reduce defect density, and enhance light reflection. The company proposes to refine and scale up its state-of-the-art chemical mechanical polishing techniques for engineering the surfaces of gallium nitride, silicon carbide, diamond, and other extremely hard materials. This capability could spawn an estimated $1 billion market for super hard materials with engineered surfaces, enhance energy efficiency in lighting and other products, and reduce manufacturing costs in the semiconductor industry.

For project information:
Rajiv Singh, (352) 334-7237
rksingh@sinmat.com

TIP Project Brief – 100095/11H010

Manufacturing
Novel Nanomaterial Synthesis Processes to Enable Large-Scale, High-Performance, Flexible Solar Module Manufacturing in the U.S.

Develop novel processes for manufacturing organic photovoltaic materials to enable large-scale manufacturing of high-performance, flexible solar-energy modules.

Sponsor: Polyera Corporation
8045 Lamon Avenue
Suite 140
Skokie, IL 60077-5308

- Project Performance Period: 2/1/2011 - 1/31/2013
- Total project (est.): $4,953 K
- Requested TIP funds: $2,051 K

Thin-film organic photovoltaic (OPV) materials have the potential to bring the promise of low-cost, ubiquitous solar power to fruition while reinvigorating U.S.-based manufacturing and construction. Polyera has developed a class of semiconductor materials with the potential to reach ten percent power-conversation efficiencies (PCEs), the level needed to enable solar modules competitive with other technologies on a cost-per-watt basis. It proposes to develop cost-effective, high-yield synthetic methods to enable the large-scale manufacturing of these materials. The project will develop and evaluate novel synthetic routes for making the fundamental building block. It also will examine the potential of a highly-novel polymerization method—never before used in the industry—to better control the photoactive layer polymer architecture at the nanoscale. Compared with traditional polymerization methods, this new approach offers the advantages of reduced complexity and greater control over molecular weight and polydispersity, ultimately leading to higher-yield, lower-cost, and higher-performance polymer production, thus optimizing device performance.

Polyera will work with third parties to scale-up the process first to pilot levels and then to commercial scale volumes, while ensuring that the material performs adequately and is suitable for solar modules. Having reliable, cost-effective production of high-efficiency, easy-to-process photoactive materials would drive down solar module manufacturing and installation costs, create new sectors for U.S. manufacturing in a market with global demand, and provide cost-effective, renewable energy on a much larger scale.

For project information:
Brendan Florez, (240) 242-7699
bflorez@polyera.com