A SAMPLING OF FUNDED NANOSCIENCE PROJECTS

(Continued)

PROJECT	RESEARCHER	DESCRIPTION
DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT SYSTEMS		
Geometric Modeling for Computer-aided Nano Design	Yan Wang	Study multi-scale geometric modeling and simulation for Computer Aided Nano Design (CAND) by the aid of hyperbolic surfaces (NSF—CAREER)
DEPARTMENT OF MECHANICAL, MATERIALS & AEROSPACE ENGINEERING		
Ceramic Nanoparticle Reinforced Al and Ti Nanocomposites	Linan An	Process and characterize the Al/Ti based nanocomposites reinforced with ceramic nanoparticles (Oak Ridge National Lab)
Novel Brush Plating for In Situ Fabrication of Metallic nanocomposite	Quanfang Chen	Developed for in situ fabrication of CNTs reinforced metallic nanocomposites for various surface engineering applications (NSF)
Development of a Large Format and Stroke MEMS Deformable Mirror for Direct Imaging of Extrasolar Planets	Quanfang Chen	Develop an innovative deformable mirror (DM) for revolutionary adoptive optical systems
Acquisition of NIL (Nanoimprint Lithography) System	Hyoung Jin Cho	Study nanoimprint (NIL) and soft lithography techniques, which were developed in 1990's are high-throughput, low cost replication methods (NSF)
Nano-particles/tubes Integrated MEMS device for Point Contact Highly-sensitive Hydrogen Sensor	Hyoung Jin Cho	Research nano-particles/tubes and integrated device for point contact highly-sensitive hydrogen sensor
Highly Selective Nano-MEMS Low Temperature Hydrogen Sensor	Hyoung Jin Cho	Develop low temperature based hydrogen detection technology for the US space program and vehicles
3-D Prous Nanostructured Hydroxyapatite Bone-grafts Doped with Essential Trace Elements	Samar Kalita	Build 3-D porous bone-grafts and examine influences of nano-ceramic and trace elements
Composite cathodes for Intermediate Temperature SOFCs: A comprehensive approach to designing materials for superior functionality	Nina Orlovskaya	Selection and characterization of the cathode materials and cathode processing
Development of Surface Modification Techniques for Synthesis of Hybrid Tungsten Nano-Powders	Yongho Sohn *(also with Advanced Materials Processing and Analysis Center)*	Develop hybrid tungsten nano powders for pressure-assisted plasma compaction (US Army Research Laboratory)
Failure Mechanisms, Lfe Prediction and Enhanced Performance of Thermal and Environmental Barrier Coatings	Yongho Sohn *(also with Advanced Materials Processing and Analysis Center)*	Understanding in materials engineering and physics related to failure mechanisms, life prediction, and performance enhancement of thermal and environmental barrier coatings (TBCs and EBCs) for prime-reliant applications in fuel-flexible gas turbine engines
DEPARTMENT OF PHYSICS		
Ion nanobeams, focused ion beams for the nano era, Buenos Aires, Argentina, February 2006	Gabriel Braunstein	Review the state of present developments, and will explore potential future advances, in the field of finely focused ion beams (NSF)
FIB Fabrication of carbon nanotubes devices for High Tech applications	Lee Chow	Develop new thermal protection system of space shuttle orbiter based on carbon nanotubes
Gas-phase Catalytic Processes on Metal Nanoclusters	Beatriz Roldan Cuenya	Establish a relationship between nanoparticle size, shape, and chemical composition and catalytic properties (NSF)
Low dimensional vibrational dynamics on size selected 57Fe and 57FePt nanoparticles sysnthesized by inverse micelle encapsulation	Beatriz Roldan Cuenya	Provide further insight into the catalytic properties of metal nanoparticles
Surface Plasmon polariton dependence on metal surface morphology	Robert Peale	Study characteristics of surface Plasmon polaritons (SPP) on metal films as a function of film quality
Controlling Structural, Electronic, and Energy Flow Dynamics of Catalytic Processes through Tailored Nanostructures	Talat Rahman	Carrying out theoretical and compuational studies of processes that are related to reactivity and selectivity of chemical reactions on surfaces and on nanostructures [US Department of Energy (DOE)]
Testing Carboneous Samples with Vibrational Micro-Spectroscopy	Alfons Schulte	Perform micro-Raman and micro-FTIR measurements on carboneous compounds

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UCF Stands For Opportunity

WINTER 2008

HIGHLIGHTING RESEARCH ACTIVITIES AT UCF

UCF Research & Commercialization

HISTORY OF NANOSCIENCE • Q&A WITH JAMES J. HICKMAN • BONDING ABILITY • UNIQUE LABORATORY • NANO RESEARCHERS • NEWS

NANOSCIENCE

UCF Research & Commercialization

UCF RESEARCH is produced by the Office of Research & Commercialization at the University of Central Florida. For more information about UCF's sponsored research activities, contact Tom O'Neal, Associate Vice President for Research, 12201 Research Parkway, Suite 501, Orlando, FL 32826 (407-882-1120). For information about stories contained in the newsletter, contact the editor or the appropriate Web site.

Cookin' with M.J.

Nanoscience at UCF Moves into New Phase

Being able to work with materials at a scale far beyond detection by the human eye offers researchers across the board an exciting array of possibilities for discovery.

Science at the nanoscale is not new but it is generating a buzz in the scientific community as applications in medicine, materials, computing and electronics are entering the mainstream.

The state of Florida recognized this potential five years ago when UCF was granted $4 million to start a nanoscience initiative. In 2003 the NanoScience Technology Center (NSTC) was formed. James J. Hickman, who was hired as founding director in 2004, succeeded in consolidating UCF researchers across multiple disciplines and hiring many more to better respond to nanoscience funding opportunities and develop the technologies demanded by the industries of the future.

In 2007 the NSTC officially opened a 20,000-square-foot renovated research facility in the Central Florida Research Park. A total of 15 faculty and 42 graduate students at the center are creating tools to treat neurological diseases; materials that can advance solar and fuel cell technology; and longer-lasting batteries that can make ever-smaller electrical devices a reality.

Debra Reinhart

As we begin 2008 the NSTC will move into its next phase as Debra Reinhart, executive associate dean for the College of Engineering and Computer Science, takes on a new responsibility as interim director of the Nanoscience Center. A national search for a person to serve as director of both the NanoScience Technology Center and the Advanced Materials Processing and Analysis Center (AMPAC) is under way and is being chaired by Dean Eric VanStryland of the College of Optics and Photonics.

UCF owes a special thanks to James (aka 'J') Hickman who asked to return to the faculty to concentrate his efforts on teaching and his research, which is making inroads in using nanotechnology to help those who suffer from spinal cord injuries, Alzheimer's and Lou Gehrig's disease and which has received $2.3 million in funding since his arrival at UCF. Hickman set the tone for recruiting top faculty to the NSTC, developing facilities for the center and helping the center faculty secure sponsorship for their work.

M.J. Soileau
Vice President for Research & Commercialization

UCF has much to look forward to as we explore the world of the small. See the many exciting projects featured in this publication for examples. Just one such example is the work of Sudipta Seal.

Seal, who served as UCF's first nanoscience coordinator and who is currently a professor in the Department of Mechanical, Materials and Aerospace Engineering and the Advanced Materials Processing and Analysis Center as well as the NanoScience Technology Center, recently submitted a proposal to a prestigious National Science Foundation program. His proposal and 15 other proposals, from universities including the University of Minnesota, University of Michigan, Johns Hopkins, the University of Washington, Berkeley and Harvard, were the only ones funded out of 267 submissions. Not bad company.

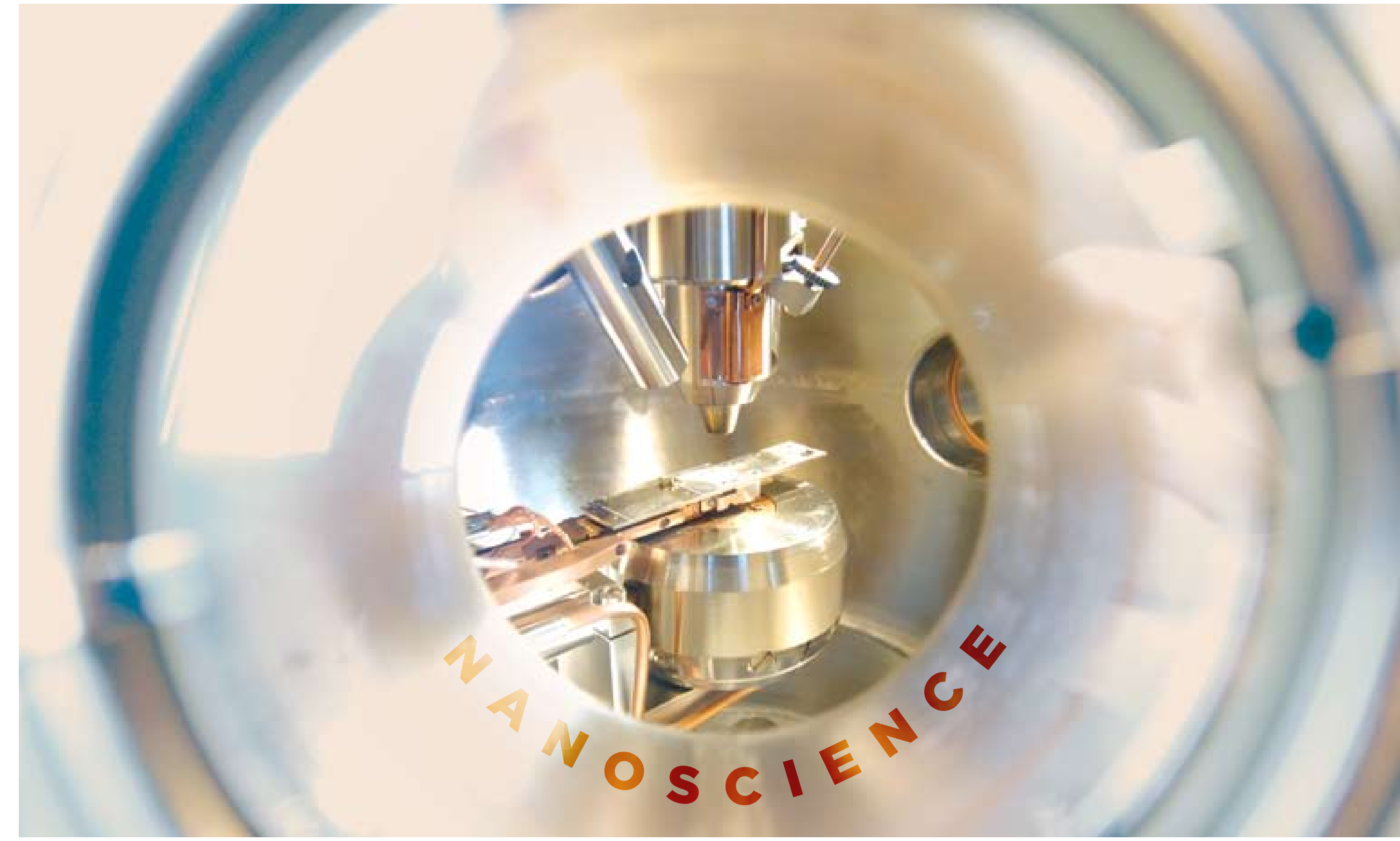
Industry has recognized the potential of nanoscale science for some time. Communities are beginning to see a payoff, not just in terms of companies and jobs but also in the development of new tools that make life easier and, in some cases, longer.

The science we are conducting at UCF is exciting and, for this community, just what we need to see.

Cheers!

MJS

mj@mail.ucf.edu

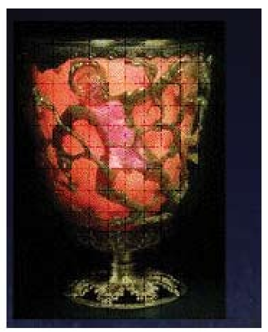


HIGHLIGHTING RESEARCH ACTIVITIES AT UCF

Contents

A Short History of Nanoscience

FOR THOUSANDS OF YEARS humans have worked with nanoscale materials without their knowledge. Nanoscience and nanotechnology deal with materials, devices and systems on a nanometer scale which is a thousand times smaller than a single strand of hair—or between 1-100 billionth of a meter in size. In fact, the earliest uses of nanotechnology have been traced to the Roman period. The Lycurgus cup, which dates to the fourth century and currently resides in the British Museum in London, actually contains nanosized gold and silver particles. Another example from antiquity is the ruby red color of some of the stained glass that was made during the Medieval period. That color was made possible because of nano-sized gold nanoparticles.



The Lycurgus Cup

Scientists started to think seriously about nanoscience and nanotechnology after the Nobel-prize winning physicist Richard Feynman delivered a speech in 1959, in which he postulated that it should be possible to write the entire contents of the Encyclopedia Britannica on a pin. That speech, titled "There's Plenty of Room at the Bottom," challenged scientists and the intellectual elite the world over to investigate science at scales so small that they were unimaginable at that time.

A Massachusetts Institute of Technology student, Eric Drexler, took the idea to the next level in the 1970s when he began focusing his studies on molecular nanotechnology. His book "Engines of Creation: The Coming Era of Nanotechnology" (1986) was visionary in scope. He popularized the notion that miniature machines could be created to perform various functions at the atomic scale. This vision was similar to the concept explored in the 1966 classic movie "Fantastic Voyage" starring Rachel Welsh, in which a miniature submarine was injected into an artery in a mission to destroy a blood clot. Drexler went on to write a more technical book "Nanosystems: Molecular Machinery, Manufacturing, and Computation" in 1992 and he coined the phrase "gray goo," for what would result if molecular "assemblers" went out of control and continued to reproduce copies of themselves, thereby destroying the environment.

Drexler's ideas were very speculative and in the end alienated many in the scientific community. The central critique of Drexler's work is his overemphasis on the creation of atom-sized machines, while he overlooked the practical applications of this developing technology at somewhat larger levels. Richard Smalley, a Rice University chemist who shared the 1996 Nobel Prize for discovering Buckminsterfullerene, a soccer ball-shaped carbon molecule, took Drexler to task in the pages of the journal *Chemical and Engineering News*, charging him with being naïve and creating unrealistic hype and concern with the general public, thereby, limiting real progress in the field.

On a positive note, most scientists understand the real value of nanotechnology to solve problems, such as treating cancer. In this case, nanoparticles can be used to selectively bind to cancer cells, thereby, killing them without exposing the patient to the widespread side effects of chemotherapy. In January 2000, this promising science received a tremendous boost from then-president Bill Clinton who dedicated billions of federal dollars to the National Nanotechnology Initiative (NNI) to expand practical utilization of this technology.

Largely because of the hype generated from Drexler's speculative conjectures, many have been concerned with this new discipline. There have been questions about nanoscience's impact on the environment, on personal health and, in some cases, have even led to extreme predictions about the actual threat posed by progress in this field. Many public organizations have been created to study the ethics and societal impact of nanotechnology. The NanoEthics Group (www.nanoethics.org) was created in 2003 to bring clarity to this dialogue.

Patrick Lin, the founder and research director of the Nanoethics group, says he is not surprised by the questions and hopes his organization can provide a forum to "try to bring science and common sense" back to the debate on nanotechnology.

Funding for nanotechnology continues to rise in the United States and across the world. In 2003, President George W. Bush signed the 21st Century Nanotechnology Research and Development Act, authorizing $3.7 billion of funding for 2005-08. The 2008 federal budget provides nearly $1.5 billion for the NNI, up from $464 million in 2001.

It is known that physical, chemical and biological properties of materials at the nanoscale differ in fundamental ways from the properties of bulk matter, but there is much that remains unknown about what can be done at such a minute scale.

While we know nanoscience and nanotechnology are going to impact our everyday life, touching everything from the design of our toothbrushes to the way we study medicine, the research possibilities are endless and exciting.

—Jeffrey Anderson, Ph.D. and Saiful Khondaker, Ph.D., UCF NSTC; Barb Abney contributed to this article

Q&A with James J. Hickman, Founding Director, UCF NanoScience Technology Center

James J. Hickman was named the director of UCF's NanoScience Technology Center in 2004. He has a Ph.D. from the Massachusetts Institute of Technology in chemistry, as well as B.S. and M.S. degrees in chemistry from Penn State University.

WHAT IS YOUR PARTICULAR AREA OF RESEARCH? DESCRIBE SOME OF YOUR MAJOR RESEARCH PROJECTS.

I was educated as a surface chemist. My current research dates back to some of my early work in nano catalysis as well as in self-assembled layers on microstructures. Since that time I've been applying nanoscience to interface design and fabrication to integrating biological materials with electronic components and other non-biological systems. One aspect of this allows us to create sensors based on living cells for toxicology, drug discovery and biological information processing.

Since our group works primarily with neuronal cells, we are also seeking ways to address problems in disease such as Alzheimer's, ALS (Lou Gehrig's disease), neuropathic pain and spinal cord repair.

WHAT ARE SOME OF THE OTHER AREAS OF NANO RESEARCH BEING CONDUCTED AT UCF?

Nano-optics—People are trying to use nanoparticles as contrast materials to enable various types of imaging.

Composite materials—Attempt to create extended battery concepts, structural materials, new electronic devices and a host of other applications.

Single-molecule electronics—Researchers are studying how molecules transmit electrons at low temperatures as a means of looking at quantum effects. This could have applications in quantum computing, quantum teleportation and other areas.

IS UCF ON THE LEADING EDGE?

UCF is certainly in the forefront in nanophotonics and the related area of bioimaging. Researcher Sudipta Seal, who has been a pioneer in the area of nanotherapeutic particles, Chris Clausen and Cherie Geiger, professors of chemistry, and Debra Reinhart, interim director of the NTSC, received a NASA Invention of the Year award for developing nanoparticles to help clean up contaminated sites at Kennedy Space Center.

HAVE UCF RESEARCHERS CREATED ANY PRODUCTS OR INNOVATIONS AS OF YET?

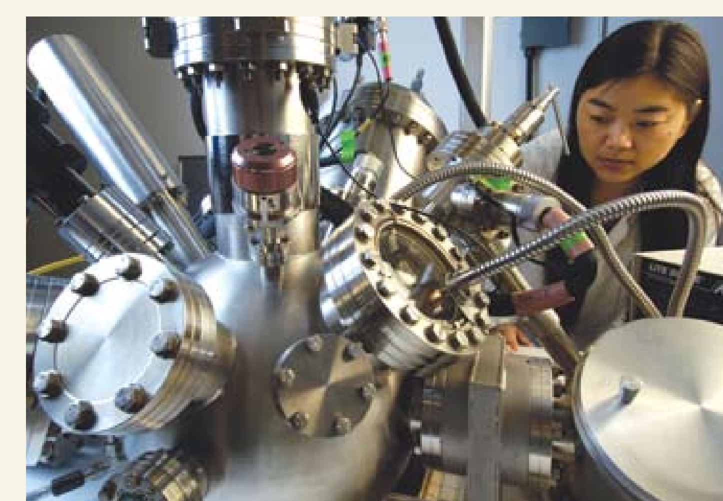
We can now actually create devices from adult neuronal cells as well as disease models or transgenic models in rats and mice. We hope we can extend these findings to humans.

Nanotherapeutics offers commercial applications that we will certainly see within the next five years.

Some of the composite materials being developed here will be integrated into existing products in that time frame as well.

HOW IS NANOTECHNOLOGY IMPACTING THE CENTRAL FLORIDA ECONOMY?

We're developing a workforce and offering an undergraduate track. There are a large number of grants that we have already received within and outside of the center and we are partnering with local companies, such as VaxDesign and Raydiance.



Nanoparticles Enable Physicians to Visualize Tumors at an Earlier State of the Disease

IMAGING TOOLS SUCH AS Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) have revolutionized medicine, but they are not perfect. For instance, when someone has cancer you can visualize large tumors when the disease is advanced, but MRI is poor at revealing small tumors. Because of this limitation in MRI, many contrast agents have been created in the past decade. When they are injected prior to a scan, the agents help to highlight tumors. Nanoscience has helped this process significantly because small particles (i.e., nanoparticles) can be designed to bond to cancer cells. Once they bond to the cells or molecules, the cancer can be visualized at an earlier stage of the disease.

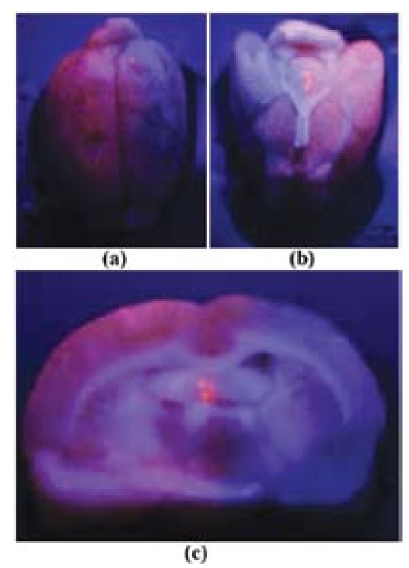
"Current molecular imaging techniques essentially allow us to do three things and do them much better than we were able to do them a couple of years ago. One of them is to detect disease much earlier. The second one is to stage cancer and some other diseases much more accurately and non-invasively, and the third is to facilitate and speed up the drug development process," said Dr. Ralph Weissleder, director of Harvard Medical School's Center for Molecular Imaging.

Research now being pursued by UCF faculty members are moving this field forward. J. Manuel Perez, who studied under Weissleder and who is now at the NanoScience Technology Center, has designed sensitive nanoparticles that become activated (light up) upon reaching a particular target. This work is supported by a career development grant from NIH's National Cancer Institute.

Another approach is being pursued by Swadeshmukul Santra, also from the NSTC, who is creating multimodal Quantum Dots (or Q-Dots) that are activated (or light up) in either a MRI, an optical scanner, or even an X-Ray machine. These dots offer researchers and physicans the ability to perform multiple tests on a suspect area with a static marker. Patients are relieved of the need to be injected with multiple marking agents.

These nanoparticles can be made to target specific areas in the body, depending on the molecules attached to the surface. This technology can be used for understanding stem cell "homing" and "differentiation" pathways, early diagnostic cancer imaging and treatment, ultra-sensitive and real-time monitoring of intra-cellular processes, and sensitive detection of pathogens. Santra's research is supported in these efforts through a prestigious Nanoscale Interdisciplinary Research Team (NIRT) award from the National Science Foundation. These findings were also recently published in the prominent *Journal of the American Chemistry Society.*

—Jeffrey Anderson, Ph.D., UCF NSTC



This image shows selective imaging of rat brain tissue using fluorescent Quantum Dots (Q-Dots). The pink glow demonstrates that the Q-Dots have passed through the blood-brain-barrier and have entered brain tissue. This is an important step in using Q-Dots with human patients.

Unique Hybrid Laboratory Enables Integration of Electronics and Living Brain Samples

Functional Circuits Provide New Window into Alzheimer's, ALS and Spinal Cord Injury

A UNIQUE LABORATORY at UCF's NanoScience Technology Center gives scientists the unprecedented ability to integrate electrical and neuronal systems and create, in essence, a piece of the brain on a circuit. The lab allows researchers to model circuits with neurons from patients with brain disorders, such as Alzheimer's disease, in the hope of finding a cure. A separate project is focusing on spinal cord injuries and the mechanism that keeps some patients from walking or to find a solution for those suffering from ALS (or Lou Gehrig's disease as it is commonly called). Other ongoing projects include efforts in creating an in vitro model of the lung, cardiac model systems as well as the development of new wound healing methodologies.

The science conducted in the Hybrid Neuronal Systems Laboratory is not possible at any other lab in the world. Because of the complexities involved in producing functional in vitro systems where neurons connect with each other and their signals are recorded, the lab's ability to keep the circuits alive and functioning for up to three months is critical. The ability to do this with adult neurons is unique.

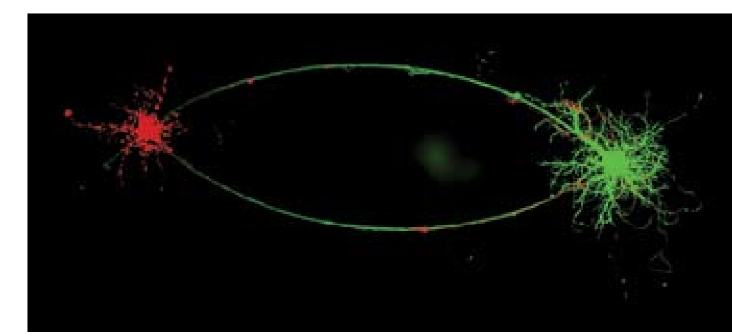
The application of nanotechnology produces the surface interface chemistry that favors cellular attachment and supports long term survival of these individual cells and makes this survival rate possible.

Researchers in the lab also can pattern neurons and cardiac cells on solid-state electronic systems, such as micro-electrode arrays (MEAs), utilizing advanced surface chemistry techniques. These electrically active cells form functional circuits in which the cells are in communication with each other as well as the electronics. The electrical responses of the cells are then monitored by the MEA and when these cells are exposed to different chemical compounds, including toxins, their electrical responses change in a way that is consistent and specific to each compound. This enables these patterned MEAs to be used for unknown toxin identification and, potentially, to predict the responses of electrically active cells to drugs, including those in discovery phase.

The Hybrid Systems Lab is actually four interconnected labs, each with a separate purpose. While they usually exist independent of each other, all four labs must collaborate in order to create the neuronal circuits.

The Surface Chemistry Lab is the first stop in the process of creating functional cellular systems. It provides the patterned surfaces that supply the environmental clues for guiding the attachment, differentiation and interconnection of the various cell types.

The Cell Culture Laboratory is a biological clean room that provides the neuronal cell cultures of individual neurons, which are the building blocks of these functional circuits. It is also used for the other cell types as well. They have achieved significant success in developing a defined medium which supports long-term survival of different cells. Here the cells are cultured on the top of surface patterns created on glass coverslips or on the top of microelectrode arrays. Functional testing of the neuronal circuits occurs in the Electrophysiology Lab, which is a state-of-the-art complex equipped with two dual patch-clamp electrophysiology rigs that can examine the dynamic behavior of these now functional neuronal circuits. It also contains a spinning disk confocal microscope, the solid state recording systems as well as a time-lapse video recording system. Finally, the Biochemistry Lab contains all the necessary equipment for modifying surfaces with protein signaling molecules to control cellular behavior.



An example of an in vitro engineered network with two living brain cells that have formed individual synapses to each other.

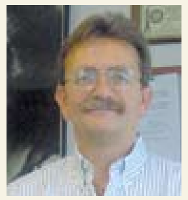
This combination of research laboratories and expertise could be used to help spinal cord injury patients walk again. By integrating fundamental neuroscience, microsystems engineering, cell biology and surface chemistry, researchers have been able to reestablish connections between motorneurons and muscle cells. The fabrication of this functional in vitro system enables the creation of hybrid devices on modified surfaces (in vitro) in order to simplify the number of variables in this complex system and perfect the process. The ultimate goal is to develop and promote this technology from the laboratory to the patient (in vivo) and clinical collaborations have already been established to achieve this goal.

—James J. Hickman, Ph.D. and Peter Molnar, Ph.D., Steve Lambert, Ph.D. and Aman Behal, Ph.D., UCF NSTC

NanoScience Technology Center Focus Areas

AT THE UNIVERSITY OF CENTRAL FLORIDA, a diverse group of scientists are exploring an expanding scientific frontier. In 1959, Nobel-prize winning physicist Richard Feynman opened the door to scientific research into nanotechnology with a challenging talk titled, *There's Plenty of Room at the Bottom.* UCF researchers at the NanoScience Technology Center have accepted the challenge of exploring this "room at the bottom" and are in the process of creating tools to treat our most troubling clinical disorders (including Alzheimer's disease, Amyotrophic Lateral Sclerosis (ALS), and diabetes); novel materials that can advance the fields of solar and fuel power technology; and long-lasting batteries that make ever-smaller electrical devices a reality. While the scientists all work in the NanoScience Technology Center, most also have appointments with other UCF academic units.

IN VITRO TEST SYSTEMS



James J. Hickman specializes in the creation of hybrid systems for biological computation and fundamental investigations in neuroscience and cell biology. He has formed interdisciplinary teams that work in a unique Hybrid Systems Laboratory (HSL). Working in the HSL, which combines a cell culture lab, a biochemistry lab, a chemistry lab and an electrophysiology lab, scientists in Hickman's group are able to keep stem cells alive for up to three months while, at the same time, they prepare specialized materials and apply electrodes to monitor changes. Hickman is the founding director of the NanoScience Technology Center and a professor in chemistry in the Burnett School of Biomedical Sciences and in the School of Electrical Engineering and Computer Science.

Peter Molnar's work explores the physiology and pathophysiology of neuronal systems and stem cell innervation of nano myotubes. One recent lab-based study explored the use of nanotubes and stem cells as a bridge to fill the gap when the spinal cord has been severed. Molnar is an assistant professor in the NSTC as well as in the Burnett School of Biomedical Sciences.

FUNCTIONAL NANOMATERIALS

Lei Zhai is an assistant professor in the NSTC and the Department of Chemistry. In diabetics, insulin and glucose levels vary during the day as the patient consumes food and the body processes it. While diabetic patients inject insulin to compensate for the lack of this important compound, the insulin is not always delivered at the same time the body is processing food, causing insulin levels to vary widely at any given time. However, over the past decade, great progress has been made in developing new sustained and controlled drug delivery systems utilizing nanoscale materials. Using nanofibers with stimuli-sensitive polymers and nanoparticles, the release of drugs can be controlled by temperature, light and magnetic/electrical fields, potentially enabling a much more effective method of keeping blood sugars stable.

Talat Shahnaz Rahman is researching the theoretical and computational modeling of materials with particular interest in understanding mechanisms that control chemical reactivity of nanostructured surfaces and nanoparticles. Rahman is a Provost Distinguished Research Professor and chair of the Department of Physics.

Qun "Treen" Huo supervises a nanomaterial chemistry group that specializes in the synthesis, property study and application development of nanoparticle materials. In this bottom-up approach towards nanomaterial development, she creates nanobuilding blocks and assembles these nanobuilding blocks into materials or devices with expected structures, properties and functions. But because the property of a nanomaterial is also determined by the architectural organization of those nanobuilding blocks, it is extremely important to control both the chemical structures of individual nanoparticles and the architectural structures of the assembled nanoparticle materials. Currently, she has two major research projects: the first one is controlled chemical functionalization of nanoparticles and the second one is to study their applications in the development of nanoparticle/polymer hybrid materials with well-defined architectural structures and properties. Huo is an associate professor in the NSTC and the Department of Chemistry.

Sudipta Seal studies nanomaterials processing and characterization, biomaterials and biocell/material interaction, surface science and advanced surface characterization techniques, and absorption kinetics of polymer molecules on steel substrates. His nanomaterials research focuses on producing powders, coatings and thin films for sensors, high temperature coatings, optics and electronic applications. He has been recognized as a pioneer in creating functional coatings for extreme environments. Seal is a professor in the Department of Mechanical, Materials and Aerospace Engineering and also served as coordinator of UCF's Nanotechnology Center Initiative. He is on the faculty of the Advanced Materials Processing and Analysis Center and is the director of the Surface Engineering and Nanotech Lab in the NanoScience Technology Center.

COMPUTER SIMULATIONS

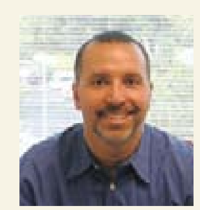
Artem E. Masunov uses advanced computational systems to model and explore the theory of energy conversion processes and the design of functional materials used for that purpose. The thermoelectric devices he models hold great promise for increasing the efficiency of conventional power generators, renewable energy sources (e.g., solar and geothermal), and refrigeration and air conditioning systems. Advantages of this power generation system include solid state operation, zero emissions, vast scalability, no maintenance, long operating life, high reliability, lack of moving parts and possibility of miniaturization. NASA has used this principle to provide electrical power for deep space probes such as Voyager I and II and the Cassini mission to Saturn. Masunov is an assistant professor in the NSTC and the Department of Chemistry.

Aman Behal's research focus is the identification and modeling of the behavior of signaling pathways inside cells as well as the interaction of living cells with non-biological surfaces such as electrodes. A few systems under study are ion channels in neuronal cells and the transduction of electrical signals from the neuronal cells onto metal electrode arrays for subsequent recording on a computer. Behal's approach is to quantify the relationship (possibly nonlinear) between the experimentally obtained input output data sets while keeping the quantification succinct so that many such objects can then be put together to form a larger system (with predictive capabilities). A further goal is to predict the existence of certain signaling mechanisms or dynamical structures inside these cells through use of optimization approaches and systems theory. Behal is an assistant professor in the School of Engineering and Computer Science and in the NSTC.

QUANTUM DYNAMICS

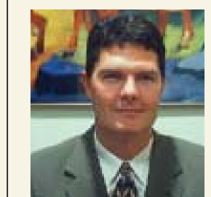
Michael N. Leuenberger is exploring the fascinating world of quantum dynamics and the possibility of teleportation. TV and movies aside, quantum teleportation does not teleport matter, it teleports quantum information. The current focus of his studies is in the transfer of quantum information from one quantum dot to another one, distant from the first one. It is noteworthy that Dr. Leuenberger completed a total of three postdoctoral fellowships and is a first author for an article for the prestigious journal *Nature*. Leuenberger is an assistant professor in the NSTC as well as in the Department of Physics.

BIOMEDICAL IMAGING



Research in **J. Manuel Perez's** laboratory focuses on the development of nanoparticle technologies and their application in nanomedicine, molecular imaging and molecular diagnostics. His specific area of research interest include the development of nanoagents for cancer diagnostics. His work also involves the creation of nanoparticles that can be used in optical imaging. He also has created nanoparticles that can detect the presence of toxins. Perez is an assistant professor in the NSTC as well as in the Department of Chemistry.

Swadeshmukul Santra's research work focuses on the development of multimodal biodegradable/biocompatible nanoparticles which act as probes. Upon reaching their targets these nanoprobes will light up in either a MRI or an optical scanner. The goal is to develop "smart" nanoprobes for various animal and lab based applications, such as understanding how stem cells become located in various tissues after they are placed in a patient, early diagnostic cancer imaging and treatment, ultrasensitive and real-time monitoring of intracellular processes, as well as sensitive detection of pathogens. Santra is an assistant professor in the NSTC, the Department of Chemistry and the Burnett School of Biomedical Sciences.



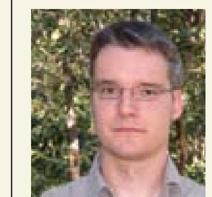
Jeffrey Anderson, the associate director of the NTSC, coordinates research projects that use imaging systems such as functional Magnetic Resonance Imaging (fMRI), structural MRI, & functional near-infrared spectroscopy (fNIRS) to explore neurological disorders such as traumatic brain injury.

NANOELECTRONICS

Saiful I. Khondaker's primary research is in the electron transport properties of nanoscale materials. The overall goal of his research is to investigate the fundamental electronic properties of nanomaterials and to create prototype functional devices like field effect transistors, single electron transistors, and sensors involving nanomaterials. He pioneered and demonstrated a simple and highly reproducible technique for the fabrication of below five nanometer spaced electrodes using colloidal gold nanoparticles and used these electrodes for the fabrication of functional devices including individual nanoparticles, conjugated organic molecules and polymers. In addition, he is also exploring the utility of nanocrystal arrays, nanowires and nanotubes. Khondaker is as assistant professor in the NSTC and in the Department of Physics.

Work in **Diego Díaz's** laboratory focuses on the integration of scanning probe microscopies (AFM) and electrochemistry which offer the ability to not only image surfaces at very high resolution, but to control interactions on the surface at the nanoscale level. He can currently modify AFM probes with different chemicals in order to tailor the tip to different chemical reactions. In this technique that he calls Redox Probe Microscopy, the tip is the electrochemical probe and it allows him to spatially control the electrochemistry. The careful control of the electrochemistry, together with the high spatial resolution of an AFM, permits him to create novel nanolithography patterns on surfaces. After a full chemical, morphology and electrochemical characterization of the modified surface is determined, he can then apply such nanostructured surfaces in the preparation of sensor devices. Diaz is an assistant professor in the Department of Chemistry and in the NSTC.

PHOTONICS



Andre J. Gesquiere explores the extreme sensitivity of single molecule laser scanning confocal microscopy which allows him to detect the presence of a single molecule or nanoparticle in a material. The excellent spatial resolution of this research tool allows the tracking of biological processes at the molecular level. He quantitatively examines biophysical processes at the single molecule level to understand the mechanism and kinetics of biologically important processes, such as DNA and protein folding dynamics, and biochemical reactions involving enzymes. His work also involves the development of novel imaging and spectroscopic techniques for biological systems. These include tracking individual nanoparticles to study processes inside living cells. This multidisciplinary research program shows promise of having a significant impact on the emerging fields of nanobiology and nanomedicine. Gerquiere is an assistant professor in the NSTC and in the Department of Chemistry.

INTEGRATED NANODEVICES

Research in **Ming Su's** group is focused on the fabrication of novel nanostructured materials using a variety of existing and emerging techniques. He also investigates the process of integrating these materials into devices for a number of possible applications, such as disease detection and energy management. Recently, he developed a method to create large arrays of nanocolumns with controlled size, aspect ratio and intercolumn spacing. The excellent controllability and tunability of this unique method enables the use of these materials in a wide range of integrated devices. For instance, one of his ongoing research projects is to establish a platform for the integration of on-chip handling, separation and the detection of biomarkers using this integrated nanocolumn array platform. Su is an assistant professor in the NSTC and the Department of Mechanical, Materials and Aerospace Engineering.

NEWS

QUANTUM DOT LASERS SPUR FUNDING, INDUSTRY INTEREST

A microscopic dot that has the ability to change the way light is formed is the basis of a new area of emphasis at UCF's Center for Research and Education in Optics and Lasers.

Dennis Deppe, whose expertise is in semiconductor lasers and whose research group demonstrated one of the first successful uses of quantum dots as an alternative to traditional laser diodes, was hired as UCF's first Florida Photonics Center of Excellence (FPCE) Nanophotonics Chair in September 2005. Deppe's work with quantum dots and the creation of specialized films enables the creation of high performance devices, such as computer chips and DVDs, at a much smaller size and with much lower power requirements than required currently.

Quantum dots, which are basically nanoscale regions in a crystal, have the ability to trap the electrons and "holes" that transmit current in a semiconductor. What starts as an electrical current can be reshaped into light or optical power. Deppe's group is working on controlling how those electrons and holes sit on a film, developing light sources capable of extremely specialized functions.

Multidisciplinary Team Explores Life Extending Mechanism in Nanoparticles

Experiments on rats have shown that certain types of nanoparticles have some amazing and unexpected abilities—they have shown the potential to extend lifespan, preserve eyesight and protect against spinal cord neuron damage. A UCF team is now looking for the biomolecular explanation of why it works.

The question is especially perplexing because of how the particles were initially used: to coat industrial machinery that operates at super high temperatures. Because of their unique structure, including multiple oxygen vacancies or spots that intensify chemical reactions, the nanoparticles are now being studied for use in solid oxide fuel cells and as catalysts in catalytic converters.

With funding from the National Science Foundation and the National Institutes of Health, William T. Self, a UCF microbiologist, and Sudpita Seal, a professor in the Department of Mechanical, Materials and Aerospace Engineering and the Advanced Materials Processing and Analysis and NanoScience Technology Centers, are characterizing nanoparticles of varying sizes and chemistry to uncover the properties that make them effective catalysts.

Company Funds UCF Researchers for Clean Manufacturing Process

A UCF researcher is developing an environmentally friendly process using waste materials to make a new building material potentially stronger than concrete.

Sudipta Seal, an engineering professor who works in both UCF's Advanced Materials Processing and Analysis Center and the NanoScience Technology Center, received $475,000 from nSolGel, LLC, to apply his proprietary technology into chemical conversions of industrial wastes to the creation of a new class of materials for construction.

Seal and colleague Larry Hench, director of special projects for UCF's Office of Research & Commercialization and a retired professor of ceramic materials at Imperial College, London, have jointly developed the processing concept which is based on chemical bonding of nanomaterials.

Nanoscience Researchers Reap Prestigious Awards

Three UCF nanoscience researchers received prestigious early career awards from the National Science Foundation in 2008, joining four other affiliated faculty members who have also been honored with the achievement.

Saiful Khondaker, Andre Gesquiere and Lei Zhai all received notification of their new awards in January. They all have faculty appointments in UCF's NanoScience Technology Center. Khondaker is working on a project involving fabrication of single electron transistor devices using carbon nanotubes; Gesquiere, on understanding optoelectronic processes in materials for solar energy conversion and Zhai, on increasing the efficiency of organic electrons by building ordered polymer structures.

Other faculty who have recently received the award include Pieter Kik, a professor in the College of Optics and Photonics, for a project titled "Silicon Compatible Hybrid Nanophotonic Systems"; Beatriz Roldan Cuenya, assistant professor in the Department of Physics, "Gas-phase Catalytic Processes on Metal Nanoclusters"; Qun Huo, associate professor in the NSTC, "Gold nanoparticles with single copy functional groups synthesis and study"; and Joe Cho, assistant professor of Mechanical, Materials and Aerospace Engineering, "A Micro SPR Sensor with Integrated Microfluidic Components for In-situ Monitoring of Biomolecules."

Human Lung Model for Infectious Diseases Funded by the Army

A UCF research team, led by Pappachan Kolattukudy, director of the Burnett School of Biomedical Sciences in the College of Medicine, and VaxDesign, Inc. are developing a functional tissue equivalent of a lung from human cells. The model will be used to assess infectious and environmental challenges to the lung. The project, which involves UCF researchers from the Center for Research and Education in Optics and Lasers, the NanoScience Technology Center and the Department of Materials, Mechanical and Aerospace Engineering, is funded by the U.S. Army.

A SAMPLING OF FUNDED NANOSCIENCE PROJECTS

Nanoscience is an enabling technology that touches almost every discipline. While the bulk of nanoscience research at UCF is conducted by faculty of the NanoScience Technology Center, the list below shows some of the other disciplines on campus in which funded projects are under way. Federally funded projects are noted.

PROJECT	RESEARCHER	DESCRIPTION
NANOSCIENCE TECHNOLOGY CENTER		
Nanoscale Optical and Electronic Processes in Active Nanostructures and Devices for Solar Energy Conversion	Andre Gesquiere	Investigate the opto-electronic processes in materials and devices energy conversion National Science Foundation (NSF)
Nanoscale processes in energy conversion materials and devices	Andre Gesquiere	Effect of the nanostructure of the materials, interfaces and layers in devices (NSF)
Function-based biosensors for use in hazardous waste remediation	James Hickman	Develop function-based biosensors for use in hazardous waste remediation Department of Energy (DOE)
High Throughput Electrophysiology for Pathway Identification	James Hickman	Focus on the marriage of solid-state electronics and neuronal function National Institutes of Health (NIH)
An In Vitro Model of Stem Cell Innervation of Myotubes	James Hickman	Build and test a hybrid device, leading eventually to designing schemes to prevent, diagnose, and treat developmental abnormalities and chronic neurological/muscle disorders (NIH)
Nanoscience Technology Development & Applications	James Hickman	Develop research efforts linking nanotechnology to the degradation of volatile chemicals
"Determining Extra-cellular Matrix Deposition Quantity and Composition from Cells in Response to Electronic Materials"	James Hickman	Enable rapid integration of research efforts to determine the composition and quantity of the extracellular matrix (ECM) deposited by cells when placed in contact, in vivo or in vitro, with electron ic materials to enable analysis of ECM in real devices for use in operations related systems (Air Force Office of Scientific Research)
Total chemical synthesis, property and theoretical modeling study of nanoparticle/polymer hybrid materials	Qun Huo	Use chemical methods to synthesize nanohybrid materials NSF Nanoscale Interdisciplinary Research Teams (NIRT)
Gold nanoparticles with single copy functional groups synthesis and study	Qun Huo	Develop a synthetic methodology to prepare nanoparticles with single surface functional groups (NSF—CAREER)
Room Temperature single electron transistor using carbon nanotube	Saiful Khondaker	Demonstrate a novel approach to fabricate room temperature SET using single wall carbon nanotubes
Numerical Renormalization Group Techniques	Michael Leuenberger	Implementation of numerical renormalization techniques to make quantitative calculations for Berry-phase oscillations of the Kondo effect in single-moleculate magnets
Computer simulations of decomposition thermodynamics and kinetics of hydrogen clathrate hydrates as novel hydrogen storage materials	Artem Masunov	Theoretical investigation of the Chemical Physics of phase transitions in hydrogen clathrate hydrate
Engineered neuronal networks for drug screening	Peter Molnar	Develop engineered neuronal networks (NIH)
Development of Magnetic Sensors for MRI Cancer Research	J. Manuel Perez	Use of magnetic nanoparticle conjugates to detect telomerase activity in cancer cells (NIH)
Development of Sogel Derived Monosized Oxide Nanoparticles	Sudipta Seal	Collaborate with the University of South Wales (Australia) in nanotechnology research (NSF)
Development of Metal/Ceramic Nanocomposite Powder and Laser Consolidation to Bulk Nanocomposite Components	Sudipta Seal	Further develop nanocomposite materials using sol-gel (Office of Naval Research—Young Investigator Award)
Development of H2 gas sensor with selectivity and sensitivity based on doped nanocrystaline-nanoporous metal/metal oxided for space exploration	Sudipta Seal	Nanotechnology for hydrogen sensor technologies
Electrically induced deflective amplification for molecular sensing and recognition	Ming Su	Explore a novel concept of chemical and biological devices for the detection and analysis
Bio-inspired Smart Surfaces with Extreme Wetting Properties	Lei Zhai	Nature has developed an approach to achieve extreme wetting properties such as superhydrophobicity
A Novel User Interface for Operating an Assistive Robot in Unstructured Environments	Aman Behal	Collaborative research (NSF)
Multimodal QDot-Based Nanoprobe for Real Time Noninvasive Bioimaging	Swadeshmukul Santra	Funding to develop multimodal (fluorescent and paramagnetic) quantum dot-based nanoprobes and use them to label hematopoietic stem cell (HSC) (NSF)
BURNETT SCHOOL OF BIOMEDICAL SCIENCES		
Human In Vitro Lung Model for Infectious Diseases	Pappachan Kolattukudy	Develop a functional tissue equivalent of lung from human cells for assessing infectious challenge (US Army Medical Research and Material Command)
Biologically compatible engineered nanoparticles to prevent UV-radiation induced damage	William Self	Research nanoparticles and bio compatibility (NSF)
DEPARTMENT OF CHEMISTRY		
Nanoscience Technology Development & Applications	Christian Clausen, III	Develop research efforts linking nanotechnology to the degradation of volatile chemicals
Nanocrystalline Composites as novel, high-performance electrodes for Direct Methanol Fuel Cells for space applications: Breaking the Ru-Pt catalyst barrier *(project linked to 68019016)*	Diego Diaz	Implement novel methodologies to find alternatives to fossil fuels and our dependence on oil
Polypeptide Nano-Templating: A New Method for Creating Metal and Semiconductor Nano-Scale Structures with 3D-Shape Control	Stephen Kuebler	Develop material deposition chemistries for a new approach to nanofabrication called "Polypeptide Nano-Templating"
CREOL & FPCE, COLLEGE OF OPTICS & PHOTONICS		
FPCE Chair Nanophotonics	Dennis Deppe	Funding to support nanophotonics research
Ellipsometry of Nanolaminate Films	William Folks	Ellipsometry of nanolaminate films (Sandia National Labs)
Nanoscopic Optical Sensors	Aravinda Kar	Develop a fundamental understanding of nanoscale changes in the refractive index of a high temperature material and vibration-tolerant interferometry
Nanoscopic Optical Sensor Science and Engineering	Aravinda Kar	Develop a fundamental understanding of high temperature materials using vibration-tolerant interferometry
Nonlinear Spectroscopy: Absorption and Refraction	Eric Van Stryland	Investigation of the spectra of nonlinear optical (NLO) absorption and the dispersion of NLO refraction in a variety of materials types (NSF)
Er Doped Si nanocrystal sensitized microlasers	Pieter Kik	Develop Er Doped Si nanocrystal sensitized microlasers
Research Support—Plasmon Nanofibers	Pieter Kik	Research work in the field of plasmon nanofibers
Silicon Compatible Hybrid Nanophotonic Systems	Pieter Kik	Develop silicon compatible hybrid nanophotonic systems (NSF)
FLORIDA SOLAR ENERGY CENTER		
Nanocrystalline Mg-Al Alloys for Hydrogen Storage	Darlene Slattery	Prepare nanocrystalline MG-Al alloys and send them to FSEC where they will be characterized for use