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MSEMatters Fall 2007

Department of Materials Science & Engineering

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THE UNIVERSITY of TENNESSEE UT
COLLEGE of ENGINEERING

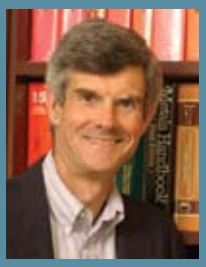
MSE MATTERS

MATERIALS SCIENCE AND ENGINEERING

A Newsletter for Alumni and Friends of the UT MSE Department

FALL 2007

Department Head's Message



Dr. George Pharr

Welcome to the first edition of our redesigned Department of Materials Science and Engineering (MSE) newsletter. We are pleased to have this new venue to provide you with information about department activities.

These are exciting times for the MSE department and for the discipline of materials science in general. On the horizon is a new building, the Joint Institute for Advanced Materials (JIAM), supported by $20 million in federal funding. JIAM will be a joint UT-ORNL institute for advanced materials multidisciplinary research field. The facility is slated to be constructed on the Cherokee Campus, UT's new research campus located on the riverfront off Alcoa Highway. JIAM will offer many opportunities for innovative research and collaboration, and our department will be at the forefront of these activities.

The MSE department also welcomes two new faculty members this fall, each of whom have impressive research and teaching backgrounds.

We are featuring articles in this issue about our interactions with COE research centers, including the Center for Materials Processing (CMP) and the Scintillation Materials Research Center (SMRC). SMRC was established last year through a joint partnership between UT and Siemens and offers numerous prospects for multidisciplinary research related to medical imaging and homeland security.

We hope you enjoy this issue of the new MSE newsletter, and we welcome your feedback. Please contact us by phone at (865) 974-5336 or via e-mail at mse@utk.edu.

We look forward to hearing from you.

Sincerely,

George Pharr, Department Head

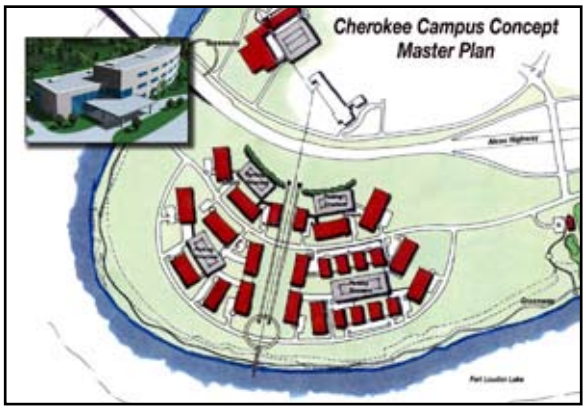
New Materials Research Facility Strengthens UT-ORNL Partnership

The University of Tennessee and Oak Ridge National Laboratory (ORNL) have always had an exceptional relationship, and this year the two institutions are tying the knot again for a venture into the material world.

Through the efforts of former Senator Bill Frist and Senator Lamar Alexander, $20 million in federal funding was secured in July 2005 for the Joint Institute for Advanced Materials (JIAM)—an institute focused on fostering interdisciplinary research, education and development in materials. UT's College of Engineering Department of Materials Science and Engineering (MSE) and College of Arts and Sciences Departments of Physics and Chemistry will be the primary benefactors of the new JIAM building.

Nanotechnology has been dubbed the next Industrial Revolution, and JIAM will be a front-runner in the education and development of students and faculty trained for this new revolution.

"The driving force to make things smaller is not only to save space and volume, but as you get smaller, properties in materials change," said Dr. George Pharr, professor and head of MSE and interim deputy director of JIAM.



Ward Plummer, a UT Distinguished Scientist in the Department of Physics, will be the JIAM director.

According to Dr. Wayne Davis, COE associate dean for research and technology, design for the building will be completed by early fall of 2008. "Plans to break ground are currently set for late 2008, with a projected completion date of 2011," said Davis. This will be the first building located on the new Cherokee Campus off U.S. Highway 129 (Alcoa Highway).

Barber/McMurray are the primary architects for the project, and will be assisted by Bullock, Smith & Partners. With 150,000 square feet of space, the JIAM building will house four major research groups comprised of faculty and researchers from ORNL and UT: functional materials; materials theory, modeling and simulation; soft and hybrid materials; and structural materials.

JIAM will primarily be a research facility and collaborate with ORNL's Materials Science & Technology Division, including the Center for Nanophase Materials Science (CNMS), the High Flux Isotope Reactor (HFIR) and the Spallation Neutron Source (SNS), a one-of-a-kind facility providing the most intense pulsed neutron beams in the world for scientific research and industrial development.

"This is a great opportunity for us to take the lead in advanced materials development with all the potential economic benefits for our region," said Pharr.

New Faculty Members Focus on Biomaterials and Tissue Engineering

The Department of Materials Science and Engineering (MSE) welcomes two new faculty members: Dr. Shanfeng Wang and Dr. Wei He.

Dr. Shanfeng Wang

Dr. Shanfeng Wang, assistant professor, received his Ph.D. from the Department of Polymer Science at the University of Akron in Ohio. Prior to accepting a position in the College of Engineering at UT, Dr. Wang worked as a research fellow in the Tissue Engineering and Polymeric Biomaterials Laboratory, Departments of Orthopedic Surgery and Biomedical Engineering at Mayo Clinic College of Medicine in Rochester, Minn. Dr. Wang's research expertise include biomaterials and tissue engineering; polymer physics and rheology; and polymer chemistry and condensed-matter physics of advanced materials. Dr. Wang is a member of the Society of Rheology, American Physical Society, American Chemical Society, Materials Research Society and the American Institute of Chemical Engineers. With five patents and over 30 published papers, book chapters and review articles, Dr. Wang will be a welcome addition to the MSE faculty.

Dr. Wei He

Dr. Wei He, assistant professor, received her Ph.D. in chemistry from the University of Connecticut in Storrs. Before coming to UT, Dr. He worked at the University of Washington as a Senior Fellow under Professor Buddy Ratner to develop novel biodegradable polymers for esophageal tissue engineering. Prior to that, she worked at the Georgia Institute of Technology on designing and developing strategies to improve tissue integration of neural silicon microelectrode arrays. Dr. He has two appointments in the college—one in MSE and the other in the Department of Mechanical, Aerospace and Biomedical Engineering (MABE)—a first for engineering faculty. Her research group is currently engaged in interdisciplinary projects that will integrate advanced materials science and engineering with critical issues in neural engineering. In particular, Dr. He is focusing on improving biocompatibility of neural implants, such as cortical recording electrodes and deep brain stimulation devices, as well as developing functional biomaterials for faster and enhanced functional recovery from peripheral nerve injury. Working at the interface of MSE and MABE, Dr. He is sure to contribute to the growing movement towards nanotechnology in science and engineering.

SMRC Extends Materials Research Opportunities

The Department of Materials Science and Engineering (MSE) in the College of Engineering (COE) at the University of Tennessee has numerous opportunities for students and faculty to pursue research in materials. In a unique collaboration between the University of Tennessee and CTI Siemens Medical Solutions Molecular Imaging, a Knoxville-based company founded by four COE alumni, the Scintillation Materials Research Center (SMRC) was formed in late 2005, adding to the growing knowledge of materials science and engineering.

A photomicrograph of scintillating crystals developed by the SMRC under UV excitation.

"SMRC is an extension of the research MSE has traditionally been involved in," said Dr. Chuck Melcher, SMRC director and research professor in MSE. "What we've done is extended materials research into opto-electronic materials to detect radiation such as X-rays, gamma rays and neutrons. Applications of our research extend into many different angles, including medical needs, homeland security and instrumentation."

Although applications extend throughout the science field, the biggest connection SMRC has with materials science is used in medical imaging equipment. The center combines academic resources of the university with scintillator research of Siemens into a research center dedicated to the development of innovative materials for radiation sensors and imaging systems. Activities include development of novel crystal growth techniques; synthesis and characterization of new material compositions; fundamental investigation of scintillation mechanisms; and mathematical modeling of detectors, materials and synthesis processes, to name a few.

SMRC Director **Dr. Chuck Melcher** demonstrates the Material Synthesis Lab's crystal growth system.

SMRC draws upon the extensive high-technology resources of the Knoxville and Oak Ridge areas, offering unique training and educational opportunities for students. Currently, five graduate students from MSE are conducting research at SMRC under the direction of Dr. Melcher, Dr. George Pharr and Dr. Philip Rack. Support from CTI Siemens, the University of Tennessee, MSE and the Department of Energy provides a mechanism for collaborative research with industrial partners and academic research groups.

"The SMRC represents a great opportunity for the MSE department to move into an important new research area related both to medical imaging technology and to homeland security," said Dr. George Pharr, MSE department head and professor. "It will also generally help to strengthen our abilities to grow and fabricate exotic single crystals that are needed in cutting edge materials research and technologies."

MSE Researchers Advancing the Nanotechnology Revolution

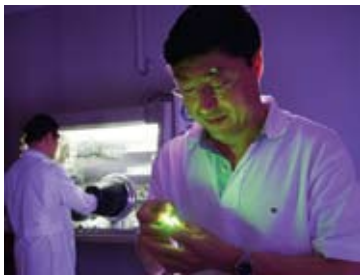
Nanotechnology has been called the new Industrial Revolution, and in the Department of Materials Science and Engineering (MSE) at the University of Tennessee, smaller is better.

"Advances in technology on extremely small scales create unique and exciting opportunities for research," said Dr. George Pharr, MSE department head and professor.

Dr. Philip Rack, associate professor of materials science and engineering, has been interested in materials science for as long as he can remember.

"I saw it as the cornerstone to all the engineering disciplines and a segue from engineering to physics and chemistry," said Rack, whose research focus is nanoscale materials and device synthesis and characterization.

"Our work has two dimensions," said Rack. "The first is to understand fundamental structure-property relationships of nanoscale materials. The second is to exploit these by synthesizing functional materials and devices for electronic, optical and biological applications."



◀ Dr. **Bin Hu's** research in organic spintronics has lead to the development of organic light-emitting diodes (OLEDs) that can be used in electronic devices of the future.

Dr. Bin Hu, assistant professor of materials science and engineering, also works on the nano level, but uses polymers to make electronic devices, specifically devices for solar cell electronics.

"My research activities include polymer design and fabrication devices," said Hu. "I also study electronic and optical devices using a magnetic field to respond to the greater challenge in controlling energy-related organic polymer devices in the electronic process."

▲ **Dr. Philip Rack** uses electron beam technology to create nanoscale materials.

Dr. Hu has received research grants for renewable energy from the Department of Energy, U.S. Air Force and National Science Foundation (NSF) and collaborates with colleagues at the Oak Ridge National Laboratory (ORNL). Recently, NSF granted a CAREER award for Dr. Hu's research titled, "Research and Education in Development of Organic Spintronics Based on Spin Injection and Modifications of Spin-Orbital Coupling in Magnetic Organic Light-Emitting Diodes (OLEDs)." The goal of Dr. Hu's project is to establish a new research and education area, specifically organic spintronics, at UT.

"My proposed research has two broader impacts on research and education," said Hu. "The research impact includes a new understanding of spin-dependent electronic processes in organic semiconductor devices such as OLEDs. The educational impact includes the curriculum enrichment of a newly formed electronic materials program in the Department of Materials Science and Engineering."

Continued on page 4

HTML Hosts Four UT Chancellor's/ORNL Summer Interns

The High Temperature Materials Laboratory (HTML) at Oak Ridge National Lab (ORNL) hosted four UT undergraduate students this summer through the UT Chancellor's Office/ORNL sponsored summer internship program. The goal of the program is to promote research and creative activity among undergraduate students. These students worked for eight weeks during the summer.

Andrew Payzant and Beth Armstrong mentored Claire Chisholm, a rising senior in the mechanical engineering program. Chisholm is interested in smart materials, and her project focuses on the synthesis and characterization of potential fuel cell materials.

Thomas Watkins mentored Dana Sippel, a rising junior in the Department of Materials Science and Engineering (MSE). Sippel has been working on determining the retained austenite content for Fe-C samples processed in a high magnetic field.

UT Chancellor's Office/ORNL Summer Interns *(left to right)* **Claire Chisholm, Elizabeth Jacobs, W. Brandon Goodwin** and **Dana Sippel** at the HTML.

Dr. Claudia Rawn mentored Elizabeth Jacobs and W. Brandon Goodwin. Jacobs is a rising junior in the chemistry department and Goodwin is a rising sophomore in MSE. Jacobs' project is a continuation of some of her research at UT where she studies high oxidation state transition metal fluorides. These materials are extremely air sensitive and reactive so part of her time at the HTML was devoted to researching environmental sample holders to be used on the room temperature x-ray diffractometer. Jabobs also traveled to the X14A beamline at Brookhaven National Laboratory to collect data on samples contained in glass capillaries with Jian-Ming Bia during her eight weeks.

Goodwin studied biologically synthesized nanocrystalline magnetite. Nanocrystalline materials give rise to broad diffraction peaks, so he collected data in a variety of configurations and used different software packages to analyze the data to find the optimum data collection and analysis combinations for nanocrystalline samples.

Research *continued from page 3*

Dr. Rack, whose funded projects total 25 to date, was recently awarded two NSF grants for research: "Collaborative Research: Electrofluidic Carbon Nanofiber Arrays for Multi-Dimensional Separations," and "Selective Carbon Nanotube Etching." Dr. Rack was also named a COE Research Fellow for 2007 during the annual college-wide Honors Banquet.

"Materials science and engineering research is fascinating and exhilarating. I consider myself terribly blessed to make a living doing something I enjoy so immensely," said Rack. "I have an innate and almost insatiable desire to know 'why' and 'how' and to me, there is nothing more fundamental than materials."

Department of Materials Science and Engineering Faculty

Roberto Benson ..... Associate Head & Professor
Gajanan Bhat ..... Professor
Hahn Choo ..... Assistant Professor
Narendra Dahotre ..... Professor
Takeshi Egami ..... Distinguished Scientist
Yanfei Gao ..... Assistant Professor
Easo George ..... Professor
Wei He ..... Assistant Professor
Bin Hu ..... Assistant Professor
David Joy ..... Distinguished Scientist & Professor
Veerle Keppens ..... Assistant Professor
Kevin Kit ..... Associate Professor
Peter Liaw ..... Professor, Ivan Racheff Chair of Excellence
C.T. Liu ..... Distinguished Research Professor
Carl Lundin ..... Professor
Carl McHargue ..... Professor
Thomas Meek ..... Associate Professor
Chuck Melcher ..... Research Professor
James Morris ..... Associate Professor
T. G. Nieh ..... Professor
George Pharr ..... Department Head & Professor
Philip Rack ..... Associate Professor
Claudia Rawn ..... Assistant Professor
Mike Simpson ..... Professor
Joseph Spruiell ..... Professor
Larry Wadsworth ..... Professor Emeritus
Shanfeng Wang ..... Assistant Professor

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