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Engineering

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MS news

MATERIALS SCIENCE AND ENGINEERING

Focusing on Directional Eutectic Crystallization

See story on page 3

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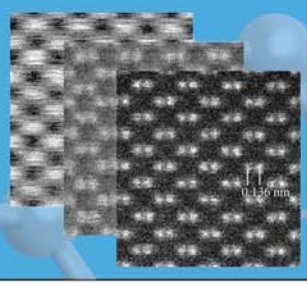

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A Note From the Department Head

Gregory S. Rohrer, W.W. Mullins Professor

Dear MSE Graduates:

Recently I had an opportunity to examine some of the facts and figures regarding the Department of Materials Science and Engineering. I wanted to take a closer look at some of the changes that have taken place over the past three years, and my analysis has revealed some notable trends.

First, our enrollment continues to increase. MSE's undergraduate enrollment has grown from 65 students in 2005 to 91 students in 2007. Just last week, 35 freshmen decided to major in Materials Science and Engineering. Because this new class is larger than our senior graduating class, MSE's total undergraduate enrollment will increase again in the 2008-2009 academic year. The Department's graduate enrollment has also increased, growing from 59 students in 2005 to 84 students in 2007—and increasing the average graduate group size from 3.9 in 2005 to 4.8 in 2007. Committed and enthusiastic recruiting efforts by faculty, staff, and current students within the Department of Materials Science and Engineering are responsible for these advances.

While our faculty members continue to publish at their usual prolific rate, I have noted a new surge in the number of disclosures and patents—with the total growing from 5 in 2005 to 12 in 2007. I believe this trend is the result of an increase in research on functional materials and applied topics. If this trend is sustained, it will mark a significant change in our Department.

"MSE's undergraduate enrollment has grown from 65 students in 2005 to 91 students in 2007."

In addition, there has been a surge in new instrumentation funded by external grants. This includes a new transmission electron microscope (see page 4), an environmental scanning electron microscope, and EBSD mapping tools. These new instruments will all be added to the J. Earle and Mary Roberts Materials Characterization Facility, ensuring that it remains state-of-the-art.

This year, **Assistant Professors Michael Bockstaller** and **Mohammad Islam** were reappointed, **Associate Teaching Professor Robert Heard** was also reappointed, and **Professor Paul Salvador** was promoted to the rank of full professor. This summer, **Professor Chris Pistorius** will join the faculty. Pistorius conducts research in the area of metals processing and will work with the Center for Iron and Steelmaking Research.

Let me close by reminding you to join us this October for the MSE Saltminers Dinner, which is held annually during the Materials Science and Technology (MS&T) Conference and Exhibition. The MS&T '08 event will be held in Downtown Pittsburgh at the David L. Lawrence Convention Center. Watch the mail for your dinner invitation, which should arrive in August. I look forward to seeing many of you in October!

Gregory S. Rohrer
W.W. Mullins Professor and Department Head

COVER STORY

Focusing on Directional Eutectic Crystallization

Organic electronic devices are quickly becoming key components in the electronics industry. Because of their mechanical flexibility, their diverse possibilities for chemical functionalization, and economical preparation techniques, conducting polymers—such as regioregular poly(3-alkyl thiophene)s (P3AT)—have tremendous potential to revolutionize future electronic device technologies. However, in order to develop and exploit the potential of conducting polymeric materials, it will be critical to control the morphology of P3AT films—including the minimization of scattering or trapping processes that are detrimental to charge transport and mobility. One technique that has shown particular potential to facilitate the preparation of large-scale oriented film morphologies is epitaxial crystallization.

Epitaxial crystallization generally describes the controlled solidification of a crystalline material facilitated by interaction with an oriented and lattice-matched crystalline substrate. For polymeric systems, epitaxial crystallization has been explored in eutectic polymer/solvent systems in which a (typically aromatic) solvent is directionally crystallized on a substrate along a temperature gradient. As the polymer concentration reaches the eutectic composition, co-crystallization occurs, resulting in macroscopically ordered polymer thin films that are subsequently isolated by sublimation of the solidified solvent.

Emily Daniels, a visiting student in MSE's Research Experiences for Undergraduates (REU) program during Summer 2007, studied directional eutectic crystallization under the guidance of her advisors, **Professors Lisa Porter** and **Michael Bockstaller**.

The picture on this issue's cover—taken by Daniels—shows an optical micrograph of quiescent crystallized 1,3,5-trichlorobenzene (TCB), a solvent that has demonstrated suitability for the epitaxial crystallization of P3AT. TCB exhibits a layered structure (space group $P2_12_12_1$) in which the lattice plane spacing is approximately matched to P3AT along the polymer backbone direction. The different crystalline orientations and thicknesses of the crystallized TCB give rise to the different colors.

MSE Debuts "Talk to the Professor" Program

As part of its educational outreach efforts, MSE's Materials Research Science and Engineering Center (MRSEC) has created a new program called "Talk to the Professor." Supported by a National Science Foundation (NSF) grant, this program makes it easy and fun for middle school and high school students to interact with professors from MRSEC.

Instead of having faculty members travel to classrooms, or bringing students to the Carnegie Mellon campus, the "Talk to the Professor" program brings these two groups together via Internet video links. After middle or high school teachers identify a topic of interest, MSE works to identify an appropriate MRSEC faculty member—then installs the necessary video technology in both the faculty office and the classroom.

Two "Talk to the Professor" forums have already taken place. In the first event—held on November 15, 2007—Professor Robert Suter from the Physics Department responded to questions about atom structure from two classes, totaling more than 50 students, in Savannah, Georgia.

On January 23, 2008, **MSE Professor Michael Bockstaller** fielded questions on polymer science from two tenth-grade chemistry classes at West Mifflin High School near Pittsburgh. For this event, MRSEC also provided the nearly 50 student participants with classroom materials that complemented Bockstaller's lecture.

MRSEC hopes to sponsor many future "Talk to the Professor" outreach events, which may expand to include national and international student audiences. The overall objective of this new program is to expose as many young scientists as possible to careers in materials science and engineering.

Professor Suter interacts with students during the November forum.

DEPARTMENT NEWS

MSE Enters a New Era in Materials Characterization

Advanced Transmission Electron Microscope Offers an Incredible Perspective

Located on the first floor of Roberts Engineering Hall, the J. Earle and Mary Roberts Materials Characterization Laboratory (MCL) is MSE's primary facility for materials characterization. Operated by the Department, the MCL offers a range of advanced characterization tools that are used by both the Carnegie Mellon community and local industry.

The MCL currently has four transmission electron microscopes (TEMs), three scanning electron microscopes (SEMs), an atomic force microscope (AFM), several X-ray diffractometers, and associated sample preparation tools. Day-to-day operation is supervised by **Tom Nuhfer** (electron optics) and **Jason Wolf** (X-ray and AFM), while **Professors Marc De Graef** and **David Laughlin** provide guidance as Faculty Co-Directors.

Already the site of many exciting discoveries in materials science and engineering, the MCL is about to enter a new era, with the addition of an incredibly effective new transmission electron microscope this summer. The Department's new FEI Titan 80-300 (shown at right) is the world's most powerful commercially available instrument, capable of supporting next-generation research and discovery.

Built around a revolutionary 80-300kV electron column, this instrument will enable faculty, students, and researchers to perform sub-Ångström, atomic scale discovery and exploration in both TEM and scanning TEM modes over a wide range of materials and operating conditions.

MSE's incredibly powerful new FEI Titan 80-300 instrument will launch a new era of materials characterization within the Department.

A Lasting Investment—for a Broad Community of Users

This new addition to the MCL came as a result of the hard work of Tom Nuhfer and **Professor Elias Towe**, Director of the Center for Nano-Enabled Device and Energy Technologies, who holds a joint appointment in MSE and the Department of Electrical and Computer Engineering. They were able to obtain funding from two sources—the PPG Foundation, and the Gordon and Betty Moore Foundation—to support the purchase of advanced, shared instrumentation for nanomaterials characterization.

The decision to spend the funds on the Titan 80-300 microscope was made because this state-of-the-art instrument will benefit the largest number of users within the Carnegie Mellon community, as well as fostering sustainable collaborations with industry. In addition, this powerful new microscope has the capability to support research that can have a significant impact on the future of nanotechnology.

"This revolutionary new instrument will enable our faculty, students, and researchers to take their characterization efforts to a new level—while also benefiting a broader community of scientists and engineers," says **MSE Department Head Gregory S. Rohrer**. "It supports the continuing leadership of Carnegie Mellon in materials science and engineering, and we are grateful to both the PPG Foundation and the Gordon and Betty Moore Foundation for their generous support."

To learn more about the new Titan 80-300 microscope, or about the MCL facility, please contact Marc De Graef (degraef@cmu.edu), David Laughlin (laughlin@cmu.edu), or Tom Nuhfer (tn06@andrew.cmu.edu). For information about the Center for Nano-Enabled Device and Energy Technologies, contact Elias Towe (towe@cmu.edu).

SIDEBAR

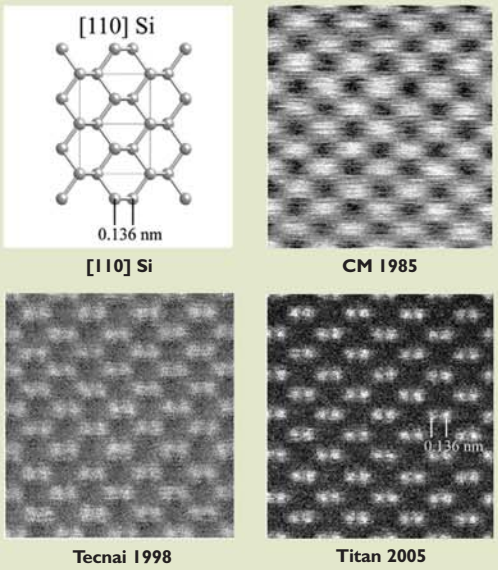
Focusing on the Future

The transmission electron microscope (TEM) was invented in Germany, around 1932, by Ernst Ruska and Max Knoll. They immediately realized that the quality of the round magnetic lenses used as image-forming elements would always be limited by aberration—especially spherical aberration.

It was spherical aberration that limited the image quality of the Hubble Space Telescope when it was first launched in 1990; an error in the shape of the primary mirror caused light rays from near the edge of the mirror to have a slightly different focal length than rays from the center, causing severe image blurring. The solution was the addition of corrector optics in the beam path during a Space Shuttle service mission in 1993. In the late 1990s, a similar corrector device became available for TEMs; it is commonly known as a Cs-corrector (Cs being the spherical aberration constant of the main imaging lens).

Despite the presence of spherical aberration, the newest TEMs and scanning transmission electron microscopes (STEMs) have achieved remarkable spatial resolution.

The pictures at right are STEM images of silicon, viewed along a [110] direction (see the crystal drawing). These images were obtained on three generations of microscopes. The first is from the Philips CM-series (1985, resolution 0.20 nm), showing white blobs at the positions of the double atom columns in the crystal structure (the projected spacing between the two columns is 0.136 nm). The second image, taken on the Philips Tecnai-series (1998, 0.14 nm), just barely resolves the individual silicon columns as pairs of white dots. The most recent microscope series, the FEI Titan (2005, 0.09 nm), produces the third image, where the silicon atoms are clearly resolved. To improve the microscope resolution beyond this level requires the use of a Cs corrector.



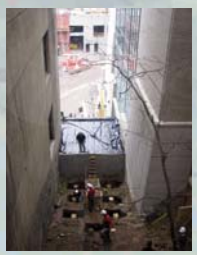
These STEM images of silicon demonstrate the radical improvements that have been achieved in transmission electron microscopy over a 20-year period.

It is interesting to note that several basic engineering materials, notably iron, demand a resolution well below 0.1 nm in order to study their lattice defects. Similarly, Lorentz microscopy (the study of magnetic materials by TEM) requires a Cs corrector to resolve magnetic domains at the length scale currently used in magnetic recording devices, such as hard disks. MSE is currently pursuing additional funding to acquire a Cs corrector and a Lorentz lens—a dedicated lens that enables magnetic material studies.

College of Engineering Among Top 10

Carnegie Institute of Technology's (CIT) graduate engineering program has once again been rated among the best in the country by *US News & World Report* magazine. In the 2009 *US News & World Report* graduate school survey, Carnegie Mellon's College of Engineering ranks 7th overall.

If We Build It...



This Spring, the Department of Materials Science and Engineering has embarked on a unique beautification project with Professor Larry Cartwright and his Senior Design and Construction class in the Department of Civil and Environmental Engineering.

The task presented to Cartwright's class was to take a long-neglected eyesore of a space—located between Doherty and Wean Halls—and transform it into an outdoor seating area for MSE students, faculty, and staff.

When the transformation is completed, we hope to use this space for meetings, lunches, and small outdoor gatherings.

This project is the second phase of the Department's Wean Hall beautification effort. This outdoor area is located at the end of the hallway that was also recently improved (see *MSE News*, Spring 2007).

The "before" photo above shows how this space looked at the beginning of the collaborative project. While work on the project is still in progress, be sure to check the Fall issue of *MSE News* to see the results in an "after" photo!

FACULTY NEWS

An "Invisibility Cloak" for Colloidal Particles

Professor Michael Bockstaller of MSE is partnering with Professor Krzysztof Matyjaszewski of the Department of Chemistry to create a version of Harry Potter's famed "invisibility cloak" for nanoparticles. Their new design paradigm is aimed at making particles invisible.

In their recent article, published in *Advanced Materials Magazine,* Bockstaller and Matyjaszewski demonstrate that controlling the structure of a nanoparticle can "shrink" its visible size by a factor of thousands—without affecting the particle's actual physical dimensions.

"We are creating a novel technique to control the architecture of nanoparticles that will remedy many of the problems associated with the application of nanomaterials, which are so essential to business sectors such as the aerospace and cosmetics industry," says Bockstaller.

Colloidal particles are commonly used as additives in current material technologies, where they can enhance strength and improve wear resistance. However, the light scattering that is associated with the presence of these particles often results in an undesirable whitish (or milky) appearance, presenting a tremendous challenge to current material technologies. This collaborative team is focused on preventing this problem by grafting polymers onto the particles' surface.

"We have found that we can improve the optical transparency of polymer composites by controlling the size, density, and composition of the polymers attached to inorganic materials," says Bockstaller. "This allows light to flow more freely through the particle."

The new "particle invisibility cloak" will help create a new spectrum of material technologies that will combine strength and durability with optical transparency—an exciting combination of properties that has never been achieved before.

The team's research was featured in *ScienceDaily* on March 7. You can read the online story at http://www.sciencedaily.com/releases/2008/03/080306161934.htm.

Rollett Organizes ICOTOM Conference

Professor Anthony D. Rollett is the conference organizer for the 15th International Conference on the Textures of Materials (ICOTOM). This event, which will be held on the Carnegie Mellon campus in June, is devoted to the study of crystallographic texture in materials—which now includes interface texture, as well as the traditional crystal (grain) texture. This topic is a core component of the Mesoscale Interface Mapping Project (MIMP) within Carnegie Mellon's Materials Research Science and Engineering Center (MRSEC). The conference will bring together a substantial international community of scientists and engineers interested in improving their understanding of texture in materials, as well as its experimental characterization, influence on materials properties, and description by models. ICOTOM is dedicated to promoting all aspects of texture research and applications in all kinds of crystalline materials, from metals and rocks to polymers. More information on the June conference can be found at https://www.acers.org/ICOTOM15/schedule.asp.

Faculty News Bits

Professor Richard J. Fruehan and MSE alum **Otavio Fortini** *(Ph.D. 2003)* received the *2008 TMS Extraction and Processing Division Science Award* for their series of published papers on "The Reaction of Iron Oxide Carbon Composites in a Rotary Hearth Furnace." The papers were published in *Metallurgical Transactions B*, and the research was also included as part of Fortini's doctoral thesis.

Professor Warren M. Garrison presented the 2008 Andrew Carnegie Lecture, "The Development of High-Performance Steels for Landing Gear Applications" at the April meeting of the ASM International Pittsburgh Golden Triangle Chapter.

Professor Emeritus Thaddeus Massalski recently traveled to India, where he gave four lectures at different locations. These included the Dara Antia Memorial Lecture in Pune, the 70th Anniversary Lecture on Phase Transformations at the Tata Steel R&D Labs in Jamshedpur, a leading lecture at the Phase Diagrams Seminar in Pune, and the leading lecture at the Bombay Annual Meeting of the Indian Institute of Metals (IIM)—where he was elected an Honorary Member of IIM. Massalski's topics included phase diagrams, thermodynamics, and Pu and nuclear energy.

Professor Sridhar Seetharaman has received the *Benjamin Richard Teare Teaching Award.* The award, which recognizes excellence in engineering education, is made to a faculty member within the Carnegie Institute of Technology. Seetharaman has also been awarded a US Patent (#7,325,392)—along with co-inventor Victor Stancovski, President and Chief Technical Officer of Catelectic Corporation—for their "Control System for Catalytic Processes."

◀ **Professor Sridhar Seetharaman**

ALUMNI NEWS

Join the MSE Facebook Community

In an effort to help our busy alumni community keep in touch, **Professor Michael McHenry** is managing an MSE Alumni Group on Facebook.com. This online alumni network is proving to be a fun and convenient way for Department alums to stay in contact with friends, faculty, and staff members at MSE.

Nearly 100 alumni from the Classes of 1988 through 2008 are already members of the MSE Alumni Group at Facebook. You are welcome to join this vibrant and growing community!

If you're interested in joining, you will need a Carnegie Mellon alumni e-mail account. To establish one, simply log on to http://www.alumniconnections.com/olc/pub/CMU/.

You will also need to establish a Facebook account at http://www.facebook.com/.

When both accounts are set up, go to the Facebook Web site, and add Mike McHenry or the Class Administrator from your graduation year as a "Friend." They will then invite you to join the MSE Alumni Group.

We look forward to seeing you online soon!

Amber Andreaco *(B.S. '04)* is working as an EEDP – Materials Engineer with General Electric.

Graham Doorley *(B.S. '06)* is employed by Lockheed Martin Commercial Space Systems as a Survivability EMI/EMC Engineer.

Andrew J. Francis *(B.S. '01, M.S. '02, Ph.D. '05)* has accepted a new position as a Senior Staff Scientist at GrafTech International in Parma, Ohio, which is near Cleveland.

Alumni Profile: *Lisa Roudabush*

Over the past 26 years, MSE alum **Lisa A. Roudabush** *(B.S. '82)* has built an impressive career at U.S. Steel—one that should serve as an inspiration to both current students and fellow alumni. She began her career at U.S. Steel while still at Carnegie Mellon, joining the company as a student co-op at its Research and Technology Center in Monroeville. Upon graduation, Roudabush was hired as a Management Associate at the Center. Over the next decade, she progressed through a series of increasingly responsible engineering positions, before being named Research Manager for Coated Products in 1992. Roudabush moved to U.S. Steel's Gary Works in 1994 to become Manager of Technology Planning. She was steadily promoted through a number of quality-assurance and technology positions, before returning to Pittsburgh in 2001 to serve as Manager of Process Technology at U.S. Steel's Mon Valley Works. In 2003, she was named the company's General Manager of Research, and in 2006 she began serving as Manager of its Clairton coke plant. In February 2008, Roudabush was named General Manager of U.S. Steel's Mon Valley Works. Her current responsibilities include the company's Clairton plant, the Edgar Thomson plant in Braddock, the Irvin plant in West Mifflin, and the Fairless plant near Philadelphia. The Department of Materials Science and Engineering congratulates Roudabush on her amazing rise from student co-op in 1982 to General Manager today.

Jennifer L. Giocondi *(B.S. '98, M.S. '99, Ph.D. '03)* recently accepted a position as an R&D Scientist with Senergen Devices, a solar cell start-up company in Fremont, California.

Frank Johnson *(B.S. '96, Ph.D. '03)* is employed as a Research Engineer with General Electric. His work specializes in magnetic materials.

Matthew R. Jones *(B.S. '07)* has received the prestigious NSF Fellowship. Jones is currently a doctoral student working on anisotropic nanomaterials for biological applications at Northwestern University.

Carsen Kline *(B.S. '99)* is a Process Engineer with Carnegie Mellon's Department of Electrical and Computer Engineering's Nanofabrication Facility.

Morgana Martin *(B.S. '03)* just completed her doctoral studies at Georgia Tech and has accepted a position with the Aerospace and Materials Research Group at the Johns Hopkins University Applied Physics Lab.

Thomas Matta *(B.S. '07)* recently accepted a position as a Business Development Associate with Capital Technologies International, Petroleum Group, in Pittsburgh.

Lalitha (Subramaniam) Rao *(B.S. '97)* is an attorney with Partridge Snow in Providence, Rhode Island.

Daniel Schmidt *(B.S. '98)* is an Assistant Professor in the Department of Plastics Engineering at the University of Massachusetts, Lowell. Schmidt's research focuses on the synthesis of porous polymers for emerging applications (tissue engineering, fuel cells, etc.); preparation and structure/properties relationships in polymer nanocomposites; organic and inorganic sol-gel chemistry; polymer crosslinking; and network formation.

STUDENT NEWS

MSE Senior Wins Churchill Scholarship

Courtney Ondeck Is First Carnegie Mellon Recipient Since 1992

Courtney Ondeck

Senior **Courtney Ondeck**—who has a dual major in Materials Science and Engineering and Biomedical Engineering—is among 13 students nationwide who were recently chosen to receive the prestigious Churchill Scholarship.

Awarded by the Winston Churchill Foundation of the United States, these one-year scholarships provide up to $50,000 in tuition, fees, round-trip airfare, and living expenses so that American students can pursue graduate work at England's Cambridge University. Since 1963, the Foundation has supported more than 400 Churchill Scholars in their studies at Churchill College, one of 31 colleges at the historic University of Cambridge, founded in 1209.

Ondeck is the first Carnegie Mellon student to receive this prestigious award since 1992. She will study in the Department of Chemistry at Cambridge, where she will pursue a graduate degree while focusing on her research interests, which lie in the biomedical applications of nanoparticles.

"I'm really excited about this new opportunity to learn and work with top international researchers," says Ondeck, who hails from McMurray, Pennsylvania. "It's going to be a big thrill just to be attending the same institution where the famed Sir Isaac Newton once studied."

"I'm really excited about this new opportunity to learn and work with top international researchers. It's going to be a big thrill just to be attending the same institution where the famed Sir Isaac Newton once studied."

Scholarship Honors Ondeck—and MSE

The Churchill Scholarship represents an honor not only for Ondeck, but also for both Carnegie Mellon and the Department of Materials Science and Engineering.

MSE Professor Michael McHenry praises Ondeck for her outstanding dedication to academics and research, which has been recognized by this elite honor.

"Courtney has received more 'A' grades from me than any other undergraduate student that I have instructed in the past 18 years at Carnegie Mellon. These grades reflect a particular persistence and patience in learning," says McHenry.

"This prestigious award is a reflection of the quality students our top-ranked engineering program attracts and the leading-edge, global research our students are exposed to," said Pradeep K. Khosla, Dean of Carnegie Mellon's College of Engineering. "We congratulate Courtney for being named a Churchill Scholar as she prepares to begin using all the important problem-solving skills she honed so successfully during her past four years at Carnegie Mellon."

Peter C. Patrikis, Executive Director of the Winston Churchill Foundation, agrees that the honor is an elite one—reflecting positively on both the character of the winning students and their academic backgrounds. "Courtney joins an astonishing elite group of young men and women whose academic talents and achievements are matched by their personal qualities and contributions to their communities," says Patrikis. He notes that the competition for the Churchill Scholarship was especially intense for the 2008-2009 academic year, with applications up 62 percent—and with applicants representing some of the strongest scholars in the country.

A Lifelong Scientist and Scholar

At 21, Ondeck admits that her interest in science, and her persistence in learning, began as a child. She recalls spending hours playing doctor, using her stuffed toys as patients. Following her studies at Cambridge, she plans to attend medical school to become a medical doctor and researcher.

In addition to being a Churchill Scholar, Ondeck also has been named an Andrew Carnegie Society Scholar, and is a member of the Lambda Sigma Honor Society, the Phi Kappa Phi Honor Society, the Mortar Board Honor Society, and the Tau Beta Pi Engineering Honor Society.

Ondeck has worked as a volunteer at the Hillman Cancer Institute and was a clinical volunteer for a month in Vietnam. She has also studied concert piano.

Courtney Ondeck's interests and talents are as impressive as they are diverse—and the Department is delighted that she will soon add "MSE graduate" to her already long list of credentials.

Recent Ph.D. Theses

Doctoral students in the Department of Materials Science and Engineering perform a range of advanced research and analysis that place MSE at the forefront of national graduate programs. Following is a list of some of the exciting thesis work that has recently been completed within the Department.

David C. Berry
"Ultrahigh Density Magnetic Recording Media: The A1 to L10 Phase Transformation in FePt and Related Ternary Alloy Films"
ADVISOR: Katayun Barmak

Patrick Fisher
"Thin Film Growth and Structure Design in the BaO-SrO-TiO_2 System"
ADVISORS: Paul Salvador and Marek Skowronski

Jason Gruber
"Interface Texture Development During Grain Growth"
ADVISORS: Anthony Rollett and Gregory Rohrer

Sabuj Halder
"Simulation of Reduction of Iron-Oxide-Carbon Composite Pellets in a Rotary Hearth Furnace"
ADVISOR: Richard Fruehan

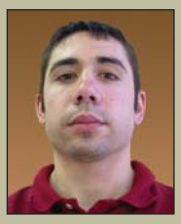
Sirisha Kuchimanchi
"Effect of Ga and Refractory Metal Substitution in 3:29 Intermetallic Permanent Magnets"
ADVISOR: Michael McHenry

Pranita Kulkarni
"Investigations on Properties and Metal Contacts to Carbon Thin Films"
ADVISOR: Lisa Porter

Jaewon Lee
"Evolution of Extended Defects in PVT-Grown 4H-SiC Single Crystals"
ADVISOR: Marek Skowronski

Saurav Nigam
"Lifetimes in Silicon Carbide"
ADVISOR: Marek Skowronski

Nitin Patel
"Structure Property Relationships of Nitride Superlattice Hard Coatings Prepared by Pulsed Laser Deposition"
ADVISOR: Paul Salvador

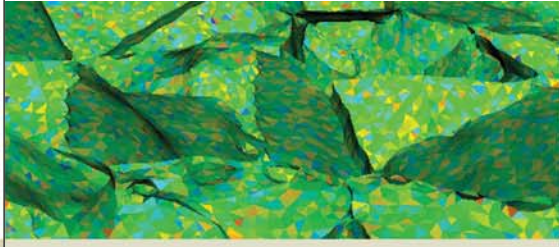


Chris Roberts
"Grain Growth and Zener Pinning Phenomena: A Computational and Experimental Investigation"
ADVISOR: Anthony D. Rollett

Eric Schmidt
"The Kinetics, Morphology, and Mechanism of Austentite Formation During Thermal Processing of Iron Alloys"
ADVISOR: Sridhar Seetharaman

George Shannon
"Oxide Inclusion Behavior at the Steel/Slag Interface"
ADVISOR: Sridhar Seetharaman

Xuan Zhang
"Extended Defects in 4H-SiC Homoepitaxial Layers"
ADVISOR: Marek Skowronski



STUDENT NEWS

MSE Students Support Lunar X Prize Effort

In Fall 2007, a Carnegie Mellon team announced its plans to compete in the Google Lunar X Prize—a $30 million competition for the first privately funded team to send a robot to the moon; travel 500 meters; and transmit video, images, and data back to Earth. The Carnegie Mellon team is headed by Professor Red Whitaker of the Robotics Institute, who recently led the Tartan Racing team's robotic vehicle to victory in the DARPA Urban Challenge.

The goal of the Lunar X Prize competition is daunting: design, build, and transport a small rover to the surface of the moon and complete a set of tasks—ranging from taking photos to visiting artifacts from previous missions. But the payoff is significant, with up to $20 million in prize money to be claimed by the winning team, if their rover is the first to complete all of the tasks specified by the X Prize Foundation. The winning team can earn another $5 million in bonus prizes for completing additional tasks.

There are many hurdles that need to be overcome on a tight schedule, as the value of the first-place prize drops to $15 million after December 31, 2012. The final deadline for winning the prize is December 31, 2014. The Carnegie Mellon team will compete with nine other teams from around the world.

A design course has been created to support this effort, and students from many Carnegie Mellon departments have elected to participate in projects that develop systems or subsystems for the rover. Materials design and performance figure heavily in many of the problems being investigated, so it is no surprise that four MSE sophomores are involved: **Collin Edington, Ankur Gupta, Maryanna Saenko,** and **Brittany Selman.**

Gupta and Selman are working with **Professor Jay Whitacre** in testing the performance of high-temperature tolerant battery materials, and will also be assembling and testing a prototype battery pack. Saenko and Edington are working with **Professor Michael McHenry** on materials and design for the rover wheels.

If all goes well, the MSE students' work will be incorporated into the final rover, which is slated to go to the moon sometime in 2009.

You can learn more about the Lunar X Prize competition at http://www.google-lunarxprize.org/.

Shown left to right are the Lunar X Prize team members from MSE: Maryanna Saenko, Collin Edington, Brittany Selman, and Ankur Gupta.

Student News Bits

GEM Fellowship Awarded to MSE Senior

MSE senior **Sophia Woodley** has received a GEM Fellowship from the National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM). GEM Fellows are selected based on an academic record that indicates the ability to successfully pursue graduate studies in engineering, or the natural and physical sciences—including chemistry, physics, earth sciences, mathematics, biological sciences, and computer science. The mission of GEM is to enhance the value of the nation's human capital by increasing the participation of underrepresented groups (African Americans, American Indians, and Hispanic Americans) at the master's and doctoral levels in engineering and science. Woodley has chosen to continue her studies at Carnegie Mellon—and will begin studying toward her M.S. degree in Materials Science and Engineering this fall.

Doctoral Student Wins SMART Fellowship

Ph.D. candidate **Nicholas Jones** has been selected for the SMART Fellowship by the Naval Surface Warfare Center, Carderock Division. Jones will receive an annual stipend of $38,000 per year, as well as full tuition, health insurance, and other benefits. He will also complete a paid internship each summer. Upon finishing his degree, Jones will be hired as a full-time employee at the Naval Surface Warfare Center.

MSE Accreditation Activities:
Defining Our Educational Objectives

On January 11, 2008, the MSE Undergraduate Program Assessment and Review Committee held a meeting to discuss ongoing accreditation activities. One of the discussion topics was the Program Educational Objectives (PEOs) for our undergraduate curriculum. In the context of Engineering Accreditation, we review our educational objectives every three years. In accordance with our curriculum assessment plan, we now publish these objectives, so that our alumni may provide feedback.

Four high-level educational objectives have been selected for the MSE undergraduate program. Our program will produce graduates who:

1. *Are successful in a top graduate school and/or in materials engineering positions*
2. *Excel in professionalism and leadership in modern materials engineering practice, while accounting for the impact of their profession on an evolving society*
3. *Creatively advance our collective understanding of the principles of materials science and engineering and/or innovate in the design of technological systems*
4. *Contribute effectively as an individual, team member, or leader to achieve group and institutional goals*

Achievement of these objectives will fulfill the educational component of the MSE mission statement; the objectives are also consistent with the mission statements for the University and the College of Engineering.

In addition to the PEOs, we have also formulated, and continue to review, a set of 10 Program Outcomes. Based on the broad range of destinations for graduates of the MSE program, our curriculum is designed to provide a strong foundation in fundamental knowledge and skills. This provides an excellent basis for the substantial fraction of our graduates who go on to graduate school. For the equally substantial fraction who find employment in industry, the program provides the foundation on which a company can build its domain-specific knowledge. For those individuals who move on to other areas, the MSE curriculum provides a modern liberal education—i.e., one that inculcates a thoughtful, problem-solving approach to professional life. Our intended outcomes for the B.S. program are, therefore, that students should have acquired the following set of skills and attributes:

A. *An ability to apply a knowledge of mathematics, physics, chemistry, materials, and statistics to identify, formulate, and solve the problems encountered in the production or application of a material*
B. *An ability to apply core concepts in materials science (structure, properties, processing, and performance) to identify, formulate, and solve contemporary materials engineering problems*

C. *An ability to communicate effectively*
D. *An ability to design and conduct experiments, and to analyze and interpret the data derived from these experiments, with an emphasis on relating properties and processing to structure and on relating structure and properties to materials performance*
E. *An ability to select materials to meet relevant performance criteria during the design of engineered systems and components, within realistic constraints*
F. *An ability to function responsibly and ethically in a professional, multidisciplinary environment as an individual or as a member of a team*
G. *An ability to employ the techniques, skills, and tools of modern materials engineering practice*
H. *A recognition of the need for lifelong scholarship, as the field of materials is continually evolving as new knowledge and materials are developed*
I. *A knowledge of contemporary issues in the application of materials*
J. *The broad education necessary to understand the impact of materials engineering solutions in a global and societal context*

We invite comments from you on all or any of these statements. Realizing that curricula change over time, we are, in particular, interested in finding out whether or not we have achieved our educational objectives. In other words, in your present professional situation, do you feel that the MSE undergraduate curriculum has provided you with the proper skills to be successful in your career? If not, then what could we do to improve our curriculum? Have we forgotten to address any important items that should be part of our educational objectives?

Please send your comments to **Professor Lisa Porter**, Chair of the Undergraduate Program Assessment and Review Committee. She can be reached by phone at 412-268-4047, or via e-mail at lporter@andrew.cmu.edu.

MSE news

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Carnegie Mellon

Pittsburgh Named #6 Emerging Tech Center

Forbes recently identified 10 American cities as up-and-coming technology centers—and Pittsburgh ranks #6 on its list. The magazine cited Carnegie Mellon University's Collaborative Innovation Center as a major factor in encouraging technology leaders like Intel and Apple to build labs in this region. *Forbes* also called Pittsburgh an "innovative force" in health care, biomedical technology, nuclear energy, and robotics.