PENNSTATE

MatSENews

Materials Science and Engineering Spring 2007 www.matse.psu.edu

Research Spotlight:

Mesoscale Components in Materials

Scanning Electron Micrograph of Mesoscale Bend Bar

Dr. Gary L. Messing

Distinguished Professor of Materials Science and Engineering
Head, Department of Materials Science and Engineering

Dear Friends,

When I was an undergraduate at Alfred University, I was fortunate enough to receive financial assistance in a number of ways. Frankly speaking, I didn't know at that time where those monies came from until I became your department head in 2001. I would like to take the opportunity to share with you the impact of your donations in MatSE.

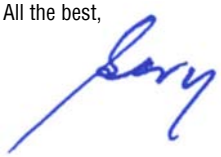
This past year, we gave a total of $163,250 in undergraduate scholarships from the department plus we received matching support from EMS of $113,310. We received $15,000 for department miscellaneous expenses.

In addition, alumni have been instrumental in helping to obtain corporate foundation support. Bayer and Alcoa's recent contributions to help with student travel costs as a part of the International Internship in Materials are two examples. We appreciate that many of you designate your contributions for equipment. Last year, with generous gifts to the Davis fund we purchased a state of the art inverted microscope, automatic polisher, and a low speed diamond saw for our new metallography facility.

Your contributions also supported the travel of nineteen undergraduates to attend the Materials Science and Technology (MS&T) meeting in Cincinnati, Ohio plus support the annual MatSE Awards banquet. This banquet which is held each spring, has been a tremendous opportunity to celebrate the scholarship, service and leadership of our undergraduate and graduate students.

We take serious our role as stewards of your contributions and work hard to stretch these funds for maximum benefit. However, we are outstripping the available scholarships. Therefore, I'd like to encourage you to consider establishing a named Trustee's Scholarship. The Trustees match your contributions one to one for these scholarships. Activities that you support make MatSE the terrific department it is. We very much appreciate your generosity. Please call me if you want to discuss a contribution.

All the best,



"Activities that you support make MatSE the terrific department it is. We very much appreciate your generosity."

In this Issue:

Editor: Gary L. Messing
Writer/Editor: Katina L. Bartley
Design/Layout: Michael W. Fleck

MatSE News
Department of Materials Science and Engineering
The Pennsylvania State University
121 Steidle Building
University Park, PA 16802
(814) 865-0497

www.matse.psu.edu

DEPARTMENT OF
MATERIALS SCIENCE AND ENGINEERING
COLLEGE OF EARTH AND MINERAL SCIENCES

Under the Leadership of Professor Susan Trolier-McKinstsry, we are pleased to announce the establishment of the:

"Ben Franklin Technology PArtners Center of Excellence in Piezoelectric Materials Devices"

Center Mission

The Center of Excellence in Piezoelectric Materials and Devices (CPMD) fosters scientific and technical understanding of electromechanically active materials and the applications that utilize them. Among the products for which piezoelectrics play a pivotal role are: medical imaging and therapeutic ultrasound systems, non-destructive testing, actuators, flow meters, precision positioning devices, a wide variety of sensors (e.g. accelerometers, cardiac health monitors) timing standards, oscillators, and resonators. Center faculty focus on cutting-edge piezoelectrics research as well as seeding of new technology. The center trains scientists and engineers in the core areas of new piezoelectric materials development, new processing methods, device modeling, measurements, and prototyping. This provides a cadre of trained personnel to industry.

Benefits to center membership include:

- Access to world-class expertise and facilities
- Voting rights on center research directions & projects
- Focused and leveraged projects
- Timely reviews of developing technologies
- Tutorials and workshops
- Access to intellectual property

Research Program

The Penn State electroceramics faculty have led the field of piezoelectrics for > 35 years, and in the last few years have pioneered the exploration of high strain piezoelectric single crystals, new high transition temperature morphotropic phase boundaries, high strain polymer piezoelectrics, Cu-metallization for piezoelectric fuel injectors, and thin film piezoelectrics for microelectromechanical systems (MEMS). The faculty also has extensive experience in working with industry in this area, with recent projects from Agilent, APC Int., Bosch, Bridge Semiconductor, Intel, Northrop Grumman, TRS Ceramics, and Wilcoxon Research, among others. Consequently, they are poised to make significant contributions to the piezoelectrics industry.

Planned Research Directions

- **Piezoelectrics for Ultrasound Applications**
  - High frequency array transducers
  - High power & temperature stable single crystal transducers
  - Wireless ultrasound systems
  - Composites
- **New Piezoelectric Materials Development**
  - Piezoelectrics for harsh environments (high temperature, exposure to radiation, etc.)
  - Lead-free piezoelectrics for RoHS compliance
- **Piezoelectrics for Resonators and Sensors**
  - Thin film piezoelectrics and MEMS
  - High coupling coefficient thin film resonators: deposition, structural, and electromechanical characterization
  - Wireless sensors
  - AlN films
  - Glass - ceramic piezoelectrics
  - Quartz measurements

Facilities

The Center of Excellence in Piezoelectric Materials Devices is housed in Pennsylvania State University's 70,000 square foot Materials Research Laboratory building, which is designed for the needs of interdisciplinary materials research. The laboratory maintains central facilities for scanning and transmission electron microscopies, two and four circle X-ray diffraction, thermal analysis, particle size analysis, wet chemical analysis, and sample preparation.

Processing and Prototyping

Extensive facilities are available for powder synthesis, ceramic processing, and ceramic machining. In addition, the W.M. Keck Smart Materials Integration Laboratory includes a cleanroom for processing piezoelectric materials, a low temperature ceramic co-fire processing line, as well as facilities for rapid prototyping and electroding.
Piezoelectric single crystal growth capabilities include flux growth, Bridgman, Czochralski, and laser heated pedestal growth. Alignment and machining facilities are also available.
MEMS facilities include a full suite of piezoelectric/metal film growth tools (rfand dc magnetron sputtering, chemical solution deposition, pulsed laser deposition, and mist deposition) as well as patterning, etching, and release facilities for 4" substrates. Multiple mask level processes are run routinely.

Measurements

Pennsylvania State University has one of the most comprehensive electrical and electromechanical measurement facilities in the world. Low and high field piezoelectric measurements can be made from liquid nitrogen to 200°C on bulk samples and thin films. Induced displacements can be tracked down to 10-4Å. Electromechanical measurements can be made at temperatures up to 1200°C over a wide frequency range. Complementing these facilities are ultrasound methods to self-consistently determine the full dielectric, elastic, and piezoelectric tensors of samples.

Transducer Design and Modeling

Penn State faculty have extensive experience in KLM and finite element modeling of piezoelectric materials devices, and systems. Composite piezoelectrics, flextensional motion amplification, phase field modeling, and phenomenology are particular strengths. In addition, staff and facilities are available for the development of associated electronics. Close-coupling between the modeling and the fabrication efforts enables modeling to be verified by prototyping devices.

Contact Information

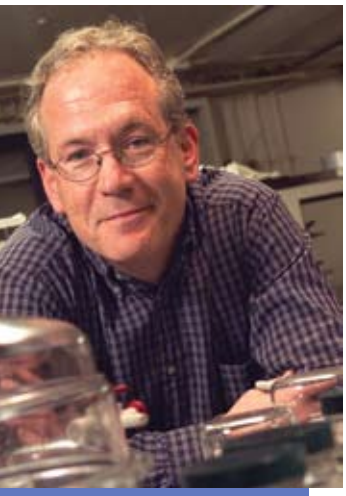
Ben Franklin Technology PArtner Center of Excellence in
Piezoelectric Materials and Devices, Center for Dielectric Studies

149 Materials Research Laboratory
The Pennsylvania State University
University Park, PA 16802
Tel (814) 865-3325 •Fax (814) 863-6734

CPMD Director: Susan Trolier-McKinstry: STMcKinstry@psu.edu
CPMD Associate Director: Thomas R. Shrout: trshrout@psu.edu
Center for Dielectric Studies Director: Clive A. Randall: car4@psu.edu

Image:
Mike Fleck,
Materials Science and Engineering

News from the Graduate Office



Dr. Jim Runt

Chair, iMatSE Graduate Program

We are all truly saddened by the tragic deaths of two of our first year graduate students. Trista Martin and Kristy Murray will be greatly missed. Please see the article in the Student News section for additional information.

We had a very productive Fall semester in the graduate office, probably because yours truly was on sabbatical. Katina Bartley took a mid-semester promotion and now works with Gary Messing, while Michelle (Matis) Hill has stepped into Katina's position. Fall semester was the first full semester of the new Intercollege Materials Science and Engineering Graduate Program ("iMatSE") : our total enrollment in the Fall was 197 graduate students (!), with 45 new students. As of January 2007, we are very pleased to announce that Professor Qi Li (Physics) will serve as iMatSE co-chair. Her principal responsibility will be to serve as liaison for students with advisors in departments other than MatSE.

As before, we would like to extend a very special thanks to 3M and Bayer MaterialScience for their generous support of Graduate Fellowships to assist in recruiting outstanding domestic graduate students. This support has been invaluable for making early offers to high achieving applicants and subsequently attracting them to Penn State.

MatSE Spring Enrollments:

130 Undergraduate Students

197 Graduate Students

News from the Undergraduate Office

Dr. John R. Hellmann

Associate Head for Undergraduate Studies

Our undergraduate enrollment is very healthy, with 130 full time students. And, our recruiting activity continues to attract some very talented and bright men and women; the Department boasts seventeen Schreyers scholars among its ranks, and the undergraduate program cumulative GPA is hovering around a 3.0! We graduated 19 students in the 2005-2006 academic year, and anticipate nearly 30 for 2006-2007.

Job opportunities are remarkably robust again this year; hardly a day goes by that we don't receive one or more requests from industry for graduates for full time employment, and for students interested in internships. Let us know soon if you're looking to hire our graduates, or if you need an undergrad for a summer internship position!

Speaking of such, with generous support from Bayer MaterialScience LLC and Alcoa, Inc. our International Internships in Materials

program is growing rapidly and exceeding all of our expectations! We have placed students in semester-long research internships in laboratories in Limoges, Padua, Sheffield, Zurich, Leeds, Darmstadt and San Sebastian this year, and hosted students in our laboratories from Limoges, Padua and Darmstadt. These opportunities have dramatically enhanced our students' preparation for performing in the increasingly globalized world of materials upon graduation. We'll keep you apprised as this program continues to grow!

Across the board, our students are a bright, motivated, and productive bunch. They are active participants in a host of materials societies, and garner frequent recognition for the quality of their participation. For example, the Penn State chapter of the Keramos National Professional Ceramic Engineering Fraternity was awarded Sapphire Chapter status this year, and our Material Advantage™ chapter was represented by over twenty undergraduates at the Materials Science and Technology conference (MS&T2006) in Cincinnati this past October. Our students are very well engaged in professional development and are already doing a wonderful job serving the materials community!

We encourage your input to improve our undergraduate program even more. Please, by all means, chime in with your thoughts!

Perrotta Scholarship Luncheon

Back Row L-R: Yan Ling, Dan King, Dan Magagnose, Patrick Mangiagli, Helen Larsen
Front Row L-R: Anthony Perrotta, Alberta Perrotta

Anthony J. and Alberta L. Perrotta created a scholarship in the Materials Science and Engineering Department in 1994. The purpose of this scholarship was to provide recognition and financial assistance to outstanding students enrolled in the MatSE Department. Since the 1998/1999 academic year the Perrotta's have given scholarships to thirty-three students.

On November 20, 2006 the Perrotta's met with the 2006 scholarship awardees at the Nittany Lion Inn for a luncheon.

The Perrotta's currently reside in State College, PA.

Stacy Davidson Receives College Ambassador Award

Stacy Davidson, Advising and Counseling Assistant in MatSE received the 1st annual College of Earth and Mineral Sciences Ambassador Award. The award honors a staff member who promotes a positive work environment within their unit, the College and the University.

This person performs beyond their job description, exhibits innovation, and fosters creativity and process improvement. Well done Stacy!

New Undergraduate Materials Processing Lab

The Materials Science and Engineering Department at Penn State offers an in depth education over the full spectrum of materials science and engineering including polymers, ceramics, metals, and electronic and photonic materials. The faculty in MatSE cover all interdisciplinary areas of research in materials including nanotechnology, electronic and photonic materials, biomaterials, computational materials science, composites, and a myriad of processing techniques.

The 130 undergraduate students in MatSE specialize in ceramics, polymers, metals, or electronic and photonic materials (EPM). In addition we offer minor options in biomaterials, polymers, materials and EPM science and engineering students. Undergraduate students are actively engaged in high level research through the Undergraduate Research Fellows program, International Internships in Materials, numerous COOP activities with industry and government labs, and the senior capstone project.

To boost the undergraduate experience the department has allocated 2100 square feet of space to create a state of the art multi-functional Materials Processing Laboratory. The new facility will be located in a highly visible area on the ground floor of Steidle Building. This cutting edge facility will provide a learning environment that will allow our students the opportunity to work with material development in the areas of thin films, micro deposition, bulk forming, plastic deformation, powder synthesis, and thermal processing. This lab will introduce a taste of the industrial world including the newer processing techniques such as: spin coating, ink jet printer deposition, rapid prototyping, spray drying, and electrophoretic deposition.

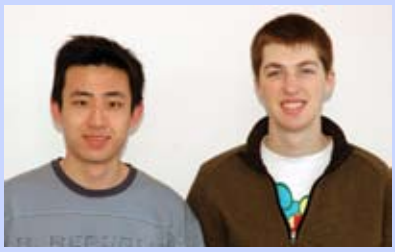
The student experience will span multiple disciplines, allowing our students to work strategically with our materials faculty. This lab will be utilized to facilitate classroom experiences and give the opportunity for students at an early stage in their educational experience to participate in the processing techniques used in industry today.

The department has currently invested $250,000 toward this effort and expect it iwill take an additional $300,000 to equip the lab. We are seeking additional funding for this innovative plan to continue to develop a great undergraduate department. We would like to request that you become part of this plan to help our students better prepare for the world of materials. You can make a donation by completing the information on the back of this newsletter and sending it to MatSE Department, 121 Steidle Building, University Park, PA 16802.

The Department of Materials Science and Engineering continues to raise the bar and to stay competitive in this exciting time in the materials world. This lab will become a leading tool in the success of our undergraduate program. Your support of this initiative will be appreciated for generations to come.

www.matse.psu.edu

Enright Annuity to Benefit Students



MatSE students receiving the 2007 Enright Annuity Scholarship are Zhifeng Li (left) and Stefan Yohe (right).

Dorothy P. Enright, 1948 Materials Science and Engineering, has recently made the College of Earth and Mineral Sciences the beneficiary of an annuity. These funds will bring the "Dorothy Pate Enright Endowed Scholarship in Ceramic Science and Engineering" to a new level. This scholarship provides recognition and financial assistance to outstanding undergraduate students enrolled, or planning to concentrate on Ceramic Science and Engineering. Dorothy's generosity will also contribute toward her "Academic Excellence Fund in the College of Earth and Mineral Sciences". This endowment promotes the academic excellence of the undergraduate and graduate students, enriches faculty and student research, and other initiatives within the College.

Dorothy received a Masters Degree in Ceramic Science from Penn State. Since then she has been employed as a chemist and/or engineer for a number of companies; among them, the Naval Ordnance Laboratories, White Oak in Silver Springs, Maryland, and Baker Hughes Drilling Fluids in Houston, Texas. She currently volunteers at the Museum of Fine Arts, Houston and is active in the Museum Guild. She also works on a limited basis for Baker Petrolite as an assistant to a laboratory manager. To name a few of her many accomplishments, Dorothy holds several patents, authored numerous technical papers, and has received the Meritorious Civilian Service Award from the US Navy and the Henry Kahn Roos Volunteer of the Year Award from the Museum of Fine Arts, Houston. She is a member of both the George W. Atherton Society and the Obelisk Society at Penn State.

Dorothy created the "Dorothy Pate Enright Endowed Scholarship in the Ceramic Science and Engineering Program" scholarship in 2000. Since the scholarship was created, twenty-six students have benefited from her generosity.

Dorothy currently resides in Houston, Texas.

Dorothy P. Enright, 1948 Materials Science and Engineering

Ultraviolet Light Reveals Secrets of Nanoscale Electronic Materials

An international team of scientists has used a novel technique to measure, for the first time, the precise conditions at which certain ultrathin materials spontaneously become electrically polarized. The research provides the fundamental scientific basis for understanding this "ferroelectric" state in materials needed for next-generation "smart card" memory chips and other devices. The research is published in a recent issue of the journal Science.

"We provide a complete picture of how the ferroelectric transition temperature changes when the electrical and mechanical conditions change within nanoscale ferroelectric materials," said Xiaoxing Xi, professor of physics and materials science and engineering at Penn State, who led the research effort. The team is the first to use a technique known as ultraviolet Raman spectroscopy to reveal a range of temperatures, thicknesses and structural configurations at which nanoscale barium titanate can store a switchable electric field.

"The work led by Xiaoxing Xi on nano-thick ferroelectric multilayers is groundbreaking," said Refik Kortan, a program manager at the Basic Energy Sciences division of the U.S. Department of Energy, one of the sponsors of the U.S.-funded research project. "It is truly remarkable that UV-Raman can resolve displacements in ultrathin films that are just a few atomic layers thick." Other sponsors include the National Science Foundation, the Office of Naval Research and the National Aeronautics and Space Administration.

Various difficulties exist in fabricating materials that can retain their ferroelectric properties at small dimensions and at temperatures at or above room temperature. "How thin can a ferroelectric material be at room temperature?" is the fundamental question that lies at the root of efforts to determine how much data can be stored on next-generation electronic devices. "We found that a film of barium titanate ($BaTiO_3$) whose thickness is just four-tenths of a nanometer -- or 400-millionths of a centimeter -- can retain its ferroelectric properties when it is layered in thin sandwiches with non-ferroelectric layers of strontium titanate ($SrTiO_3$)," said Darrell Schlom, professor of materials science and engineering at Penn State and a member of the research team. "This layer is just one molecule of barium titanate thick, the thinnest imaginable, but we have shown that it is ferroelectric at room temperature."

Xi explained, "The ferroelectric layer can induce ferroelectric properties in neighboring layers that normally are not ferroelectric, especially in materials that are easily polarized. For example, we found that even one layer of ferroelectric barium titanate is capable of polarizing 13 adjacent layers of strontium titanate." The scientists found that they could manipulate ferroelectricity by imposing different kinds of electrical and mechanical boundary conditions. The electrical conditions include the degree of resistance to polarization of the nonferroelectric material. The mechanical conditions included sandwiching ferroelectric layers between different layers of other materials, which mechanically restricts the movement of the atoms. By varying the thickness and composition of the nanoscale thin films, the researchers were able to change the phase-transition temperature by almost 500 Kelvin above room temperature. "Our research shows that, under favorable conditions, room-temperature ferroelectricity can be strong and stable in nanoscale systems," Xi said.

The team successfully tackled Xi's goal of using ultraviolet Raman spectroscopy to detect the moment when vanishingly thin layers of materials developed ferroelectric properties under a variety of conditions, a goal that leading experts in the field initially told him was so difficult that it was "impossible" to achieve. "Because most measurement techniques that work for thick films don't work well for films less than 100-nanometers thick, a new technique was needed, and I believed that UV-Raman spectroscopy should work," Xi explained. "Our record thinnest detections so far with UV-Raman spectroscopy are a layered superlattice film just 24-nanometers thick and a single-layer film just 10-nanometers thick."

Ultraviolet Raman spectroscopy is a very new technology that is in the early stages of being developed, and few instruments exist that can achieve the resolution that Xi and his research colleagues require. "The number of photons that change their energies after interacting with phonons of lattice vibration is very small, and it is difficult to detect this weak signal at UV frequencies," Xi said. Xi overcame this obstacle by building a collaboration with scientists whose labs contained high-resolution UV Raman scattering systems, where his former postdoctoral fellow Dimitri Tenne, now an assistant professor of physics at Boise State University, made the measurements presented in the paper published in Science.

"We have demonstrated that we can use UV Raman spectroscopy to discover more about the unusual phenomena that occur in ultrathin ferroelectric materials, and that it is possible to tune the ferroelectric properties of nanoscale materials by changing the electrical and mechanical boundary conditions," Xi said. "It is exciting to realize that this is just the beginning of a whole new field of research."

Contributed, Barbara Kennedy, Eberly College of Science

Susan Trolier-McKinstry Receives American Ceramics Society Richard M. Fulrath Award

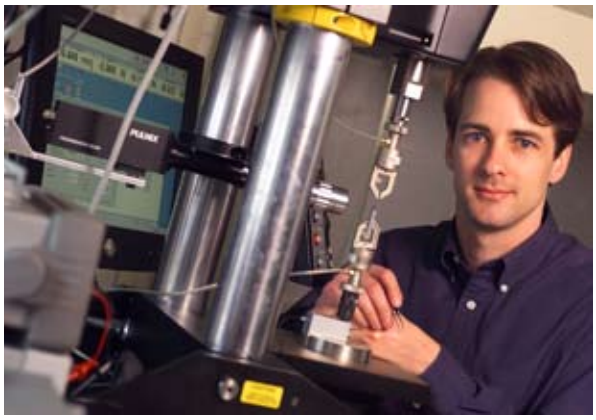
Susan Troiler-McKinstry was presented the ACerS award at the 108th Annual Meeting held in conjunction with the Materials Science & Technology 2006 Conference and Exhibition in Cincinnati, Ohio, October 15-19.

Susan Trolier-McKinstry is \ professor of ceramic science and engineering, director of the W. M. Keck Smart Materials Integration Laboratory and Director of the new Center of Excellence in Piezoelectric Materials and Devices at the Pennsylvania State University. Her main research interests include dielectric and piezoelectric thin films, the development of texture in bulk ceramic piezoelectrics, and spectroscopic ellipsometry. She obtained B.S., M.S., and Ph.D. degrees in Ceramic Science at Penn State, and on graduation, joined the faculty. She has held visiting appointments at the Hitachi Central Research Laboratory, the Army Research Laboratory, and the Ecole Polytechnique Federale de Lausanne, Switzerland.

Digby Macdonald Receives Khwarizmi International Award

In 1987, the leading Iranian Research Organization for Science and Technology (IROST) created an award to acknowledge the outstanding Iranian achievements in the field of Science and Technology. IROST proposed the creation of the Khwarizmi Award in memory of Abu Jafar Mohammad Ibn Mousa Khwarizmi, the great Iranian Mathematician and Astronomer(770-840 C.E). The Khwarizmi Award became international in 1997. The Iranian researchers and scientists Residing Abroad (IRA) are invited to take part in this prestigious scientific competition. Year by year the area of participation in the KIA is extending, attracting more scientists from all over the world. Today, the Khwarizmi International Award is continuing to pursue its successful course with more participation and more international recognition.

Chris Muhlstein Creates Nanomaterials Curriculum for High School Students



Dr. Chris Muhlstein likes to think small—in fact, one-billionth-of-a-meter small. As an assistant professor in the Department of Materials Science and Engineering at Penn State, Muhlstein's nanoscience research deals predominantly with how tiny pieces of material bend, twist and break.

"Our experiments help us to understand how the arrangement of individual atoms affects the mechanical behavior of materials," Muhlstein explained. And now, through the new Keystone Digital Education Portal, Muhlstein will be providing high school teachers with a curriculum that draws on experiments from his laboratory.

"[The program] builds on the math, chemistry and physics concepts that high school students are learning," he said. Muhlstein hopes to explain to students the fundamentals of nanoscience and demonstrate its relevance to their lives, as well as capture their interest in a future career in the physical sciences.

Chen Receives Materials Science Research Silver Award

Long-Qing Chen received the Materials Science Research Silver Award administered by the ASM Materials Science Division at the ASM's Annual Awards Luncheon in Cincinnati, Ohio. The Materials Science Research Silver Medal was established in 1986 to recognize and honor an active materials scientist whose individual and collaborative work has had a major impact on the science of materials. "For contributions to computational modeling of the evolution of structurally inhomogeneous materials".

Upcoming MatSE Distinguished Lecture Series 2007

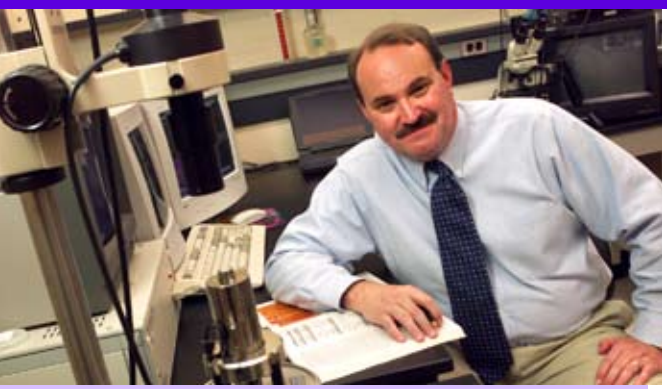
March 29, 2007
Dr. Tabbetha Dobbins,
Louisiana Technical Univ.

April 5, 2007
Dr. William Brittain,
Vice President of R&D at
Bausch and Lomb

April 12, 2007
Dr. Ryan R. Dirkx
Vice President R&D,
Arkema Inc.

April 19, 2007
Ms. Lisa Roudabush,
Manager, Mon Valley Works'
Clairton Plant, US Steel

April 26, 2007
Dr. Joseph Shepard
RTP Process Engineer
IBM Microelectronics Division



Professor Jim Adair, Materials Science and Engineering

Mesoscale Components in Materials

Professor Jim Adair is known for his research in nanoparticles including synthesis and processing of ceramic, metal, and nanocomposite particles. Although nanoparticulate synthesis was first documented by Michael Faraday and have been around for over 150 years, only recently have the efforts of Dr. Adair, his students, and collaborators led to the enabling technology to disperse nanoparticulates in liquids. The dispersion technology developed by the Adair Group permits the implementation of nanoparticulates in a variety of applications. Adair's effort in materials chemistry applied to materials synthesis and processing has resulted in 175 publications including 13 patents issued or filed. His recent efforts over the past five years have been directed toward nanomedical applications of materials and nanoparticulates, in particular. Dr. Adair's collaborations driving toward medical uses of nanoparticulates range from the Departments of Physics and Mechanical Engineering at University Park to Pharmacology and Biomaterials at Hershey Medical Center on the Hershey campuses of Penn State.

The Adair Group research covers two broad areas of medical applications for their nanoparticle research; mesoscale surgical instrument development such as that shown on the cover, and calcium phosphate nanocomposite particles for bioimaging, biassays, and drug delivery.

The Adair Group is developing nanocomposite colloids with a calcium phosphate matrix embedded with organic molecules for bioimaging, bioassays, and drug delivery. The Adair Group is collaborating with Professor Peter Eklund of Physics to develop a fundamental understanding of the photophysics of fluorescent molecules embedded in calcium phosphate. They are also working closely with collaborators at Hershey Medical Center particularly Professors Mark Kester and Gavin Robertson of Pharmacology and Professor Victor Ruiz-Velasco of Anesthesiology to develop the unique ability of the so-called Molecular Dots (M-Dots) to simultaneously bioimage and deliver drugs via the resorbable calcium phosphate nanocolloids. Some of the properties of M-Dots are summarized in the figures at right and bottom. The typical formulation is composed of fluorescent molecules and drugs embedded in the calcium phosphate matrix shown schematically with a transmission electron photomicrograph in Figure 1. Typical particles sizes are between 20 and 40nm. Adair and his co-workers have shown that the calcium phosphate nanocolloids are stable in a variety of physiological solutions including phosphate buffered, isotonic saline used in many cell culture media and formulations for drug delivery. The fluorescent emission is dictated by the fluorescent molecules captured within the calcium phosphate matrix of the M-Dots with the range of visible fluorescent emission from blue to red shown in Figure 3. The potential for near infra-red imaging in identifying cancers and other human illness is immense. The enhanced emission intensity for 1μM indocyanine green, a NIR emitting fluorophore, embedded in the M-Dots relative to the free dye in aqueous solution is also shown in Figure 4. NIR gives the potential for deep tissue imaging. Adair, Eklund and Kester are initially focusing on NIR of human breast cancer with M-Dots to improve the ability for early detection.

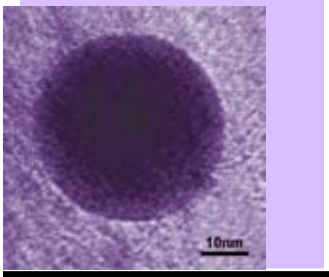


Fig. 1 | Transmission electron photomicrograph of M-Dot on a carbon sample holder

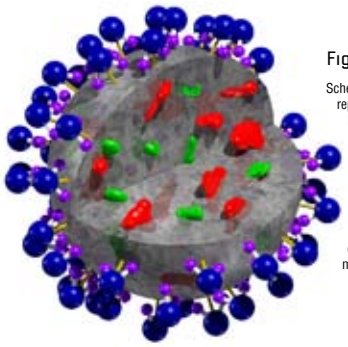
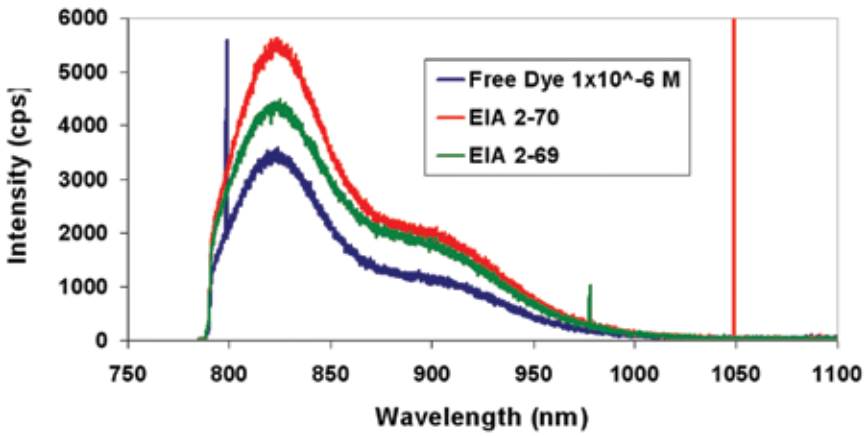


Fig. 2 | Schematic representation of M-Dot with blue amine surface groups, green fluorescent molecules and red drug molecules embedded in the calcium phosphate matrix

Fig. 3 | Array of fluorescent M-Dots over the visible spectrum

Fig. 4 | Near infra-red (NIR) fluorescent spectra of indocyanine green (ICG) in aqueous solution and ICG embedded in M-Dots showing the enhanced intensity of the emission for the embedded fluorescent molecules.



The nanomedicine technology and science are being transferred to industry via several mechanisms. Adair and Kester with other founders have created a company, Keystone Nano, Inc., which has licensed the M-Dot intellectual property that includes bioimaging, bioassays, and drug delivery applications. Keystone Nano, Inc., located in State College, was founded to fully develop the potential of M-Dots via internal development of the manufacturing and co-development with other industrial partners from the pharmaceutical and other industrial sectors that benefit from the unique features of M-Dots.

In Memory of Two MatSE Graduate Students

The Department of Materials Science and Engineering is deeply saddened to announce the passing of Ms. Trista Martin and Ms. Kristy Murray on Friday, November 17 in a tragic car accident. Trista and Kristy were first semester Bunton Waller graduate students. They were an extraordinary team. Best friends from the University of Jackson, Mississippi, they moved to central PA only a few months ago. They will be truly missed.

Trista Martin

Kristy Murray

Student Advisory Committee Update

In the past year, the **Student Advisory Committee (SAC)** has had a full docket. Organized at the end of Fall 2005, SAC draws representatives from the major student organizations within MatSE and beyond (viz Keramos, Materials Research Society, Materials Advantage, College of Earth and Mineral Science's (EMS) Graduate Student Council, and University Park's Graduate Student Association (GSA). Thus the mission statement: "[SAC] advocates the best interests of the student body in Department-affairs, working toward the enrichment of MatSE student life, by representing both undergraduates and graduates of our various materials disciplines." The Committee lends advice in departmental planning; represents students at Faculty, Executive, and other administrative meetings; assists in student-recruiting; interacts with alumni; and moreover provides a resource for new and continuing students.

A number of awards were organized by SAC: The committee's graduate students and all-option associates also chose recipients of the past year's Graduate Student Travel Awards, bestowed upon Rob Klein, Kun Li, and Lisa Edge out of 14 total applications. A similar group was called upon to judge the group and individual UG poster competitions. The Committee created the first-ever students' choice Faculty of the Year Award, wherein a selection committee overseen by a SAC representative and composed of 7 students representing undergraduates and graduates from all materials concentrations individually ranked the 18 nominations received. The inaugural Award, ultimately chosen by the Department's students, was presented to Prof. Joan Redwing at April's Awards Banquet. At the Department's request, SAC provided input on the restructuring of undergraduate/graduate awards rewarding excellence in service/leadership, academics, and research. In addition, the Committee reminded and encouraged fellow students to recommend students and faculty for College-level Awards, such as the EMS Wilson Award for Outstanding Teaching.

SAC helped as requested with graduate recruitment during February's Open House, including organizing hosts for dinner and tours of materials facilities, and also provided and attracted volunteers for the UG recruitment occurring during the College of EMS Exhibition (EMEX). The Committee assisted in planning the Annual Awards Banquet, recruited UG Erica Redline and grad. Matt Heidecker as student masters of ceremonies (MCs), as well as providing the PowerPoint slide show highlighting award-winners and a collection of images depicting commendations and camaraderie. These contributions helped smooth the transition to a new format for the Banquet, one of reduced allocution. Committee members also provided feedback for events such as the MatSE/MatSC Picnic and for gatherings such as the Holiday Luncheon, and—in future years—members hope to take more active roles in planning such goings on. Event brainstorming and approval has also occurred in preparation for a get-together wholly planned by students.

Student input on the Ph.D. Candidacy Examination process was both requested by students and welcomed by faculty of the Candidacy Review Committee. The SAC's answer was the Candidacy Open Forum. After gauging student and administrative interest, concerned students were assembled and two SAC representatives oversaw a patent and constructive critique. The SAC discussed the outcomes of the Forum and compiled the anonymous results, forwarding them on to the appropriate administrators. Candidacy pass and "conditional pass" rates have risen since, and Committee members certainly appreciate feeling that they contributed somewhat to improvements implemented by the Candidacy Review Committee. At present, SAC is planning another Candidacy Forum, hopefully to become an annual event.

The SAC welcomes input from students; as well as from faculty, staff, and alumni. Please feel free to contact the Chair, Paul Cha (pcha@psu.edu) with any comments or concerns. Present membership also includes Trevor Buehl (Secretary), Becky Kirkpatrick, Melissa Lackey, Ioanna Mina, Nevin Sherlock (Vice Chair), Lauren Snedeker, and Adam Stevenson. Outgoing members include John Creek (Past Chair), Xueyong Guan, Francelys Medina, Jennifer Rygel (Past Secretary), and Vivek Tomer.

MatSE Student Dennis Shay Back from IIM Experience

Dennish Shay has just returned from The University of Sheffield, Sheffield England where he worked with Dr. Ian M. Reaney. Dennis's research was on optimizing the ferroelectric properties of xBiFeO3 - xBi(Mg0.5Ti0.5)O3 - (1-2x)PbTiO3) solid solutions. He did this by preparing samples of various compositions of the solid solution and performing electrical measurements to find the optimal composition. The material could potentially be used as a high temperature sensor or actuator.

Congratulations Graduates! Fall 2006

B.S.
McGuire, Jennie
Murphy, Nathan
Williams, Phillip
Winkler, Thomas

M.S.
Campbell, Louis
Dellas, Nicholas
Karatrantos, Argyrios
Simsek Gokcesu, Ani
Tinberg, Daniel

Ph.D.
Akarapu, Ravindra Kumar
Chen, Yingzi
Lee, Soon Il
Stringer, Craig
Tian, Lili
Zhang, Shengjun

Erin at the Chambord in the Loire Valley

Undergraduate IIM students Going Abroad: Spring 2007 Semester

Alexana Cranmer
Darmstadt University of Technology, Darmstadt, Germany

Katherine Williams
University of Basque Country, San Sebastian, Spain

Alejandro Levander
University of Leeds, Leeds, UK

Christopher Brink
Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

"My Spring in Limoges"

by Erin Haworth, MatSE IIM Student

Last spring I spent 5 months doing research on hydroxyapatite for biomedical applications at ENSCI in Limoges, France. Living abroad presented me with all sorts of challenges. I expected communication to be the biggest, and was surprised to find the adjustment to the pace of life in France so difficult. Most people took two hours off for lunch, nothing was open on Sunday, stores close by 7 or 8 pm, and taking vacation was not optional – you would never not take it. During the month of May, there wasn't a full week of work due to all of the holidays! At first, my American instincts resisted having so much leisure time, fearing I wasn't working hard enough. It wasn't until I became comfortable with their philosophy, "you aren't really living if all you do is work", that I was able to relax and enjoy myself. I began to take advantage of the time, the leisurely pace of lunch presented to really enjoy my meal and to spend time getting to know my new friends.

I knew I was starting to understand when I used a holiday on Thursday to make a long weekend! Even my advisor encouraged me to take off time to travel. This was a once in a lifetime opportunity because, due to the generosity of the Bayer Scholarship and the stipend provided by ENSCI, I had not only the time, but the means to go nearly anywhere I wanted. I visited friends in Belgium and Poland, saw my family when they went to Spain, and traveled to Paris and to the Loire Valley. In addition, I had the pleasure to work with a great advisor Dr. Roxana Chotard. She had started working on the project a month before I arrived and encouraged my input for the project development. We got along very well, she became one of my new best friends. This was a great opportunity and I was glad to be the first student to represent Penn State at ENSCI.

Undergraduate student, Garnia Juwando

MatSE Student Returns from Abroad

Garnia (Nia) Juwondo has just returned from The Swiss Federal Institute of Technology (ETH), Zurich, Switzerland with Dr. Andrea Studart and Professor Ludwig Gauckleras part of the IIM experience. While at ETH she performed research on Mechanical Properties of Highly Textured Alpha Alumina by Tape Casting. Textured alumina was fabricated by aligning anisotropic α-Al2O3 in the fine particle matrix by tape casting. The Templated Grain Growth (TGG) process was used to increase the texture by growing α-Al2O3 platelets in a fine particle size matrix during heat treatment. The aim was to determine how an aligned anisotropic microstructure with tabular grains affects the mechanical behavior of a ceramic.

Kristen Brosnan Receives Diamond Award at MS&T

Kristen Brosnan was one of three winners of the Diamond Award for the best paper at the Materials Science & Technology 2006 Meeting and Exhibition in Cincinnati, OH for her presentation on "Processing, Properties, and Application of High Strain, Textured Piezoelectrics". Kristen's Ph.D. advisors are Richard J. Meyer, Jr. and Gary L. Messing. This award is given annually by the Basic Science Division of the American Ceramic Society to recognize outstanding achievements of graduate students in Materials Science and Engineering. All graduate students participating at MS&T are eligible. The criteria for selection of this award are the scientific and academic accomplishments of the student, quality of research, and quality of the oral presentation. Ten finalists for this award are selected prior to the meeting and three of the finalists are selected as Diamond award winners based on the quality of the oral presentation. Kristen graduated with her Ph.D. and will join GE Research.

Samrat Choudhury Receives Silver Award at MRS Meeting

Samrat Choudhury, a graduate student in materials science and engineering, has received a silver award at the MRS graduate student award competition during the MRS fall 2006 meeting in Boston. The purpose of this award is to honor and encourage graduate students whose academic achievements and current materials research display a high level of excellence and show promise for significant future achievement in materials research. Samrat was one of the thirty finalists chosen from one-hundred and seventy-seven applicants. Finalists were chosen based on their personal credentials, research description and recommendation letter by their thesis advisors. Samrat is currently pursuing his Ph.D. in Professor Long-Qing Chen's research group.

External Advisory Support Board (formerly IPAC) Holds First Meeting In October

I am pleased to report that the newly constituted External Advisory Board has successfully completed the transition from the Industrial and Professional Advisory Board, to a more extensive and relevant volunteer group. The driving force for this change is largely due to a vision by Professor Gary L. Messing, Department Head and the faculty to move from "good to great", to borrow the title from Jim Collins book. With great support and input from Professor Messing and his excellent staff, the Board has identified four areas where we believe we can add value and help the Department to continue to grow in reputation and standing in the international community. These are: 1) continued ABET oversight, 2) Development for the Department, 3) Recruitment, and 4) Marketing.

Dr. David Greenspan
Vice President of Research and Development
Teutogen Medical Inc.
Chair, MatSE EASB

Photo: Mike Fleck, Materials Science and Engineering

The expanded membership of the committee includes members that are listed to the right. We will be adding three new members at the May, 2007 meeting. At the inaugural Board meeting, members each chose one of the areas to work, and these sub-committees have come up with a number of specific actions to undertake during the next year to help the Department in its educational and research mission. As a group we continue to be impressed with the quality of the students in the Department, the educational opportunities and the world-class research ongoing within the Department. We believe that as a Board we can aid in the mission of the Department and help make MatSE the best materials science department in the country.

I would like to recognize three distinguished alumni who recently stepped down from the Board after many years of service. They are: Craig Berkey '83, Greg Yurek '69, '70 and Bob Statz. Their service to the Department is greatly appreciated and we thank them for their efforts.

Professor Messing and I welcome any comments, suggestions or questions that you may have about the Board, its role and function. We will be posting articles and news of interest from time to time on the MatSE website, so please check it out. The MatSE Department will be hosting an alumni event at the annual MS&T meeting this fall in Detroit. More details will follow in upcoming mailings. I hope to meet more of the alumni in the coming years and I thank those of you who have given so much of your time and efforts.

David Greenspan Ph.D.
Chairman, External Advisory Board

Current EASB Members

Dr. Charles G. Carson, III - '66; '70
Retired VP Environment Affairs, U.S. Steel Group

Dr. John A. "Jack" Coppola - '69; '71
Senior Vice President of Science & Technology, Johns Manville

Dr. David C. Greenspan
Vice President of Research and Development
Teutogen Medical Inc.

Dr. David W. Johnson - '64; '68
Retired, AGERE Systems

Ms. Sandra Greenburg Kosinski - '78
Self-employed Consultant

Dr. Theresa A. Kotanchek - '84; '87; '91
Ventures Global R&D Director, Dow Chemical Company

Dr. Leslie D. Kramer - '68; '71
Director, Engineering Fellow
Lockheed Martin Missiles and Fire Control

Dr. Robert Kumpf - '84; '86; '88
Vice President, Future Business Americas
Bayer Material Science, LLC.

Dr. James Loftus - '84; '86; '88
Research Associate, Owens Corning

Mr. Sam Mouck - '82
Manufacturing Engineering Manager, Intel Corporation

Dr. Robert Petcavich - '76; '77; '80
President, Health Beacons Inc.

Mr. James Uchno - '71; '73
President, CED Process Materials

The External Advisory Support Board (EASB) of the Department of Materials Science and Engineering is a select group of representatives from industry, government agencies, academia and the profession who advise, support and assist the faculty, staff and students of the department in order to heighten the visibility and quality of the department.

If you would like to nominate a fellow alumni to be a member of the EASB please contact Kathy Spicer at spicer@matse.psu.edu or 814-863-1779 for more information.

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