Exploring Materials at Virginia Tech

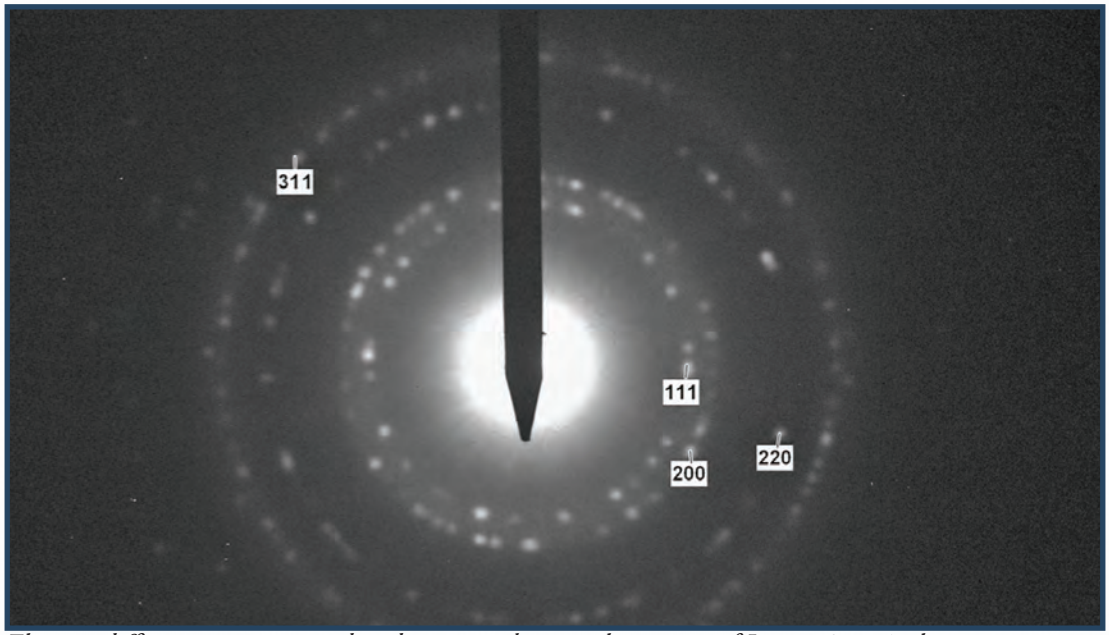
VirginiaTech Invent the Future

Fall 2012, Volume 14, Number 1

News from the Department of Materials Science and Engineering
Virginia Polytechnic Institute and State University

Spotlight

Research



Electron diffraction pattern used to determine the crystal structure of Iron – 50at% platinum nanoparticles made by chemical synthesis.

The Origin of Nanoscale-Derived Properties in Nanoparticles

By William Reynolds and Mitsu Murayama

Reprinted from ICTAS Connection, May 2011 edition

Nanotechnology's promise arises from novel phenomena traceable to spatial features in the nanometer range. One of the more established kinds of this technology involves nanoparticles – small pieces of matter a few nanometers across. Nanoparticle pigments and catalysts have been used in industrial processes and commercial products for many decades, but developments in the ways nanoparticles are synthesized and studied are enabling engineers to design new types of nanoparticles with specific functional properties. For example, nanoparticles are beginning to appear that deliver drugs to specific sites in the body, act as molecular sensors, simplify electronic packaging, impart antimicrobial properties, and serve many other functions.

The unique characteristics of nanoparticles often are associated with physical interactions taking place on the nanometer length scale. For example, metallic gold has a deep yellow color, but if it is converted to powder particles less than about 100 nm in size (less than the wavelength of visible light), it is no longer yellow. Depending upon how the particles are spaced and arranged relative to each other, they

continued on page 14

What's inside

Discover what we're made of...
www.mse.vt.edu

Research Corner

Meet Professor Bill Reynolds

by LeeAnn Ellis

Professor Bill Reynolds did not start out dreaming of a career in materials science and engineering. Growing up in the suburbs surrounding Pittsburgh, he entered Carnegie Mellon with a definite mindset toward engineering and an interest in cooperative education. When he began his undergraduate work, only one engineering department offered a co-op program, metallurgical engineering. "You take opportunities as they come," was Reynolds' philosophy, and METE offered the opportunity he desired. His father, curiously, is a materials engineer. "In a sense, I followed him, but not consciously."

Finding his way to Virginia Tech in 1988 was another golden opportunity, one that arrived in an era when faculty positions around the country were scarce. In the MSE department at Virginia Tech, some of the long-term projects with which he became involved have culminated in new groundbreaking facilities at VT. Not long after joining the MSE department, Dr. Reynolds assumed the role of Foundry Education Foundation (FEF) Key Professor, taking over from Professor Bob Swanson and serving as a liaison for the FEF, which offers scholarships to students. As the FEF Key Professor, he got to know VT alum Paul Huffman (MSE '78), the education chair at the time for the Piedmont Chapter of the American Foundry Society. The AFS was interested in bringing foundry activity back to college campuses. So Dr. Reynolds got involved in the initial effort to build a foundry education program and eventually a foundry at Virginia Tech.

He taught casting courses for the department that required field trips to foundries so that students' designs could be cast into metal. He also became aware of various student groups who would benefit from the presence of a foundry on campus. Today, thanks in part to his initial effort, and the leadership and financial support of many in the industry and in the university, the Kroehling Advanced Materials Foundry is fully operational and serves students in multiple departments as well as professionals in the metal casting industry.

In 1996/97 a convergence of influences lead Dr. Reynolds to spend a sabbatical year in Japan. In graduate school, as the only American in his research group, he learned about Japanese culture from two fellow researchers. Through this interaction, he became interested in the Japanese language and took classes, which he continued after arriving at Virginia Tech. After completing the courses at Tech, he eventually married Mariko, the Japanese instructor. In addition to this family connection to Japan, he had also developed professional relationships with colleagues at the National Institute for Metals (now National Institute for Materials Science) in Tsukuba.

At the Institute, he was able to work with equipment not available at Virginia Tech. He also met Mitsuhiro Murayama, who became his go-to person at the Institute for help in learning about equipment and getting things done. This relationship continued after he returned to Virginia Tech. Dr. Murayama joined MSE full time as an associate professor in 2011 with a focus on transmission electron microscopy among other things.

Dr. Reynolds' graduate experience with microscopy and his continued research and experience with field ion microscopy/atom probe instrumentation in Japan put him in a prime position when MSE department head David Clark began looking into getting a characterization facility established at Virginia Tech. The concept gained wider interest in the College of Engineering, and today the university is home to the Institute for Critical Technology and Applied Science. Reynolds serves as the director of the Nanoscale Characterization and Fabrication Laboratory (NCFL), which is housed in the ICTAS building in the Corporate Research Center.

As an educator, Dr. Reynolds' teaching philosophy has remained consistent over the years. "Apprenticeship is a good way of learning," he states. "You work with someone who is skilled at something and you learn by observing and working with them and working through problems together." He points out that while this philosophy is not popular in this country because it is not efficient, he believes it is a very good way to learn. ❄

MSE Professors Receive Dean's Award for Excellence

Two MSE professors received a Dean's Award for Excellence for 2012. MSE Associate Department Head, **Professor Bob Hendricks**, received the Dean's Award for Service Excellence, and **Associate Professor Kathy Lu** was a recepient of the College of Engineering Faculty Fellow Award. At the fifteenth annual Virginia Tech College of Engineering faculty reception, awards were presented to engineering professors for teaching innovation, research, service, and outreach for 2012. ❄

Norman Dowling Spends Summer and Fall 2011 as Visiting Erskine Fellow in New Zealand

Professor Norman Dowling spent the summer and fall of 2011 on a research assignment in New Zealand. As a Visiting Erskine Fellow, he was hosted by Milo Kral, head of the mechanical engineering department at the University of Canterbury, Christchurch. Dr. Dowling interacted with the faculty on a wide range of research in electronic component durability, metal microstructure micro-modeling, biodegradable medical implants. He also joined a group of ME faculty involved in an engineering research problem concerning

cracking in large specialized fans used for drying milk to powder.

Dr. Dowling taught the lecture portion of their Fracture Mechanics and Failure Analysis course, and he worked on sample preparation and procedures for tests on fracture toughness of metals for use as classroom demonstration.

Finally, he and his wife, Nancy, took advantage of their weekends and breaks to explore much of New Zealand, including museums, aquariums, sea kayaking, whale watching, shopping, and wine tasting. Their travels took them from Auckland to Te Anau and sights in between. ❄

Kathy Lu Wins Bessel Research Award

MSE **Associate Professor Kathy Lu** has been awarded The Friedrich Wilhelm Bessel Research Award from Alexander von Humboldt Foundation, Germany. The award is given to scientists and scholars, internationally renowned in their field, who in future are expected to continue producing cutting-edge achievements. Award winners are invited to spend a period of up to one year cooperating on a long-term research project with specialist colleagues at a research institution in Germany.

Dr. Lu will move to Germany to conduct research from August 2012 to May 2015 with Prof. Ralf Riedel at Technische Universität Darmstadt. ❄

New Additions to the MSE Advisory Board

The MSE Advisory Board welcomes two new members this fall: **Justin Schwartz,** Department Head of Materials Science and Engineering at North Carolina State University and **Thomas Digges, Jr.**, CEO, Virginia Semiconductor.

Alan Druschitz Receives AFS Best Paper Award

For the second time in as many years, MSE **Associate Professor Alan Druschitz** received the Best Paper Award by the American Foundry Society. The Lost Foam Casting Division gave the award for "Vacuum Assisted Filling of A356 Aluminum Alloy Engine Blocks Using the Lost Foam Casting Process." The article was published in the 2012 AFS Transactions and presented at the 2012 AFS Metalcasting Congress.❄

Department News

Tianjin University Visits Virginia Tech

Since 2009, the Department of Materials Science and Engineering and the College of Engineering have worked closely with Tianjin University's School of Materials Science and Engineering to strengthen international collaborations between the two universities.

Tianjin University is located in the metropolis of Tianjin in northern China. This relationship has resulted in several student exchanges with Tianjin students visiting VT in the spring and fall semesters and VT students traveling to China during the summer months as well as during fall and spring semesters to attend classes at Tianjin University.

A delegation of 12 Chinese students, faculty, and staff spent three weeks in Blacksburg in February 2012. They observed several MSE lectures, attended the MSE graduate seminar, and toured laboratories, including the Kroehling Advanced Materials Foundry and ICTAS.

In addition, the group met with Dean Benson, Associate Dean Scales, and Ms. Nicole Sanderlin, Director of International Programs. They also enjoyed local activities such as VT women's basketball, hiking, and shopping. One student summarized the visit and experiences with five words: diversity, freedom, responsibility, respect, and gratitude. ❄

Tracey Keister Receives a Virginia Tech 2012 Staff Career Achievement Award

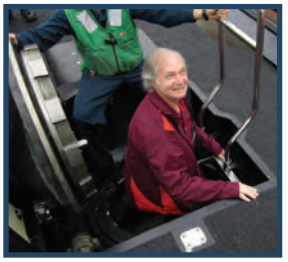
Tracey Keister, retired office manager in the Department of Materials Science and Engineering in the College of Engineering, has received a 2012 Staff Career Achievement Award. Ms. Keister retired in 2011 after 11 years of service to the department.

Created in 2011 to recognize retiring staff members, the Staff Career Achievement Award is presented annually to up to five individuals who have distinguished themselves through exemplary performance and service during their university career. Nominees must have served a minimum of 10 years at Virginia Tech. Each recipient is awarded a $1,000 cash prize.

Ms. Keister joined the department in 1999 after she retired from the U.S. Navy, where she served for more than 20 years. In the nearly 12 years that she worked in the department, she was an invaluable member of its operations. ❄

Alan Druschitz Visits the United States Naval Nuclear Propulsion Program

The United States Naval Nuclear Propulsion Program allows a few educators a never to be forgotten experience – the opportunity to visit the Navy Submarine Training Center in San Diego, California, for two days. MSE Associate Professor Alan Druschitz had this opportunity on Oct. 20-21, 2011.



This event included briefings and a tour of the USS Bonhomme Richard, an Amphibious Assault Ship, that is part of the Expeditionary Strike Group and home to a crew of about 1200 sailors.

The second day included an eight-hour tour aboard the USS Hampton, a Los Angeles Class, Fast Attack, Nuclear Powered, Submarine. Professor Druschitz even crawled down the length of a 26' long torpedo tube and signed his name on the outer wall.

The Nuclear Propulsion Officer Candidate Program is an elite program in engineering, nuclear power, and leadership offering attractive benefits for students while in school and after graduation. ❄

New Appointments and New Hires in MSE

Dr. Céline Hin joined the Departments of Materials Science and Engineering and Mechanical Engineering at Virginia Tech as Assistant Professor in August 2011. She currently works as a primary faculty in the Nuclear Engineering Program (NEP) in Mechanical Engineering.

Professor Hin received her Ph.D. at the Commissariat a l'Energie Atomique at Saclay where she worked on the understanding of heterogeneous precipitation in ferritic alloys. She spent one year at UC Berkeley in the Nuclear Engineering Department where she studied the link between the microstructure evolution and the mechanical properties in nanostructured ferritic alloys.

In 2007, she joined the Carter's Group at MIT in the Department of Materials Science and Engineering, where her research on Li-ion batteries focused on developing a Grand Canonical Kinetic Monte Carlo algorithm to study the influence of particle orientations in the electrolyte on the cell voltage at atomic scale.

Finally, she joined the Department of Mechanical Engineering at MIT in 2009, where she worked on thermoelectric materials, trying to improve the figure of merit in PbTe systems using DFT calculations. ❄

Dr. Mitsuhiro (Mitsu) Murayama joined the MSE Department full time in February 2011. He received his B.S., M.S., and Ph.D. from the University of Tohoku in Japan. He spent 11 years as a Senior Researcher at the National Institute for Materials Science in Japan, one of the world's largest materials science institutes. Dr. Murayama has over 20 years of research experience in nanoscale materials characterization with many state-of-the-art analytical techniques, including Rutherford backscattering spectroscopy, ion channeling spectroscopy, field ion microscopy/atom probe, and analytical electron microscopy.

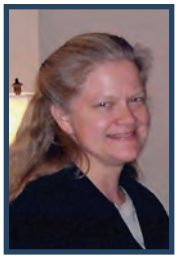
Dr. Murayama teaches electron microscopy and associated materials characterization techniques. He currently offers a graduate level course, *Introduction to Transmission Electron Microscopy*. He is responsible for the electron microscopy part of the Nanoscale Characterization and Fabrication Laboratory (NCFL-ICTAS), especially the high resolution scanning/transmission electron microscope (FEI TITAN). He provides operational support and oversees strategic management of resources. In addition, Dr. Murayama serves as a member of the MSE International Program. ❄

Dr. Alan Druschitz joined the MSE Department in Fall 2011 as Associate Professor. He received his B.S. and Ph.D. in Metallurgical Engineering from Illinois Institute of Technology in Chicago. Prior to joining the Virginia Tech faculty in January 2011, he served as the head of the Metals Casting Group at the University of Alabama at Birmingham. Previous positions include the Director of Materials R&D for Intermet Corporation and Staff Research Engineer for General Motors.

At Virginia Tech, Dr. Druschitz serves as the Director for VT FIRE (Foundry Institute for Education and Research) and the new Kroehling Advanced Materials Foundry, a world-class facility using state-of-the-art foundry equipment and best-practice scientific and safety procedures. Dr. Druschitz will be responsible for the ongoing development of educational and research opportunities for engineering and art students at VT FIRE. He will also teach courses primarily related to metallurgy and metal processing, which may include steel and steel making, metal casting, and introduction to materials. Dr. Druschitz will also serve as the Foundry Education Foundation Key Contact, providing a connection between our students and the metal casting industry. ❄

Michelle Czamanske is the new Academic Advisor and Undergraduate Services Coordinator for MSE. Michelle graduated with a B.S. in Communications from Radford University in 2002. Immediately after graduating, she joined Virginia Tech and worked at CPES in Electrical Engineering as Editorial Assistant for IEEE PELS, then in the Housing & Residence Life Office as an Assignments Coordinator. She enjoys working with students and helping them find solutions.

Michelle enjoys cooking, crafting, hiking, reading, and vacationing. With two boys and two dogs - there's never a dull moment! ❄



LeeAnn Ellis has been appointed office manager and public relations specialist for MSE. She holds a Bachelor's in elementary education with minors in English and social sciences from Virginia Tech. She has worked at the university since 1987 and first joined MSE part time in 1993 as an editor for the Center for Advanced Ceramic Materials under Dr. Jesse Brown. LeeAnn enjoys working on special projects and recently completed a photo journal on the construction of the Kroehling Advanced Materials Foundry. She is currently researching the history of the MSE department. She would love to hear from alumni and retired faculty to collect stories and recollections about the department through the years. You can contact her by email at *mse@vt.edu*. ❄

Cindy Purdue joined the Department of Materials Science and Engineering in December 2011 as the Business Services Assistant. For 13 years, Cindy has worked at Virginia Tech. She was in Apparel, Housing, and Resource Management for 10 years, as a Fiscal Technician; AIS – Finance for 2 years as Fiscal Technician. ❄

VT FIRE Dedication Held

Virginia Tech's College of Engineering is continuing its tradition of hands-on, minds-on education with the newly opened Kroehling Advanced Materials Foundry, a metal casting facility located just off campus on Plantation Road.

The 4,500-square-foot, $1.7 million facility includes a 125-kilowatt induction furnace capable of melting aluminum, copper and bronze, iron and steel; various mold making equipment including no-bake and ceramic shell; a rapid prototype; and other high-tech equipment that students likely will find themselves using upon entry into the metal casting and related industries.

The facility, hosting classes for undergraduate and graduate students since January 2011, was dedicated April 5, 2011, with an open house. On hand for the event were **John H. Kroehling**, a decorated World War II veteran and 1948 graduate of the College of Engineering, and his wife, Joan.

Kroehling, a member of the advisory board for Virginia Tech's Materials Science and Engineering Department, provided the initial funds of $500,000 for the foundry project, overseen by the Virginia Tech Foundry Institute for Research and Education (VT FIRE) program. The group's mission is to support student interest in the area of foundry science and the metal casting industry. The Kroehlings' initial funding kick-started corporate donations of money and in-kind contributions of equipment.

Kroehling has been a major contributor to Virginia Tech through scholarships and fellowships to the College of Engineering and the university's Department of Statistics. "I wanted to give back to the university for the education I received, and our son received and our granddaughter is receiving," said Kroehling, who spent 20 years at DuPont, working in metal foundries and the refractories industry, and also founded his own company, J.H. Kroehling Associates Inc. [Kroehling's granddaughter, Dilys Hall, is now a junior in the MSE program at Virginia Tech.]

In addition to COE classes for MSE, Engineering Education, ISE, and ME, the facility also will serve students in the College of Architecture and Urban Studies' School of Visual Arts and the Industrial Design program.

Among the engineering faculty leading in the foundry's inception was MSE professor, **Bob Hendricks** and **Paul Huffman Jr.**, an adjunct instructor within MSE, who also is president of Roanoke, Va.-based Dominion Metallurgical Inc. Huffman is an alumnus of MSE. ❄

Excerpts from College of Engineering press release, "Virginia Tech opens new foundry for students in engineering, art, and architecture," by Steven D. Mackay.

Foundry Classes Underway

Classes began at the Kroehling Advanced Materials Foundry in January 2011. Pictured are scenes from the first MSE Metals Casting class. Throughout the year, various groups, including middle and high school groups as well as industry and military personnel, visit the foundry and participate in tours, demonstrations, and workshops. Visit www.mse.vt.edu/vtfire to learn more. ❄

Quality Education: Teaching Students to Optimize Experiments

by Ashley Durrbeck

Reprinted from the American Ceramics Society Bulletin, June/July 2012 Issue, Volume 9, No. 5

Virginia Tech's Materials Science and Engineering Department is constantly looking for ways to improve its curriculum to prepare its students for what is coming next. One of its more recent additions includes the class, Materials Optimization through Designed Experiments. The department developed this class to better prepare seniors for their design projects by examining ways to refine their experiments as well as to prepare the students for challenges they will face in the work place.

The goal of the class is to understand how to make experimentation more efficient, more powerful and more predictive, according to MSE instructor, Professor Gary Pickrell. More efficient experiments require fewer trials to produce meaningful data, saving time and money. The more powerful the experiment, the better the understanding that will be obtained from it. The more predictive an experiment, the easier it is to optimize and improve the performance characteristics. With these goals in mind, Professor Pickrell introduced the students to concepts such as Six Sigma, Statistical Process Control Charts and the Taguchi Method.

An example of a projectile system created and optimized for this class.The factors that were varied include board angle, elastic pull back position, ball position and peg location.

Lectures include interactive building of Statistical Process Control Charts, where students gather data over the course of several class periods, and the data were entered into an –x chart and an R chart. Through examining these charts — –x chart for analyzing the average and R chart for analyzing the variation — students are able to determine if the data is in an acceptable range for the given experiment. Students also learn how to detemine when changes in a system over time are significant and what to do when the system does not behave as expected.

A real world perspective from prior industry experience often is shared with the students, as concepts that are important, such as the Six Sigma method for quality control. The Taguchi Method was discussed in depth, as it utilizes loss functions, system design, the interaction of data and outcome analysis to improve the quality of the product. The Taguchi Method is heavily used for the group project assigned to each class.To put the lessons into practice, students work in groups to build a projectile system that has four variables with three levels each. These four variables were peg height, pin location, draw-back position and ball position (the photograph shows an example projectile system).

Once this system is built, the groups are given different target distances to achieve, and they have to optimize the system to decrease variance from the target. By creating and analyzing these systems, students are able to better absorb the information presented in their lectures.

The Materials Optimization through Designed Experiments course provides invaluable information to students that is applicable to many real-world situations. By learning about Six Sigma, students will increase their career marketability and will be able to become valuable members in any company because of their ability to design efficient experiments, analyze the results of data and determine when the changes in a process have occurred. ❄

Ashley Durrbeck will be a senior in materials science and engineering at Virginia Tech in the fall of 2012. For her Senior Capstone Design Project, she will be working on accessing the feasiblity of glass-ceramics for guitar nuts and saddles. She will also serve as the 2012-13 MEPS Outreach Officer.

Student News

MEPS: Materials Science and Engineering Professional Society Highlights *by Christian Birkett*

AY 2011-2012 has turned into a very busy and rewarding year for MEPS students at Virginia Tech.Throughout the year, MEPS students have actively found ways to provide opportunities to students. Officers organized visits from guest speakers, corporate and academic info sessions, and numerous trips to facilities with materials-related activities.

In October 2011, MEPS students (VT chapter) received a Material Advantage Chapter of Excellence at the MS&T (Materials Science & Technology) 2011 Conference and Exhibition, Columbus, Ohio.

Furthermore, the students, led by **Jacob Monzel**, took first place in the Mug Drop Contest at the conference. This was the first year VT-MSE participated in the mug drop.

Also, MSE junior, **Charles Forman**, took third place overall in the student speaking contest.

Professional Information Sessions

MEPS officers coordinated a talk on a polymer matrix composite project currently being pursued for space applications. **Dr. Mark Shuart**, Senior Advisor for composites and structures for NASA Langley and Research Professor in MSE at Virginia Tech, gave students a quick background in the basics of PMCs. He also discussed the current projects involving composites and NASA's plans for a new heavy-lifter rocket system.

Field Trips

Five MEPS field trips were organized last year. Students attended trips to a local steel mill, a high end assembly facility, a ceramic substrate factory, a nuclear waste disposal facility, and an artisan wrought iron bloomery.

The students were able to see two factories in action at Roanoke Steel and Corning ceramic factory. At Roanoke Steel, students were able to see the complete production path of steel through a minimill, from scrap to shipped product. Similarly, the Corning plant showed how ceramic materials were shaped and fired from raw materials.

Students also toured a MOOG plant in Blacksburg where they saw how precision manufacturing is performed for high-value applications.

MEPS members visited the Defense Waste Processing Facility at the Savannah River Site near Aiken, SC. The trip was organized by MEPS officers and Dr. George Wicks, MSE Advisory Board member and a senior engineer at the Savannah River National Laboratory. The students saw the current processes being used to immobilize and store extremely high-level radioactive waste left over from the Cold War. They learned about current materials-related projects underway at the Savannah River Site.

In February 2012, MEPS students provided security and registration needed for the Annual Conference on Composites, Materials and Structures at Cocoa Beach, Florida.

Social Activities

MEPS's biggest social events are the fall tailgates for home football games. These events, organized by MEPS and financially supported by the department, are a great way for students of various levels and faculty to talk informally and get to know each other. ❄

2012-2013 Elected Officers

Stephanie Sparks
President

Pat Sinko
Vice President

Andy Wentzel
Treasurer

Alexandra Egert
Secretary

Morgan Brown
Social Chair

Experiences in the Workplace

Charles Forman and Patrick Sinko are MSE juniors and had interesting summer work experiences, albeit very different.

Government Sector
By Charles Forman

I participated in a Department of Energy sponsored Science Undergraduate Laboratory Internship at the Thomas Jefferson National Accelerator Facility in Newport News, Va., last summer. Jefferson Lab is a world-class nuclear physics research facility that houses a 7/8-mile continuous electron beam accelerator for studying subatomic particles.

I was assigned a mentor, Michael Kelley, who gave me a unique materials research project. My project was the very first to dissect and analyze a high-performing superconducting radio-frequency niobium accelerator cavity. Many Jefferson Lab engineers are relaxed in terms of attire, but they are all very involved in their work. My research experience was more formal, because my mentor treated me as a graduate student. I am still impressed by the quality of equipment present at Jefferson Lab. I needed only to sign up online, and I had access to top of the line optical, scanning and atomic force microscopes. In addition to my mentor, I reported to the supervisor of the internship program. All interns are expected to write a formal research paper and present their work in a poster session at the end of the summer. The DOE annually chooses the top 14 papers from about 500 national lab interns nationwide to be published in the agency's Journal of Undergraduate Research. They selected my paper and arranged for me to compete in a national conference in Washington, D.C. Overall, they treated me very well, and I had a great research experience. ❄

Private Sector
By Patrick D. Sinko

For the past two years I have been working in the pharmaceutical industry as a materials scientist and engineer at Bristol-Myers Squibb. Although the company is global, I worked at the original site in New Brunswick, N.J. I spent my first summer at BMS characterizing pharmaceutical excipients and active pharmaceutical ingredients. I had the opportunity to work with experienced materials engineers from all over the world as well as world-class pharmacists. This was beneficial because I was using traditional methods and cutting edge technologies to generate a central database of pharmaceutical materials properties. I had the opportunity to develop a platform formulation. The working atmosphere at BMS is relaxed, but you are expected to deliver results on time or early. The dress code was relaxed, business casual in the office and appropriate lab safety gear while in the lab. My job resided in the Drug Product Science and Technology Department, but I actually belonged to two smaller groups within that department that deal with materials characterization and development. My team was five people ranging from 25 years of experience to myself with only a year of experience.

BMS holds an internal symposium, which the upper management and most of the top level scientists attend, and this is where you present the findings from your research. The amount of learning that I experienced over my two years at BMS was not limited to material systems and pharmaceutical knowledge, but extended to professional development and learning how to work in industry as an engineer. ❄

Conquering the Conference

by Samara Levine

Samara Levine is an MSE junior. She is the communications chair of Presidential Council of Student Advisors (PCSA)

One of my biggest regrets in my academic career was not going to the Materials Science and Technology conference my sophomore year. I thought that because I had just selected Materials Science and Engineering as my major, I would not benefit from going. I immediately knew I was mistaken when a couple of my peers, who had been more adventurous than me, returned from the conference excited by their new contacts and new insights.

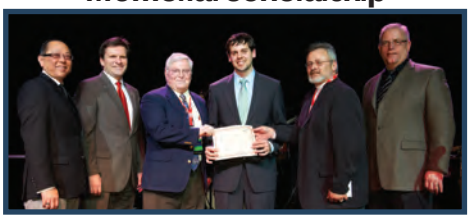
Not being one to make the same mistake twice, I immediately made plans to go to MS&T the following year. I went to MS&T with several students from Virginia Tech. We arrived on Sunday morning and registered. Receiving the schedule of presentations was overwhelming. It was a booklet! Who knew there could be so many talks on sintering? Luckily, scheduling on the first afternoon was light so I did not have to make any decisions with my time right away. It was Sunday, and the conference was not in full swing yet. However, there were several programs for students. I spent the afternoon supporting a fellow student in the ACerS speaking contest and attending a forum on graduate schools.

The following morning I perused the schedule over breakfast and figured out what talks I wanted to attend for the day. I was not prepared for how difficult a task it would be. I complained to my friend while frustratingly gesturing with my bagel, "How am I supposed to choose between all these presentations? There are so many that sound interesting!"

Eventually, I developed a list of presentations I wanted to attend for the day.

continued on page 15

Cameron Curtis Receives Bert Krisher Memorial Scholarship



MSE junior, **Cameron Curtis,** received a Bert Krisher Memorial Scholarship at the NACE Convention in Salt Lake City, March 2012. Cameron worked with chemical engineers in co-op with Eastman Tennessee in 2010. The scholarship was created through a generous gift by the Materials Technology Institute (MTI) to stimulate outstanding students to pursue careers in the area of Materials Engineering in the Process Industries. MTI is a not-for-profit technology development organization focused on both developing new technology and transferring existing knowledge to day-to-day practice. Students awarded the scholarship receive $10,000. ❄

Stephanie Wittman Receives Patricia C. Perna Sophomore Scholarship

Stephanie Wittman, a dual major in Materials Science and Engineering and Psychology, received the The Patricia C. Perna Scholarship from the Virginia Tech Honors Program in the Spring of 2012. The scholarship was created by the Perna family in honor of the family's matriarch, Patricia C. Perna, who passed away in 2006, following an extended battle with cancer.

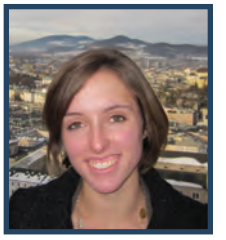
The Perna Scholarship was established so future pre-med students would experience and research quality of life issues associated with healthcare treatment and equipment, that impact patients suffering from cancer or terminal illness or injury. Through participation with the scholarship, students can develop opportunities to acquire hands-on field experiences that can inform solutions to specific challenges associated with the treatment of disease and injury.

With the endowment, Stephanie will be visiting the Naval Medical Center in Portsmouth Va., to work with soldiers who have lost limbs in battle. She will be interning with psychologists, psychiatrists, and engineers who work with the prosthetics at the Center. ❄

Charles Forman Receives Honorable Mention for Research Paper

MSE junior, **Charles Forman**, received an honorable mention for his research on SRF cavity topography. Charles was invited to present his research at the annual American Association for the Advancement of Science Meeting in Washington, D.C., in February 2011. He performed research at Jefferson Lab under the mentorship of Dr. Michael Kelley. His project was the microscopy of a high-performance superconducting radio-frequency niobium cavity. Forman's research paper on SRF cavity topography was selected for publication in the *DOE Journal of Undergraduate Research*. ❄

Kelly Ramsburg receives SMART Scholarship



Kelly Ramsburg, a junior in MSE, has won a Science, Mathematics And Research for Transformation (SMART) Scholarship for Service through the Department of Defense. This program aims to increase the number of civilian scientists and engineers working in DoD laboratories. Her scholarship includes full tuition for two years, a cash award, and a paid summer internship. After graduation, Kelly will work in the Sensors Directorate of the Air Force Research Laboratory for two years.

MSE Students Receive VT FIRE Scholarships

Three MSE students received VT FIRE scholarships from the AFS - Piedmont Chapter. The recipients for the 2012 Scholarships were **Corey O'Connell** (graduate student), **Mary Seals** (junior), and **Adam Humphrys** (Senior). The Piedmont Chapter of the American Foundry Society held their annual VT FIRE update meeting March 13 & 14 at the Holiday Inn, Blacksburg. During the dinner, students gave presentations detailing their experiences at the foundry. ❄

MSE Seniors Win 2nd Place in Casting Competition

Adam Humphry's and **Peter Kim**'s airplane casting won second place in the AFS Birmingham Chapter Student Casting Competition held on April 9 at the Wynfrey Hotel in Birmingham, Alabama. They received a $250 prize, and the Birmingham Chapter donated another $250 to the VT AFS Student Chapter for participating in the competition. ❄

Spring 2012 Materials Science and Engineering Bachelor of Science Degrees

Christian G. Birkett

Larissa N. Bridgers

Paul H. Cho

Tyler J. Corley

Gina R. Davis

Robin S. De Leon

Peter B. Evans

Jonathan Fajardo

Daniel C. Ferraro

Peter S. Firey

Jeffrey A. Geldmeier

Michelle R. Gervasio

Thomas H. Hays

Adam H. Humphrys

Aaron C. Jones

Michael S. Kidd

Peter S.J. Kim

Alexander N. Krull

Andrew A. Lindeman

John M. Lucci

Matthew I. McCarley

Anneke K. Nelson

Kevin J. Penyak

Andrew D. Philips

Laura A. Spieldenner

Troy A. Ukrop

Rachel L. Webster

Mackenzie F. Welch

Rebecca G. Zapata

2010-2011 Undergraduate Awards and Scholarships

Michael Stuback Memorial Scholarship

Samir Javid
Kevin Penyak

Thomas G. Stroyan Memorial Scholarship

Jonathan Fajardo
Jeffrey Geldmeier
Colin McClain
Laura Spieldenner

John H. Kroehling

Thomas Hays
Daniel Drew
Devon baker
Patrick Ahearn
Tyler Corley
Zachary Bear
Ben Conlon
Vincent Iozzo
Salem Maud

Gary S. Clevinger Memorial

Laura Patrick
Elizabeth Belcastro

Warren T. Gentry Memorial Scholarship

Stephanie Sparks

MSE Faculty

Lyndsay Kibler

William McAllister

Andrew Wentzel

Ronald S. Gordon

Kelly Ramsburg

Gerard H. Beyer Scholarship

Stephanie Sparks

Pratt Scholarship

Kelly Ramsburg
Joshua Rice

Gilbert and Lucille Seay

Stepahine Sparks
Brendan Ondra
Colin Glesner
Samir Javid
Lyndsay Kibler
Sarah Shipkey

Alfred E. Knobler

Kelly Ramsburg
Jeffrey Geldmeier
Laura Spieldenner
Andrew Wentzel
Brendan Ondra
Dan Flagg
Lyndsay Kibler
Paul Cho
Kirby Boone
Peter Evans
Alex Krull
Joshua Rice
Ariell Strong

2011-2012 Materials Science and Engineering Graduate Degrees

Name	Dissertation Title	Advisor
Yaodong Yang	Barium Titanate-Based Magnetoelectric Nanocomposites	Viehland
Andrew Zeagler	On a Bimodal Distribution of Grain Size in Mechanically Alloyed Bulk Tungsten Heavy Alloys	Aning
Eric Faierson	Structure-Property Relationships of Tantalum Carbide Foams and Synthesis of an Interpenetrating Phase Composite	Logan
Tongan Jin	Interactions of Air Electrode with Electrolyte and Interconnect in Solid Oxide Cells	K. Lu
Reza Montazami	Smart Polymer Electromechanical Actuators for Soft Microrobotic Applications	Heflin
Luke Gibbons	Nanocomposite Dispersion: Quantifying the Structure-Function Relationship	Leo
Derek Klinedinst	Structure/Property Relationships of: 1) Novel Polyurethane and Polyurea Segmented Copolymers and 2) The Influence of Selected Solution Casting Variables on the Solid State Structure of Synthetic Polypeptide Films Based on Glutamate Chemistry	Wilkes
Katia Rodriguez Rivera	Electrospun Nanocellulose: A New Biomaterial	Renneckar
Brian Scott	Semiconductor Core Optical Fibers and Fabrication Dependence of the Grain Structure	Pickrell
Jianjun Yao	Structural Investigation of Highly Strictive Materials	Viehland

Master of Science

Name	Thesis Title	Advisor
Benjamin Glaesemann	Ovalbumin-Based Scaffolds Reinforced with Cellulose Nanocrystals for Bone Tissue Engineering	Whittington
Diane Folz	Variable Frequency Microwave Curing of Polyurethane	Clark
Nathanael May	A SAXS-based Morphological Study of PFCB-ionomer/PVdf Copolymer Blend Membranes for Fuel Cell Application	Moore
Samantha Smith	Novel Preparation of Porous Alumina using Ice Particles as Pore-Forming Agents	Pickrell
Susan Holt	Effect of Processing Parameters on Bond Strength and Effective Plasticity in Al2O3-TiB2 Composites	Logan
Patrick Dykema	Reaction Synthesis of HfB2 in a Variety of Metallic Environments	Kampe
Elizabeth Belcastro	Life Cycle Analysis of a Ceramic Three-Way Catalytic Converter	Clark
Andrea Rojas	Particle Manipulation with Electric Field Gradients in Microdevices	Davalos/Aning
Hanguang Zheng	Processing the Properties of Die-attachment on Copper Surface by Low-temperature Sintering of Nanosilver Paste	GQ Lu

Masters of Engineering

Tyler Horseman	N/A	Whittington

Virginia Tech Honors Engineer Tom Digges for His Career Achievements

Lindsey A. Haugh

Thomas G. Digges II, of Westmoreland County, Va.,who earned his bachelor's degree in metallurgical engineering from Virginia Tech in 1960, is a 2012 inductee into Virginia Tech's College of Engineering Academy of Engineering Excellence, joining an elite group of 112 individuals out of more than 58,000 living engineering alumni.

From Left to Right: Dr. David Clark, MSE Department Head; COE Dean Richard Benson; Dr. Thomas Digges.

The Academy of Engineering Excellence was founded in 1999 by F. William Stephenson, past dean of the college of engineering, and the College's Advisory Board. The inductees are engineering graduates of Virginia Tech who have made continuous and admirable engineering or leadership contributions during their careers. This year marked the thirteenth anniversary of the first induction.

Raised by college educated parents, Digges himself, ended up with four degrees: a bachelor's in French from the University of Virginia; a bachelor's in metallurgical engineering from Virginia Tech; a master's in metallurgical engineering from the University of Tennessee, and a doctorate in metallurgy and materials science from Lehigh University.

At the young age of 23, Digges started Virginia Tech with enough credits to provide him with junior status. He suffered a hiccup in his academic life, going on academic probation as he "fished around" for his true vocation. But the minor setback caused him to bounce back strongly. He graduated with an interview and an immediate job offer from Newport News Shipbuilding in 1960.

Upon his third graduation from University of Tennessee, he received a number of employment offers from aerospace companies in California as well as the Naval Research Laboratory (NRL). He selected the latter even though the salary was only $6000 a year, only two thirds of what the private industry offers were. The NRL position led Digges to pursue a doctorate, and he received a National Science Foundation Fellowship to attend Lehigh University. He worked with Richard Tauber, one of the best in the semiconductor industry at Lehigh, from 1966 thru 1968.

Following his fourth and final graduation, the scholar moved to the Lone Star State to work at Texas Instruments, a company that employed the famous Jack Kilby who led a team that invented the first handheld calculator showcasing the integrated circuit. Digges found himself working with people who worked with this icon in the field, and he was chief engineer among the researchers who were the first to use computers to control silicon crystal growth in 1969. In 1972 he developed the silicon vacuum float zone technology pilot line for producing high resistivity silicon to serve as sensor material. For the 1974 Skylab Crystal growth experiment, Digges personally prepared the germanium crystal and instructed the astronaut how to make furnace temperature changes. The results were successful.

Digges, his brother Robert, and Ingram decided to start their own semiconductor company in late 1977. The Digges sold their own house and with their savings headed for Virginia. However, upon their arrival, Digges had to take on the role of supervisor of the manufacturing facility, while his brother recuperated from back surgery. With his wife by his side, Digges drew no salary in the beginning, and they constructed and assembled furnaces for the nine months prior to producing the first silicon crystal as well as finishing the building that housed the manufacturing facility.

Digges, the holder of 10 patents, four trade secrets disclosures and greater than 30 refereed technical publications, said, "Technically, I knew we could do this. Making crystals is an art and a science. My problem was I am hard-headed, and did not appreciate good business practices," Digges added. But with his sibling's business prowess, they made their first crystal, and started selling to companies like TI, Western Electric and RCA. From 1986 to 1996, the company's averaged growth rate increased at over 20 percent per year. In 1991, Virginia Semiconductor won the "Photonic Spectra Circle of Excellence" award for the introduction of the two to four micron thick wafer, judged as one of the year's 25 most significant technical developments in the photonics field. The company also won the prestigious Blue Chip Award given by U.S. Chamber of Commerce and Connecticut Mutual, judged as the best small business in the state of Virginia in overcoming adversity (too few customers). In 1994, the company received the Virginia District Export Council Merit Award for increasing its export business from 20 percent of sales in 1986 to 40 percent of sales in 1993.

The Virginia native was appointed by the Governor to serve on the Virginia College Building Authority from 1997 to 2002.

Digges' son, Thomas G. Digges III, is president of the company today while his father remains the chief executive officer.

continued in page 15

The Origin..continued from page 1

can be made to absorb or scatter specific wavelengths and appear invisible, black, red, or almost any color one might want. Phonons, many kinds of electromagnetic waves, magnetic interactions and even chemical interactions can take place at the nanometer length scale, and consequently can couple with nanoparticles to produce interesting behavior.

In order to effectively design new nanoparticles, it is important to develop an understanding of the stability of these small particles and how it changes with the size of the particles. We hope to shed some light on this issue by using analytical microscopy to assess directly the structure and composition of individual nanoparticles of metallic alloys as a function of their size and shape.

One of the groups of alloys we are investigating is the copper-gold system. Copper-gold alloys can adopt a number of crystal structures in bulk samples (these have dimensions greater than about a micron) depending upon the temperature and relative concentrations of copper and gold. These structures differ in the periodic patterns, or order, of copper and gold atoms arranged on a crystal lattice. The way one structure transforms to another is well known in samples of bulk size. This makes copper-gold a good model system for studying the influence of particle size on the transformation behavior.

Figure 1 shows an example of copper-gold nanoparticles less than about 5 nm in diameter.

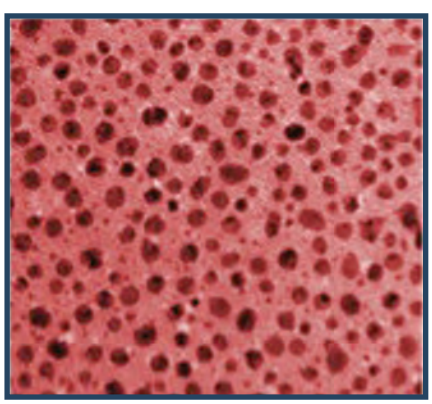


Figure 1: Copper – 50at% gold nanoparticles made by pulsed-laser deposition. The larger particles are approximately 5 nanometers in diameter.

These particles were made by generating a plasma of copper and gold atoms with a pulsed laser and then condensing the energetic atoms onto a substrate. The larger particles in the figure are about 5 nm in diameter. The as-formed particles adopt a face-centered cubic crystal structure, which is metastable at room temperature. Energetically speaking, an equal mixture of copper and gold atoms would rather rearrange themselves into an ordered structure.

If the particles are warmed slightly, the atoms acquire enough energy to transform into an ordered structure, but the dimensions of the particles can affect this process. For example, the atoms adjacent to a particle's surface experience a different environment than atoms located deeper in the particle, and this difference can influence the stability of the ordered phase.

Also, in larger bulk crystals, the initial metastable structure converts to the ordered version by the migration of vacant sites on the crystal lattice. However, the concentration of these vacancies is always small, and when the particle size is reduced to the nanometer range, a significant number of the particles may contain no vacancies at all. It is an open question whether the vacancy-free particles are able to convert from a metastable structure to a stable one.

There are other factors that can influence the stability of the particles and their ability to convert from one structure to another. As the size of the particles decreases into the nanometer range, it is possible for the particle size to drop below the so-called critical nucleus size, a theoretical size below which it becomes statistically unlikely for the stable structure to appear from a metastable one.

Finally, the chemical reactivity of the nanoparticles is sensitive to the precise locations of the different atom types (gold and copper in the case of Figure 1) on the particle surfaces.

Taken together, the influence of particle size on a nanoparticle's stable structure, its ability to transform, and its chemical reactivity are all important issues in the design of nanoparticles, but they remain to be explored. Understanding the influence of these size effects on particle stability and transformation kinetics is important for designing functional nanoparticles such as catalysts for the energy industry or memory devices.

Our approach consists of comparing analytical S/TEM observations of the processes in individual particles to data from bulk alloys. Concurrently, first principle and variational computational models are being developed to provide a framework for interpreting the critical thermodynamic and kinetic factors controlling the processes. A central issue to address in the thermodynamic analyses of small particles is to identify the relevant thermodynamic potentials that define equilibrium. Classical nucleation theory assumes the critical nucleus is in equilibrium with its surroundings and typically uses equality of chemical potentials in the nucleus and surroundings to assess this. However, in nanoparticles, it is not possible to form a fluctuation without simultaneously changing the composition of the rest of the particle. Thus, a somewhat different thermodynamic formulation is needed to describe the stability of small particles. To perform realistic modeling of the physical chemistry of individual nanoparticles, we are accumulating experimental results from a statistically reasonable amount of individual nanoparticles.

Scanning transmission electron (STEM) microscopy provides the nanometer-level resolution and high chemical sensitivity needed to explore the aforementioned issues. The FEI-TITAN at the Nanoscale Characterization and Fabrication Laboratory has two comprehensive chemical analysis capabilities that enable these kinds of measurements: an energy dispersive X-ray spectrometer (EDS), and an electron energy loss spectrometer (EELS). Together, these permit analysis of atomic species allowing us to probe electronic structure such as oxidation states and bonding orbitals. The Titan has better than 0.2 nm spatial resolution in scanning transmission electron microscopy high angle annular dark field (HAADF) mode, providing direct atomic column-by-column imaging.

Figure 2 is an example of a second type of alloy system we are investigating with these techniques. These nanoparticles are a mixture of iron and platinum, and they are the focus of intense

study by numerous researchers for next generation magnetic memories. Like copper-gold nanoparticles, iron-platinum nanoparticles can adopt a variety of crystal structures. The magnetic characteristics required for memory components are peculiar to one ordered phase. The ordered state of the particles can be identified by electron diffraction, and we are correlating the crystal structure of the nanoparticles to their size.

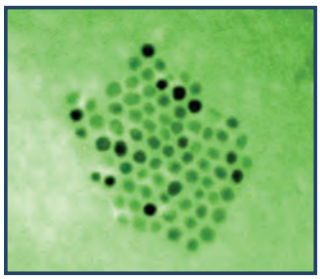


Figure 2: Iron–50at% platinum nanoparticles made by chemical synthesis. Each particle is approximately 4 nanometers in diameter.

One goal of our work is to provide answers to several intriguing fundamental questions. How does an alloy that is metastable at bulk sizes behave in a particle whose size is near the characteristic length scale of the transition processes? Is nucleation even possible in particles below the dimensions of a critical nucleus, and can phase separation take place in particles smaller than the critical wavelength? The answers to these questions are important to establishing the stability of nanoparticles, and we are trying to resolve these questions through a combination of direct observation of kinetic processes in individual nanoparticles.

It is hoped the answers to these questions will provide insights into predicting stable nanoparticle structures. This, in turn, can provide tools for designing nanoparticles with specific atomic configurations for a variety of applications. ❄

Conquering...continued from page 10

However, the same scene would repeat itself each morning of the conference.

Sitting in on presentations filled me with nerdish delight. It was as if everything I was learning in class was put into context. Suddenly seeing the applicability of topics like thermodynamics made all the equations I had strugled to learn in class redeeming and worthwhile.

At the same time, it was a humbling experience to see how my knowledge skimmed only the surface of the field of materials science and engineering. As I listened to presenters from various universities and companies, questions I had wondered about during class were being answered and new ones were being formulated. A number of new perspectives were being opened to me. My experience at MS&T was invaluable. I could argue that I learned more during the few days I spent at the conference than during an entire semester of school. My time at MS&T also connected me to the material science community. After the conference I kept in contact with one of the presenters who spoke on a topic in which I was particularly interested. Whether it is MS&T or another material science symposium, I highly recommend the experience. I eagerly look forward to this fall and am excited this time around to join the dialog, presenting on behalf of the ACerS's President's Council of Student Advisors on ceramics education. ❄

Digges...continued from page 10

They hope to continue the expansion of the company. With some of the pressure of running the business taken off his shoulders, Digges and Lana purchased a 37-acre farm, on the Potomac River in Westmoreland County. He spends time planting fruit trees, nut trees, hardwood trees and fencing out deer so he can grow a garden that features eggplants to watermelons as well as rebuilding a cabin from an old hunting lodge. He also finds time now to perform some philanthropic work, traveling to Mississippi four times in four years after Hurricane Katrina struck in 2005.

The Digges are members of Virginia Tech's *Ut Prosim* Society and the Committee of 100, and he is a former member of the College of Engineering Advisory Board from 2007 until 2011. ❄

Exploring Materials at Virginia Tech

Department of Materials Science and Engineering
213 Holden Hall (0237)
Virginia Tech
Blacksburg, Virginia 24061

We always enjoy hearing from alumni and friends. Send us a note or send an email.
email: mse@vt.edu
website: www.mse.vt.edu

Publication Committee
Christine Burgoyne
David Clark
LeeAnn Ellis
Abby Whittington

Contributing Writers

David Clark
LeeAnn Ellis
Christine Burgoyne
Lindsay A. Haugh
Bill Reynolds
Mitsu Muruyama
Charles Forman
Ashley Durrbeck
Samara Levine
Patrick Sinko
Christian Birkett

Original Cover Background

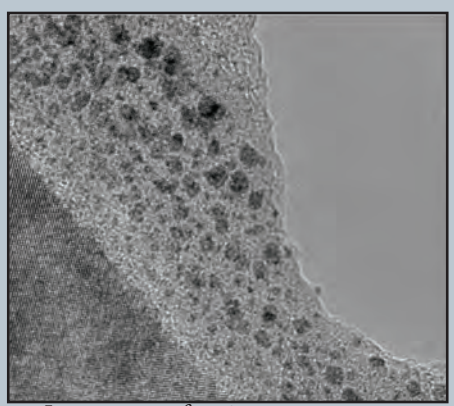


Image courtesy of: Professor Mitsu Muruyama, 'CuAu Cross Section.' from FEI-Titan Microscope

Cover Design: LeeAnn Ellis

VirginiaTech
Invent the Future
Department of Materials Science and Engineering
213 Holden Hall (0237)
Virginia Tech
Blacksburg, Virginia 24061
www.mse.vt.edu

Non-Profit Org.
U.S. Postage
PAID
Blacksburg, VA 24060
Permit #28

Heads Up!

David Clark

MSE Department Head

As you can see from the contents of this newsletter, the students, faculty and staff continue to be very active and successful. Since the last newsletter we have added 4500 sq. ft. to our space inventory with the completion and dedication of the Kroehling Advanced Materials Foundry. This facility is now fully operational and the research and education activities (including several new courses) are directed by Professor Alan Druschitz. The department would like to thank Mr. Paul Huffman, president of Dominion Metallurgical, Inc., and Professor Bob Hendricks for their leadership roles in making this high tech foundry a reality. Bob Hendricks received a College of Engineering Outstanding Service Award for his role in this.

The first metals were successfully cast on November 4, 2010. One of the favorite castings is the Virginia Tech Hokie Bird; everybody wants one! This facility together with the Nanoscale Characterization and Fabrication Laboratory (NCFL) and Virginia Tech's high-power computing capabilities has placed MSE in a very competitive research and education position. Three new faculty have been hired to strengthen these areas: Professor Alan Druschitz, metal casting; Professor Mitsu Murayama, materials characterization; and Professor Céline Hin (joint with mechanical engineering), computational materials science with emphasis on nuclear materials.

We have had two recent staff retirements, Jan Doran, our undergraduate student coordinator, and Tracey Keister, the department's office manager. Tracey received Virginia Tech's 2012 Staff Career Achievement Award. Michelle Czamanske has assumed the role of undergraduate academic advisor and services coordinator and LeeAnn Ellis has assumed the role of office manager and public relations specialist. Michelle has created a blog to improve communication with students and LeeAnn has begun working on a history of the department. We welcome both!

Our students continue to be very active in the professional societies and departmental activities. They take abundant trips to industry and professional society meetings. In 2011 they again received a Material Advantage Chapter of Excellence Award at the MS&T conference and exhibition in Columbus, Ohio. During recruiting events, students and parents always ask about our international programs. This has become an important factor in a student's decision to come into our department. We are proud to report that MSE has two formal partnerships with international universities, Tianjin University in China and Darmstadt Technical University in Germany. Both of these partnerships allow the student to spend from a few weeks to a couple of semesters abroad. The student feedback that we have received has been very positive. A third partnership is being discussed with the University of São Carlos in Brazil.

Space, quality and quantity, continues to be the single largest issue for the department. Our present main building, Holden Hall, is in need of renovation and expansion to accommodate the growth in student population and research activities that we anticipate over the next decade. The planning for this is now a part of the College of Engineering six-year strategic plan. We have made this a major priority for the department and will be working together with our advisory board to make this a reality in the next 6 – 10 years.

As always, we thank our alumni for their continued support and loyalty. Please e-mail us, stop by the department for a visit or join us during one of our pre-game tailgates. Just stay in touch.

Continued on page 15