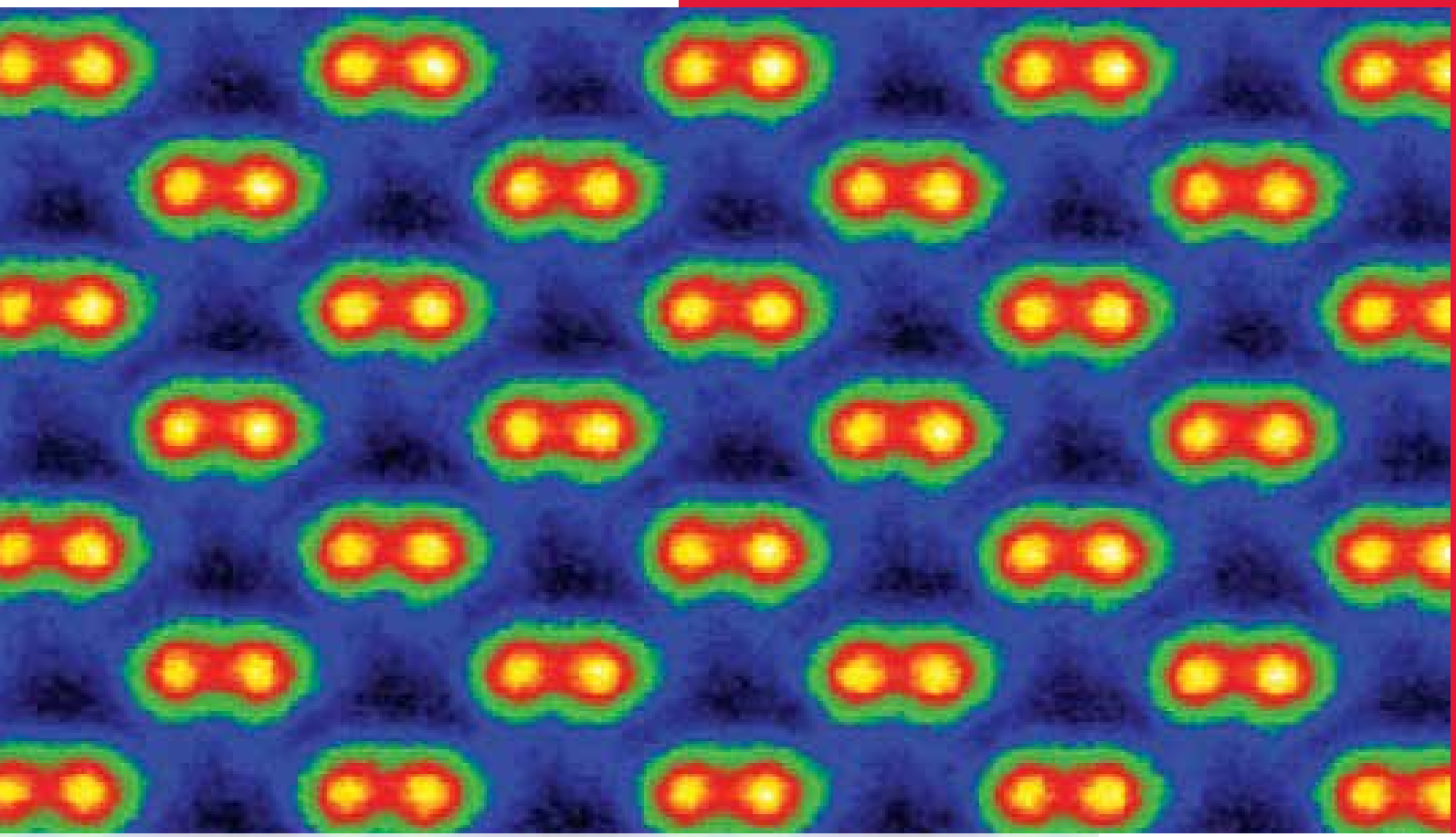
MSE NEWS

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

COLLEGE OF ENGINEERING
NORTH CAROLINA STATE UNIVERSITY
FALL 2014



A RESEARCH TITAN

The FEI Titan microscope is paying off, giving NC State researchers and students new insights.

NC STATE
Engineering

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IN THE SPOTLIGHT

STUDENTS STUDY ABROAD

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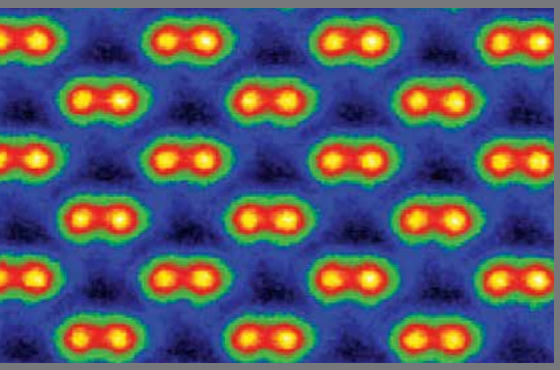
Dr. Thom LaBean leads students on a month-long trip to Denmark to conduct research, explore a new culture.



ABOUT THE COVER

The FEI Titan microscope equipped with state-of-the-art imaging and spectroscopy tools is benefiting faculty all across campus.

A MESSAGE FROM THE DEPARTMENT HEAD

I hope you'll enjoy reading the Fall 2014 newsletter, which clearly shows why Materials Science and Engineering at NC State continues to be the up and coming MSE department in the United States.

Since our last newsletter, we have continued to increase the size of both our faculty and our undergraduate and graduate student populations. Our federally funded research portfolio has continued to grow as well, despite the overall decline in federal programs. The Titan G2 HR-STEM and the Verios SEM are having significant impact on our research productivity and the launch of the Master of Nanoengineering Program has only added to the overall strength of our department. By and large, we are excited with our progress!

The Department hosted a workshop on Ethnic Diversity in Materials Science and Engineering with support from the National Science Foundation, the Department of Energy and the University Materials Council with Congresswoman Eddie Bernice Johnson as the keynote speaker. The ultimate goal of the workshop is to, over time, create an ever-increasing number of minority role models in science fields who will, in turn, draw others in to contribute to the workforce of the future. We accept those challenges locally as well, and have seen improvements in the diversity within our department.

Since our last newsletter, we welcomed Dr. Mildred Dresselhaus and Dr. Herbert Gleiter to campus as part of the R.F. Davis Distinguished Lecture Series. We are proud of this exciting departmental event and look forward to the continued success of this prestigious event.

Lastly, I am happy to announce that the College of Engineering and the University have committed to three new faculty positions in the next three years, which will bring us to 30 tenured/tenure-track faculty in the department. Stay tuned for upcoming announcements of our faculty search and new hires!

We appreciate your interest in our department and look forward to continuing our relationship with all of you.

Justin Schwartz
Kobe Steel Distinguished Professor
MSE Department Head

MSE Welcomes New Faculty

› The Department has welcomed two new additions to the faculty, **Drs. Jacob Jones** and **Srikanth Patala**.

Dr. Jones joined the Department as an associate professor in August 2013 coming from the University of Florida, where he was an assistant and later associate professor. After receiving his PhD from Purdue University in 2004, he was awarded an international postdoctoral fellowship from the National Science Foundation, working primarily at the University of New South Wales in Sydney, Australia. His research mainly develops structure-property-processing relationships in emerging functional materials through the use of advanced diffraction tools and techniques for in situ characterization. The primary functional materials under investigation include piezoelectric, ferroelectric, and multiferroic crystals, thin films, and ceramics that have applications including but not limited to impact and displacement sensors, actuators, microelectromechanical systems, diesel fuel injectors, vibrational energy harvesting, sonar, and ultrasound.

Dr. Patala joined the faculty as an assistant professor in July 2013 from Northwestern University, where he was a postdoctoral research associate. His research interests include structural characterization and quantification of structure-property relationships across multiple length scales, statistical analysis of defects and their interactions in polycrystalline materials, and in developing inverse design principles for optimizing performance in structural and functional materials.

His most recent awards include Outstanding PhD Thesis Research Award, Department of Materials Science and Engineering, MIT, and James Clerk Maxwell Young Writers Prize, Philosophical Magazine. He earned his Bachelor of Technology in metallurgical and materials engineering from Indian Institute of Technology Madras in 2005 and his MS and PhD in materials science and engineering from Massachusetts Institute of Technology in 2008 and 2011. •

Undergraduate growth continues

U*S News & World Report*, which showcases the best universities and degree programs in the nation, will release its annual college rankings for undergraduate programs in this fall.

In 2013, the Materials Science and Engineering undergraduate program at NC State placed 17th among all materials programs in the country. Currently, the MSE department has 139 full-time students, which is more than double the number of students enrolled for the fall semester in 2010.

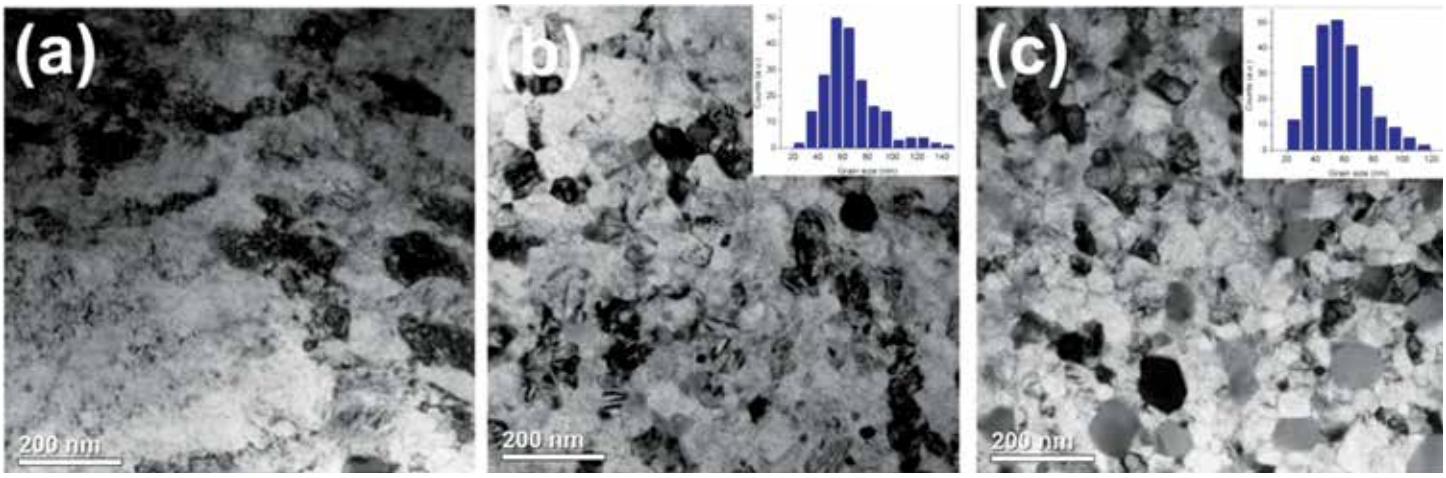
"We have been able to double the size of our undergraduate population while continuing to improve the quality of our program and our graduates because of the dedication of our impressive staff and internationally recognized faculty who truly value undergraduate education," says Dr. Cheryl Cass, MSE director of undergraduate programs. "Our focus has been on maintaining the benefits of a small department as we continue to grow. We want to preserve our status as a 'boutique' department — one that provides unique and high impact opportunities for our students."

Female enrollment has surpassed the national average and has increased over the last three years to 25 percent in 2014 from 13 percent in 2011.

The MSE undergraduate program has become well known for offering small class sizes; personal interactions with faculty, staff, and academic advisors; enriching undergraduate research projects; and high-quality laboratory and senior design experiences. Current initiatives include multidisciplinary senior design projects, streamlined curriculum integration with study abroad, and new programs in biomaterials and nanomaterials. •

RESEARCH HIGHLIGHTS

New model should expedite development of temperature-stable nano-alloys



TEM images illustrating the effect of Hf additions on the stabilization of grain size in Spex milled Fe14CrxHf alloys annealed for 1 hour at 900C. (a) 1% Hf – micron grain size (b) 2% Hf and (c) 4% Hf – nanoscale grain size as given by the distribution functions. Model simulations indicate that Hf additions of 2% or higher would be needed for stabilization.

NC State researchers have developed a new theoretical model that will speed the development of new nanomaterial alloys that retain their advantageous properties at elevated temperatures.

Nanocrystalline materials are made up of tiny crystals, or grains, that are less than 100 nanometers in diameter. These materials are of interest to researchers, designers and manufacturers because two materials can have the same chemical composition but very different mechanical properties depending on their grain size. For example, materials with nanoscale grains can be harder and stronger than chemically identical materials with larger grains.

But widespread use of nanocrystalline materials has long been handicapped by the tendency of nanoscale grains to grow when exposed to elevated temperatures — thereby losing their desired mechanical properties.

This is a problem because creating bulk materials from powdered nanomaterials involves exposure to high temperatures, and even nanomaterials made using other techniques may be exposed to elevated temperatures. The grains in some nanomaterials can even grow — and lose their desired properties — when exposed to room temperature for an extended period of time.

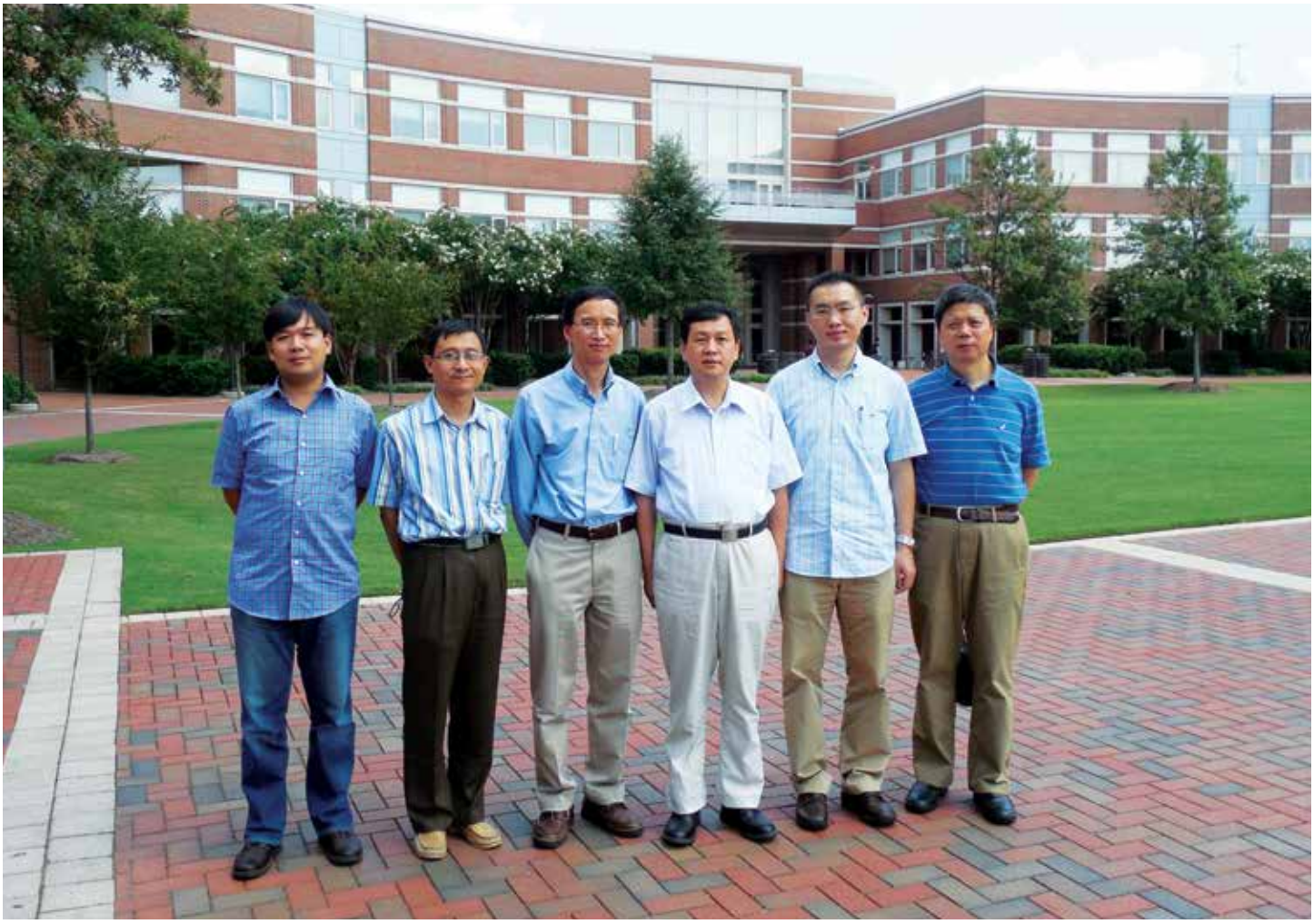
NC State researchers decided to tackle the problem by exploring a concept that had been discussed in the research community for some time: stabilizing nanomaterials by introducing small amounts of an additional element. The idea is that this additional element would serve as a stabilizing agent, migrating to the grain boundaries — or interfaces between grains — and preventing the grains from growing at elevated temperatures. Implementing that concept had been daunting, since there are thousands of possible combinations of these elements.

To turn that idea into a practical solution, the researchers developed a theoretical model to identify suitable candidates that can be used as stabilizing agents.

The theoretical model focuses on alloys that consist of two elements, such as iron and chromium, then allows users to see what would happen if a third element is added to the mix. If users plug the atomic size and thermodynamic properties of each element into the model, the model predicts the grain size of the alloy at any given temperature.

"This model allows anyone to design alloys in a targeted and effective way without having to resort to a trial-and-error approach," says Dr. Ron Scattergood, a professor of materials science and engineering at NC State and senior author of a paper describing the work. "And our experimental results confirm the accuracy of the model."

"We are already using the model in our investigations into lightweight aluminum alloys and high-temperature alloys for nuclear energy applications," says Dr. Mostafa Saber, lead author of the study and a postdoctoral research scholar in materials science and engineering at NC State. •



From left, Professor Feng Xu, associate dean of the School of Materials Science and Engineering at NUST; Professor Jianfeng Lu, associate dean, School of Computer Science and Engineering at NUST; NC State MSE Distinguished Professor Yuntian Zhu; Professor Jinchun Mei, provost of NUST; Professor Songjie Wei, School of Computer Science and Engineering at NUST; and Professor Wenhe Liao, vice president for human resources at NUST.

3+X program opens door to Chinese students

An agreement between NC State and Nanjing University of Science and Technology will bring Chinese students to the Department to study.

Under the 3+X master's program agreement, undergraduate students who complete three years of course studies at Nanjing University of Science and Technology (NUST) and one semester of studies at NC State may enroll in the Department's non-thesis master's program.

The master's may be completed in an additional 12 to 15 months. Upon successful completion of the NC State master's, students may be accepted into NUST's materials science PhD program.

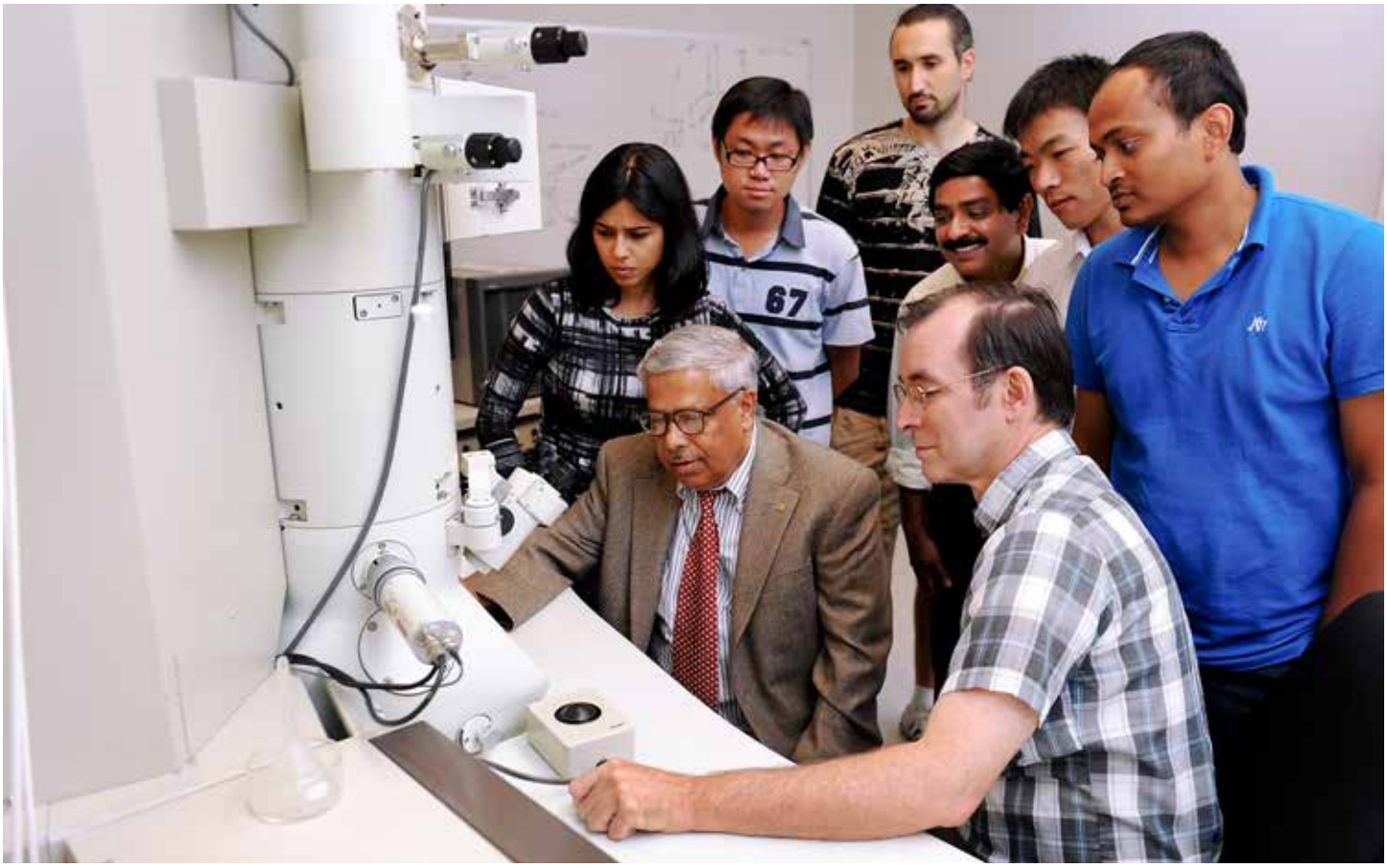
Dr. Yuntian Zhu is Distinguished Professor in the MSE Department at NC State and dean of the School of Materials Science at NUST. He says that good coordination between the two universities will be critical if this program is going to be successful. An associate dean has been appointed in the School of Materials Science at NUST to assist.

Senior NUST students will take a semester at NC State as a special student. Those credits from NC State will count toward their bachelor's degree from NUST and then toward their master's degree from NC State.

Established in 1953, NUST offers both graduate and undergraute programs in science, engineering, liberal arts, economics, business, management, law and education. In addition, NUST encompasses a wide array of centers, institutes, programs, and administrative support offices.

Nearly 30,000 students attend NUST.

The program will begin in fall 2015. •



Dr. Jay Narayan, seated at left, and Dr. John Prater, seated at right, work with students in the department. Narayan is senior advisor in the new Master of Nanoengineering program.

Master of Nanoengineering program breaks new ground

The Master of Nanoengineering (MNAE) program, which launched in fall 2013, is designed for students with an undergraduate degree in a science or engineering discipline who wish to pursue a graduate degree in nanoengineering. It is a 30-credit-hour degree program that does not require a thesis, final oral exam or on-campus residency. The program is being led by Dr. Lew Reynolds, director, and Dr. Jay Narayan, senior advisor.

"This is one of only a few comprehensive, engineering-specific master's degrees focused on nanotechnology and nanomaterials," says Dr. Jay Narayan, John C. C. Fan Distinguished Chair Professor of Materials Science and Engineering. "We are giving our students a firm understanding of how to use scientific research to develop new technologies, and how to shepherd those technologies through the manufacturing process to create nanosystems and nanodevices."

The field of nanoengineering is expected to revolutionize technology and improve quality of life, particularly as it relates to energy, environment, and health. Students will achieve an understanding of the fundamental advantages in nanoscale materials, devices, and systems. The program will hold classes on campus but is also the first master's degree program in nanoengineering that is being offered via online distance education – making the program available to students who are already in the workforce. The program will also offer concentrations in biomedical science in nanoengineering, materials science in nanoengineering and nanoelectronics and nanophotonics.

"To stay competitive, businesses in fields from medical devices to energy need employees with the skills to develop and manufacture new devices," Reynolds said. "This program will provide industry with a highly trained, educated workforce. By the same token, our graduates will be able to thrive in a competitive, global marketplace."

The degree program was developed with support from the University of North Carolina General Administration.

More information on the degree program is available at engineeringonline.ncsu.edu/master-nano-engineering.html. •

THE TITAN
TWO YEARS LATER

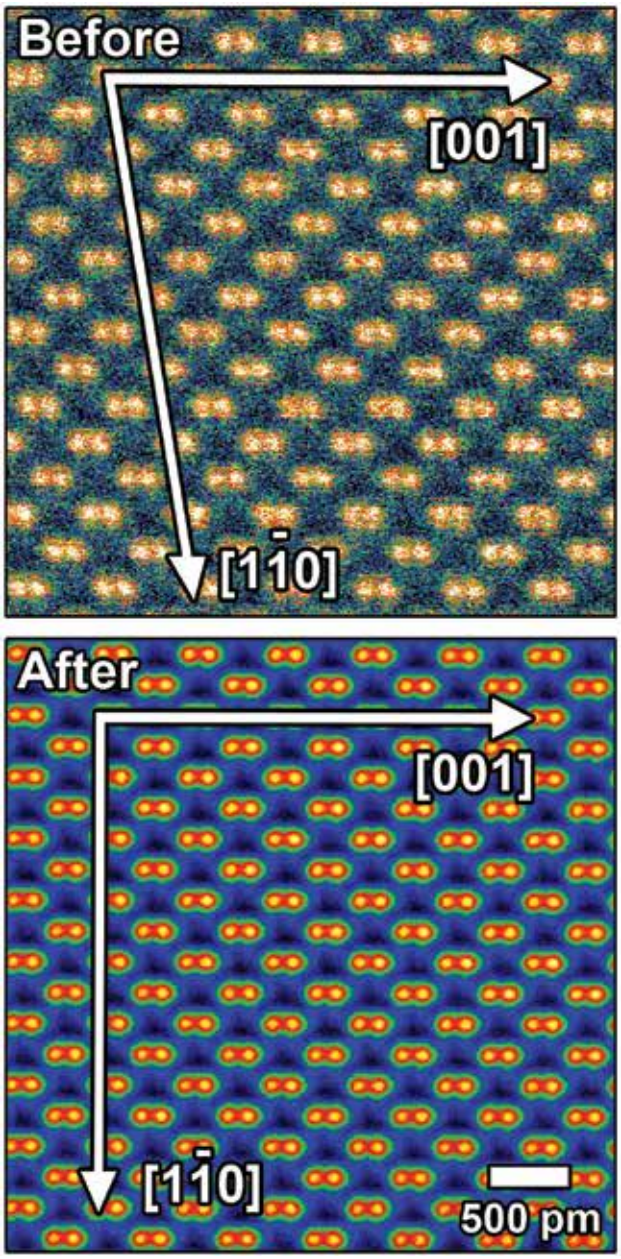
In 2012, NC State invested in an FEI Titan microscope equipped with state-of-the-art imaging and spectroscopy tools. Significantly, the instrument's aberration corrector provides a focused electron probe less than an ångström in size. This results in dramatically improved image resolution that was well beyond the reach of prior generation instruments, thereby unlocking new details at the atomic scale. Even with these advances, tiny movements of the sample have typically distorted atomic scale imaging.

To overcome this major obstacle, Dr. James LeBeau's research group has recently developed a technique that accounts for that movement and eliminates the distortion. Specifically, they programmed the microscope to rotate the direction in which it scans the sample. For example, it might first take an image scanning from left to right, then take one scanning from top to bottom, then right to left, then bottom to top. Each scanning direction captures the distortion caused by drift from a different vantage point.

Those images are then fed to a program that measures the features in each image and uses that data to determine the precise direction and extent of drift. Once the drift is quantified, the images can be adjusted to remove the distortion caused by the drift. The resulting images accurately represent the actual structure, and lead to new capabilities to understand the structure of materials and defects. In this way, the instrument and new imaging methods have unleashed a previously unthinkable level of material analysis.

Faculty all across campus and around the Research Triangle area have significantly benefited from these new capabilities. The Titan is situated among a suite of other materials characterization tools in the NC State Analytical Instrumentation Facility (AIF), conveniently located in the Monteith Research Center on Centennial Campus.

Training is available for interested users with TEM experience, and for-fee service and analysis are available. Interested parties should contact AIF for more information (www.aif.ncsu.edu). •

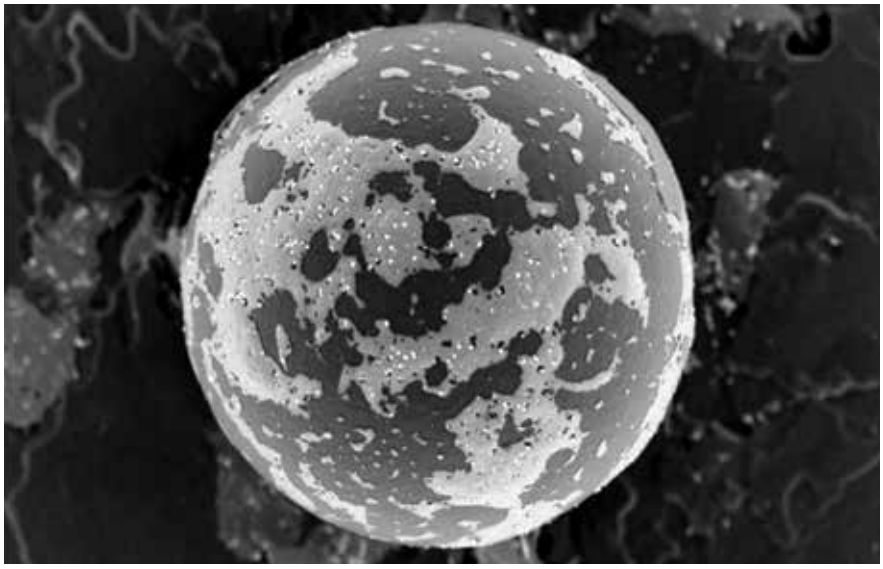


A new technique developed by the LeBeau group effectively eliminates distortion for imaging at the atomic scale.

Verios SEM opens new doors for researchers

As a companion to the Titan, NC State in 2014 acquired an extreme resolution scanning electron microscope (SEM) that can image surfaces with extraordinarily low electron landing energies.

Historically, achieving extreme resolution required that the electron beam be accelerated to very high energies, which would, in turn, damage sensitive samples and limit surface sensitivity. The Verios SEM introduces an array of enabling technologies that free materials researchers from these limitations. Most importantly, the electron beam can be "formed" at high energies (thereby creating a sub-nanometer probe) but decelerated just before landing on the sample surface with negligible loss of resolution. The sample stage can be DC-biased, which funnels signal electrons into the detectors, thus increasing signal-to-noise ratios, and the imaging chamber is maintained in ultra-clean conditions and includes an in situ plasma cleaner.



This image of latex spheres with DNA-tethered Au nanorods was produced by the Verios SEM.

With these features, researchers can for the first time image uncoated insulating samples without charging, can achieve unprecedented surface sensitivity with sub-nm resolution, and can acquire sample images without surface contamination.

By virtue of the imaging capabilities and the specimen flexibility, the Verios has propelled the research efforts in five colleges across campus. The breadth of this impact results largely from the ability to image hard, soft, and biomolecular materials. Particularly exciting examples have been demonstrated by Dr. Jesse Jur's research group in Textile Engineering, which can for the first time image nanostructured coatings on advanced textile fibers; by Dr. Zlatko Sitar's research group in MSE, which can image nanotextured surfaces of AlN crystals for optimized LED light extraction; and by Dr. Orlando Rojas' research group in Forest Biomaterials, which can image cellulose nanocrystals in natural composites.

Microscope acquisition was supported through an award from the National Science Foundation through the Major Research Instrumentation program (Dr. Jon-Paul Maria in MSE is the principal investigator) and by matching funds from NC State.

The microscope is housed in the Analytical Instrumentation Facility (AIF) and is available for use by internal and external clients. For more information, interested parties can contact either Jon-Paul Maria (jpmaria@ncsu.edu) or AIF (www.aif.ncsu.edu). •

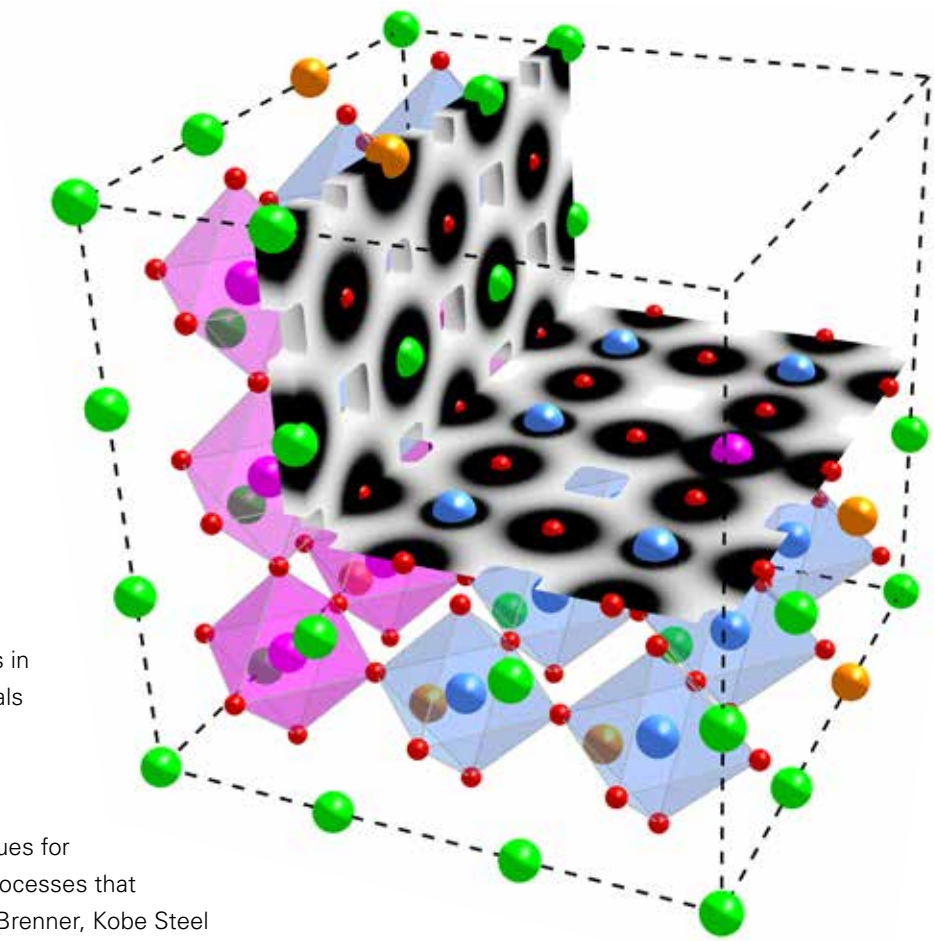
The Verios SEM has allowed research groups in five different colleges on campus research opportunities that were not available before.

Computational research: getting (and keeping) a competitive advantage in materials science and engineering

To stay competitive, businesses and governments are constantly looking for materials that will open the door to new technologies or new sources of energy. Materials that will make their products faster, lighter, stronger or more efficient. Whoever develops those materials first will have a significant edge over the competition.

And it has become increasingly apparent that the key to getting that edge, and maintaining it, is computational research.

"Problems that used to take years to solve can now be solved in a month," says Srikanth Patala, an assistant professor in MSE.



Why Computational Research Matters

Computational research uses complex models in a variety of ways, all of which advance materials science and engineering.

"These computational models can help researchers understand the outcome of an experiment, identify the most promising avenues for future experiments, and give us insight into processes that can't be easily explored in the lab," says Don Brenner, Kobe Steel Distinguished Professor and associate department head of MSE. "For example, computational research helps us understand the behavior of materials in nuclear reactors, which are exposed to high levels of heat and radiation."

"And we can now use models to design new materials that have a specific set of characteristics for use in any given application," Patala says.

"By using computational models, we can evaluate hundreds or more possible material combinations," Brenner explains. "It would take years to evaluate those combinations using traditional experimental methods, but we can narrow it down to a handful of the most promising materials combinations."

"There are a lot of people at NC State who embrace computational research as a way to gain meaningful insight into how to design new materials," says Doug Irving, an associate professor in MSE. "Ultimately, this gives our researchers a big advantage over researchers who don't use these capabilities."

For example, Brenner's lab recently led an effort to understand what causes metal oxide scales to deposit on the fuel rods in nuclear reactors – a job that would be both dangerous and incredibly difficult (if not impossible) using traditional experimental techniques.

"What we found will make it possible to develop new techniques for eliminating these scales," Brenner says, "which would make the reactors more efficient and extend the lifetime of nuclear fuel rods."

But NC State's work extends well beyond nuclear power.

"We do work on optical and electronic materials, structural materials, energetic materials, and soft materials," Irving says. "We're talking about applications in everything from electronics and LEDs to pharmaceuticals and biomedical devices."

In other words, theoretical models can lead to practical solutions for real world problems.

Marrying computational and experimental research

"We have one of the largest materials science computational research programs in the United States," says Yara Yingling, an associate professor in MSE. And that focus on computational research puts NC State in an enviable position.

In 2011, the White House unveiled its Materials Genome Initiative (MGI), stating that advanced materials "are essential to economic security and human well-being, with applications in industries aimed at addressing challenges in clean energy, national security, and human welfare." But the White House also noted that it takes too long to bring new materials to the marketplace, and put an emphasis on "accelerating the pace of discovery and deployment" of advanced materials in order to ensure that the United States remains competitive in the global economy.

The MGI, in short, urged the U.S. materials research community to marry computational research to experimental research in order to expedite the development of new materials for use in a wide range of applications. And that was good news for NC State.

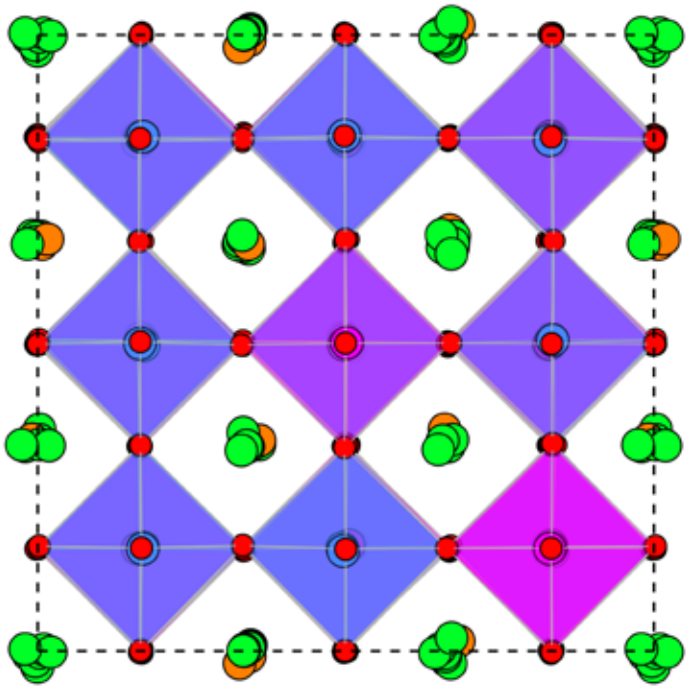
"We were effectively implementing the MGI model before the MGI even existed," Brenner says. "We've long believed that computational and experimental researchers can and should work together to address challenging problems that can't be adequately addressed by theory or experiment alone."

"MSE has made collaboration between computational and experimental researchers a priority," Patala says. "Our faculty are constantly working to identify problems that present opportunities for us to push the entire field of materials science forward."

And the broad scope of MSE's efforts to use computational research on applied problems is reflected by the organizations funding those efforts, which range from the Department of Energy to the Department of Defense, as well as the National Science Foundation and the private sector. Everyone is looking for the edge that computational research can provide.

For example, the Eastman Chemical Center of Excellence is funding a number of projects in MSE.

"We recognized early on in our partnership with NC State that combining Eastman's long history of product and polymer innovation with the computational tools resident at MSE and elsewhere at NC State presented a significant opportunity for us to 'work smarter' by using these methods to help inform and guide our research programs," says Dr. J. Stewart Witzeman, director of the Eastman Innovation Center.



Advancing computational research itself

But MSE researchers aren't focused solely on application-oriented problems – they're working to promote the field of computational research itself.

"In addition to working with experimental researchers, we are addressing fundamental scientific problems and working to advance the algorithms, methods, and theories that are essential to computational research," Yingling says.

For example, Yingling's research team has developed a novel and versatile modeling strategy to simulate polyelectrolyte systems, which are chains of molecules that are positively or negatively charged when placed in water. The model has applications for creating new materials for use in applications such as drug delivery mechanisms. But the model can also be used to study the behavior and characteristics of polyelectrolytes – including DNA and RNA.

"Don Brenner is internationally recognized as an important figure in the development of the field of computational research," Irving says, "and our department continues to develop new computational tools that can help researchers throughout the field in tackling materials science problems."

"It is exciting to see the rest of the world recognize the importance of a field where we are already established leaders," says Justin Schwartz, Kobe Steel Distinguished Professor and department head of MSE. "Our job now is to build on our experience and maintain that leadership position in materials science and engineering." •

Degree sets ceramic engineering alumnus on the right path

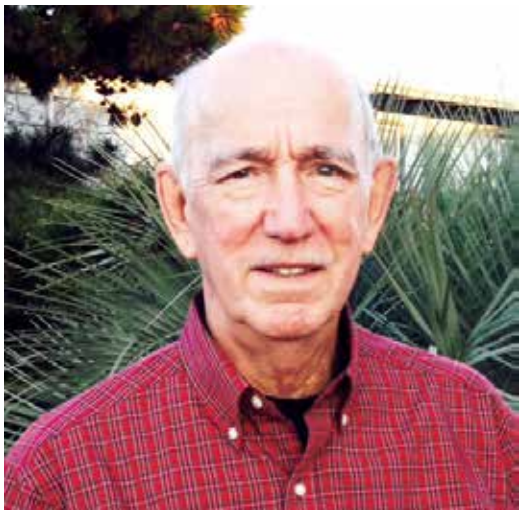
R.B. Arthur remembers his arrival on the NC State's campus as a freshman in 1955, especially the dire warning freshmen received from a university administrator during an assembly.

"Look at the person on your left and the person on your right and in four years, they won't be here," Arthur recalled being told.

The dean was right. Of the 20 freshmen that year in the ceramic engineering program, only four went on to graduate.

Arthur retired at the age of 62 after a career with Resco Products, Inc., that saw him rise to the position of vice president of manufacturing. He still consults for the company, at the age of 77.

Arthur's career had a boost thanks to his NC State engineering degree, which set him on the path to a successful career in the refractory materials industry. He describes his journey as a "fairy tale kind of experience of somebody being in the right place at the right time."



Alumnus R.B. Arthur

As a teenager, Arthur worked in the laboratory at North State Pyrophyllite, a Greensboro manufacturer of refractory materials founded by his uncle John Boren and Boren's business partner Mace Harvey.

Boren and Harvey decided to start a business manufacturing pyrophyllite bricks after seeing a publication produced by the state of North Carolina about pyrophyllite and its uses. The duo previously worked for a Greensboro company called Pomona Pipe that manufactured ceramic pipe.

Arthur's dad worked in crushed stone, sand and gravel, areas that would be covered when Arthur began taking ceramic engineering classes at NC State. While the work experience may have given Arthur a head start, he still found the course load formidable.

Arthur had hopes of playing on the golf team at NC State, but semesters crammed with 21 or 22 hours of classes dashed that dream. He explained that students in the program were in class in the morning, in the laboratory from 2 p.m. to 5 p.m. every day, and then studied all night.

And woe be unto any student who went to class unprepared.

"You knew you were going to be called on in every class because there weren't many people there," Arthur said. "You couldn't dodge."

After graduation in 1959, Arthur returned to Greensboro to continue his work in the lab for North State Pyrophyllite as a full-time employee. Along the way, he became the plant manager.

He learned a valuable business management skill during his time as plant manager.

At the beginning of every day, Arthur checked on the employee at the end of the company's assembly line tasked with removing unused material off the line. If he was working hard, the facility was not running in an efficient manner. If he was sitting down with little to do, Arthur knew the company was making money.

Arthur describes himself as a "B-C student" his first two years on campus, and an "A-B student" his last two years as his classes focused more on his major.

His time as a student helped shape his business outlook when it came to hiring the right employees.

"I'm not always after the smartest person in the class," he said. "I'm after the person who knows how to work."

North State Pyrophyllite was acquired by Resco Products, Inc., in 1976. Arthur stayed on and, over the years, worked in all facets of the company, including sales, manufacturing, research and finance.

When he was made vice president of manufacturing in the 1990s, Arthur found himself in charge of eight plants that stretched from California to England. Resco is headquartered in Pittsburgh, but Arthur was able to stay in Greensboro for the new position.

Over the years, he has seen Resco hire NC State engineering graduates with great results. It takes a couple of years of in-house training for new employees to become productive, but the NC State engineers come in ready to get started.

"They are certainly prepared," he remarked.

He and his wife, Kay, reside in Greensboro. The high school sweethearts have been married 56 years and have two children.

As a consultant, Arthur still enjoys working and likes the fact that he never knows what problem he might be trying to solve next.

"I really love it because I feel like every day is a new challenge."

Arthur has continued to support the athletics department, alumni association and College of Engineering. •

NC State engineering alumnus John Freeman and his wife, Dolores.

Alumnus honors parents for gift of an education

Walter and Ida Freeman began their lives as newlyweds during an uncertain time in United States history – the depths of the Great Depression. Walter began to grow apples, developing Freeman Orchards in Hendersonville, NC, which still exists today; Ida established a hand-woven rug business.

NC State engineering alumnus John Freeman remembers his parents' hard work, as well as the sacrifices they made to support their children's education.

"I had three siblings, and each of us went to college," said Freeman, a 1957 ceramic engineering graduate. "Throughout our time, we weren't pressured to support ourselves. This was very exemplary of my parents."

John and his wife, Dolores, pledged to establish the Walter and Ida Freeman Distinguished Professorship in the Department of Materials Science and Engineering at NC State. The Department of Ceramic Engineering was formed in 1924 – a precursor to today's Department of Materials Science and Engineering, which is led by Dr. Justin Schwartz, Kobe Steel Distinguished Professor.

"I'm impressed with how strongly Dr. Schwartz promotes materials science and engineering," said Freeman, whose daughter Karen Freeman Bisi is also a graduate of the department. "He's making a great deal of progress, and I'm motivated to support his efforts while permanently honoring my parents."

Professorships help to attract or retain renowned researchers. Additional funds also allow professors to hire talented graduate students and purchase equipment, among other benefits.

Freeman is a registered professional engineer in North Carolina and the president and general manager of Cer-Met, Inc., a Charlotte, NC, wholesale company that manufactures and installs refractories and other high-temperature materials.

He credits professors in the ceramic engineering curriculum for taking an interest in student success and sharing their experience in the ceramic industry. Professors W.C. Hackler, George Harrell and Wurth Kriegel are among those who Freeman remembers well.

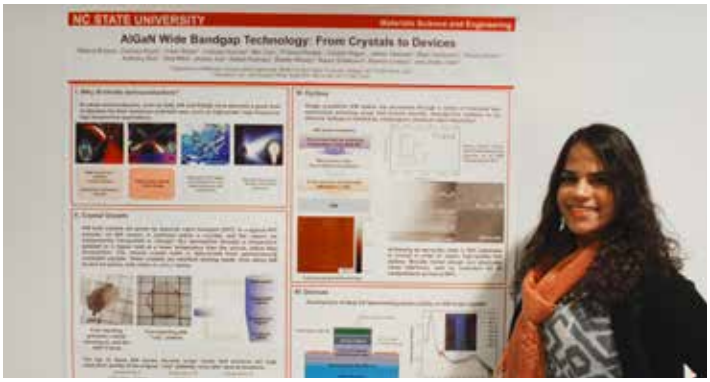
"Professor Harrell made it a point to take students on field trips to a number of the ceramic companies around the state," Freeman said. "I saw real-world application firsthand."

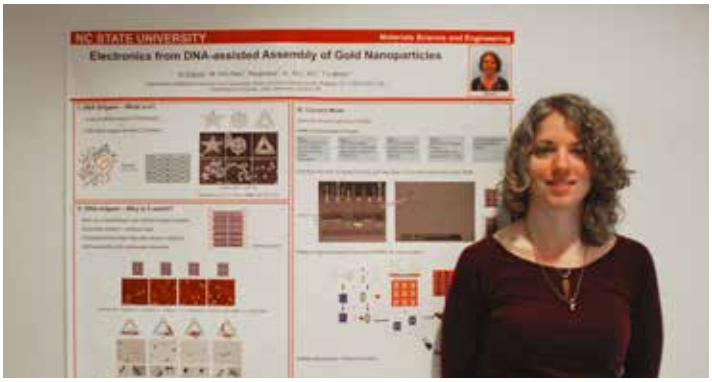
Freeman's journey to becoming his own boss began with a company known as Harbison-Walker Refractories Company in Pittsburgh which, at the time, was known for being among the nation's largest producers of the most technically advanced refractories – heat-resistant materials that make up the linings of high-temperature structures such as furnaces and reactors. He worked for the company for about 12 years, ascending to the rank of applications engineer and gaining experience in refractories applications.

Next, Freeman sought to satisfy his interest in installing refractories, as he had been visiting sites and supervising installation during his time with Harbison-Walker. He particularly liked the idea of establishing a company in the South and, in 1972, Freeman returned to Charlotte. Here, he started Cer-Met, Inc., which has now been a flourishing business for a little more than four decades.

Freeman had great resources: unwavering support from his parents, a scholarship from the Brick and Tile Manufacturers Association and a degree from one of the best colleges of engineering in the nation.

"An NC State engineering degree is a great starting point for all kinds of entrepreneurial ventures," Freeman said. "Everyone should give back when they're able, and I think NC State is a very deserving partner." •





Milena Bobea, left, and Nicole Estrich are shown with their winning posters

Graduate students take top prizes during EAB meeting

The External Advisory Board and 16 of its members met with faculty over a two-day period to receive updates on department growth, tour laboratories, and listen to overviews of research. The EAB, among other things, provides an external perspective on the Department's programs and activities, identifies issues important to the success of these initiatives, and provides guidance, counsel, consultation, and recommendations. The board continues to be a vital component as the Department continues to grow and remains an increasingly competitive program at both the graduate and undergraduate levels. During a dinner held at the conclusion of the two-day meeting, students presented posters as part of a competition. EAB members selected **Milena Bobea** and **Nicole Estrich** as the top winners.

First place winner Milena Bobea is a PhD candidate in the Department and a member of the WideBandgaps Research Laboratory directed by Dr. Zlatko Sitar and Dr. Ramón Collazo. Her research involves the characterization of III-nitride bulk crystals and thin films for the development of AlN and AlGaN-based devices for numerous technological applications, including high-power electronics and short-wavelength optoelectronics. In particular, she focuses on the development of analytical techniques using high resolution X-ray diffraction (HRXRD) for the assessment of structural features and crystalline quality in nitride substrates and epilayers. Current studies involve the evaluation of polishing-related features in AlN wafers, assessment of strain and composition of Al-rich AlGaN heterostructures, and non-polar AlN and AlGaN epitaxy on AlN single crystals.

Second place winner Nicole Estrich is interested in electronics, optoelectronics, and nanoscale manipulations. Her poster described a method to create and pattern single-electron transistors by functionalizing gold nanoparticles to self-assemble onto programmable binding sites on DNA origami templates. Her current research involves self-assembly of metallic and insulating nanoparticles onto 3-D DNA structures for optoelectronic applications. Estrich received her master's degree in 2012 through the study and fabrication of a conductive antireflection coating for silicon solar cell applications. She would like to complete her PhD and obtain a career in a high-tech industry. •

GIVING TO MSE

A gift to the Department of Materials Science and Engineering gives students an opportunity to excel and opens the door to research that makes a difference.

Gifts go to support scholarships, fellowships, professorships, academic programs, faculty research and other initiatives that are not typically funded through state appropriations. Private philanthropy allows the Department to achieve excellence in research and education.

To learn more about supporting the Department, contact the NC State Engineering Foundation.

www.engr.ncsu.edu/foundation

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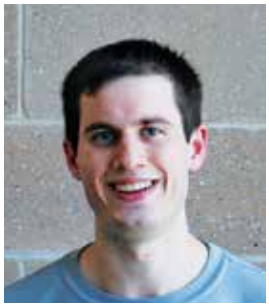


Graduate students in the department who have earned research fellowships, clockwise from top left, are: Jessica Nash, Matthew Burch, David Harris, Isaac Bryan, Richard Floyd, Everett Grimley, Daniel Long, James Peerless and Houston Dycus.

Graduate students receive research fellowships

Several graduate students in the Department have received graduate research fellowships.

Jessica Nash, Matthew Burch, Everett Grimley and Houston Dycus have been awarded National Science Foundation Graduate Research Fellowships.

The program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based master's and doctoral degrees at accredited United States institutions. NSF Fellows are anticipated to become knowledge experts who can contribute significantly to research, teaching, and innovations in science and engineering.

Nash's proposed research involves using experimental and computational techniques to understand and improve DNA nanotechnology. As a field, DNA nanotechnology aims to use the biological self-assembly properties of DNA to create complex nanomaterials. Engineered DNA materials are being used to create systems that can communicate with cells, treat diseases, and act as components in molecular electronic devices. However, several challenges remain to be addressed to improve engineered materials. These include improved efficiency of formation, responsiveness of the final structure, control over hybridization dynamics, and interaction with other molecules for DNA-based nanocomposites and smart materials. She plans to utilize multiscale modeling and experimental techniques to characterize the properties of engineered DNA structures. Jessica will work with Thom LaBean's DNA nanotechnology group and Yara Yingling's computational soft materials research group.

Burch's proposed research will focus on the characterization of flux-grown barium titanate and barium strontium titanate thin films for future electronic device applications. The flux impacts the microstructure of the thin films by increasing the kinetics of mass transport, which results in large-grained, dense films as opposed to samples without flux that are smaller grained and porous. Burch uses electron microscopy to analyze how the flux facilitates this transport and analyze other effects the flux causes within the microstructure that could affect the electronic properties of the material. Burch utilizes a number of advanced experimental techniques including an in situ transmission electron microscopy annealing that allows observation of how the films' microstructure forms with and without flux present. The eventual goal is to understand the kinetics of the annealing process with the flux present in order to optimize the microstructure for maximum performance for future electronic devices. He will work with Elizabeth Dickey's electron microscropy group and Jon-Paul Maria's thin films group.

Dycus is entering the third year of the Department's PhD program.

Over the previous two years in James LeBeau's research group, he has developed skills in scanning transmission electron microscopy (STEM), which enabled him to study materials at

the atomic scale. His current research involves exploring the atomic scale chemistry and structure bismuth telluride alloys and will focus on developing quantitative atomic resolution EDS in STEM. To accomplish this, Dycus will utilize state-of-the-art equipment at NC State and collaborate with scientists in Australia for computational support on his experiments.

Ultimately, he hopes the results of his work will lead to a new level of characterization on the atomic scale that can bring a further understanding to structure-property relationships.

Grimley is starting his second year in the PhD program and is working in James LeBeau's group.

His research involves quantitative use of the scanning transmission electron microscope to correlate the structure of functional oxide materials to their invaluable properties. He prepares thin samples of various semiconductor oxides and looks at how the atoms arrange under an electron microscope and then correlate those arrangements to the material's properties.

The work involves paying close attention to interfaces between different materials, defects or imperfections in the crystal structure and how specific elements arrange at the atomic level in the crystal structure.

"Our work seeks to develop an understanding of the relationship between oxide structure and properties to assist in further engineering and tuning of specific materials for electronic devices," he said.

Isaac Bryan received a National Defense Science and Engineering Graduate Fellowship from the US Department of Education. He is a PhD student starting his fourth year in the program.

Bryan's research is on the III-nitride materials system. A specific topic of importance is the control of point defects in wide bandgap semiconductors like GaN, AlGaN, and AlN. The wide bandgap in these materials makes controlled doping and achievement of desired free carrier concentrations challenging.

Introduction of intentional point defects is normally accompanied by incorporation of unintentional impurities, and generation of native point defects or complexes, all acting as compensators. All point defects have specific optical signatures, which can be used to determine their concentration, incorporation mechanisms, and interdependence. By studying and understanding the basics of point defect formation, one can, as an end goal, design processes for their control at either high or low levels, as required by specific devices.

Bryan works in the WideBandgaps laboratory for Zlatko Sitar and Ramon Collazo.

Richard Floyd received a Graduate Assistance in Areas of a National Need (GAANN) Fellowship from the US Department of Education. He is in his first year in the PhD program and works under Elizabeth Dickey.

His present research concerns the crystallization and growth of barium-strontium titanate (BST) thin films thermally annealed in the presence of an applied electric field. This project continues the work done by Jon-Paul Maria and his efforts at lowering the processing temperature of BST and various other thin films. BST thin films are commonly used in capacitors, thermistors, and tunable filters, due to their high dielectric constant and tunability.

Previous investigations have shown that processing temperatures can be lowered by as much as 100°C when an electric field is applied during thermal annealing. Furthermore, the electric field significantly increases grain size and tunability compared to samples not annealed in an electric field. However, previous experimental methods and reports are lacking in reproducibility and have failed to identify the mechanisms that lead to BST's improved properties and increased grain size at lower annealing temperatures.

"To discover these mechanisms, I am in the process of designing and fabricating new experimental methods, which will allow unprecedented control and reproducibility for these experiments," Floyd said. "Currently, we are creating a custom-made sample stage to begin in-situ crystallization and annealing experiments of BST thin films."

Daniel Long received an NC State Provost Fellowship. He is beginning the PhD program this fall and will be working with Elizabeth Dickey.

His current research will focus primarily on point defect redistribution in single crystal TiO_2 and, in the future, other titanates. TiO_2 single crystals are commonly used in memristor/resistive switching elements, resistive random access memory, and capacitors. It is well known that point defects in TiO_2 determine the lifetime, performance, and breakdown of these devices. The current understanding of the mechanisms that control the defect redistribution is not well formulated.

"Previous work performed by our group showed the point defects will redistribute in the presence of an external electric field and conductive filaments will form at low electric fields and at high electric fields greater than 175 V/cm, a reduction in conductivity is noted," Long said. "These conductive filaments are localized areas in the single crystal where a higher density of oxygen vacancies exist. My project will further investigate how the point defect migration under an applied electric field affects the electronic and thermal conductivity and vice versa. To facilitate these studies I will design experiments with a previously fabricated probe station for electrical characterization."

Apart from this, Long plans to utilize advanced microscopy and spectroscopy techniques to investigate the local chemistry and structure in the crystals. Thermal conductivity measurements are done in conjunction with the Air Force Research Lab and the University of Virginia.

"Currently, I am in the preliminary stages of this study, examining the defect distribution of the TiO_2 single crystals before any degradation process," he said. "This will be used as square one for future studies when I observe how the point defects change and migrate under different external pressures, temperatures, and electric fields."

James Peerless received an NC State Provost Fellowship. He spent the last three years in industry in the Boston area working with a small MIT spin-off company that commercializes thin polymer film technology for industrial, aerospace, and bio-medical applications.

"I'm looking forward to increasing my roll in broader base-level research applications that interest me and have a wide ranging impact, especially in the field of high-performance electronic materials," he said.

Peerless has not, as of yet, chosen a research group or a specific direction within the department.

David Harris received a Graduate Assistance in Areas of a National Need (GAANN) Fellowship from the US Department of Education. He is a PhD student in his fourth year in Jon-Paul Maria's lab.

His research is focused on processing of thin film barium titanate, a material commonly used in capacitors for computing and mobile technologies.

"Specifically, we are interested in lowering processing temperatures through the addition of adding liquid phases in order to enable compatibility with low thermal expansion substrates and integrated technologies," he said. •

Dickey leads new National Science Foundation center

Dr. Elizabeth Dickey is director of the National Science Foundation's new Center for Dielectrics and Piezoelectrics, which is being led by NC State and Penn State.

With its sights set on doing research that solves problems facing global industries, the center will first work to form partnerships with the industries it aims to help.

"Broadly speaking, our goal is to work with industry to address outstanding research questions and contribute to the fundamental knowledge that leads to innovative technologies and products," says Dickey, a professor in the MSE Department.

"The center has 18 inaugural industry partners, and we're working with them to identify areas where their needs and our interdisciplinary expertise overlap to develop a research portfolio," Dickey says. "This sort of dialogue and planning helps us determine our research priorities."

The center, which was announced March 1, is part of NSF's Industry & University Cooperative Research Program. The center is supported with $830,000 in NSF funding over five years, primarily to cover operating and infrastructure expenses. The bulk of the center's research funds come from member organizations.

Dielectrics are insulator materials that are used in an enormous array of consumer products. For example, every handheld device has hundreds of capacitors, which are dielectric components that can store and manage electric charge. Dielectrics are also used in transportation, communication, defense, energy, and security technologies – as well as medical applications ranging from ultrasound to MRIs to defibrillators.

Piezoelectrics are a subset of dielectrics, with a number of different applications. For example, because piezoelectrics are able to turn mechanical energy into electric energy, they hold promise for creating new energy-harvesting technologies, sensors, actuators and microelectromechanical systems (or MEMS).

The center is starting out with a handful of research focus areas. For example, the center is planning to work on developing capacitors that can operate at high temperatures. This is a key area of study for developing next generation power devices, such as the devices that are the focus of the Next Generation Power Electronics National Manufacturing Innovation Institute, which was announced by President Obama at NC State in January.

"We would welcome additional industry partners, primarily because we want to make sure we are working to answer the most important questions facing the industrial sector as a whole," Dickey says. "We want to serve as a focal point for anyone working with dielectric materials while providing international leadership for the field." •

Five faculty members earn promotion and tenure

PROMOTION AND TENURE FOR THOM LABEAN, YARA YINGLING AND JOE TRACY

During the 2012-2013 Reappointment, Promotion, and Tenure process, three MSE faculty members were promoted and/or granted tenure.

Dr. Thom LaBean was granted tenure as an associate professor. LaBean joined the department in August 2011 from Duke University, where he was a research professor. His research interests include molecular materials, biomolecular engineering, bionanoscience, and molecular self-assembly. Throughout his career, LaBean has studied the structure, evolution, and engineering of biopolymers (biomacromolecules and materials assembled from them). Current research projects involve the design, construction, and testing of self-assembling DNA nanostructures for applications in molecular materials, nanoelectronics, nanophotonics, molecular robotics, and nanomedicine. Potential applications include the further miniaturization of electronics circuits and devices, creation of stimulus responsive constructs for chemo- and bio-sensing, and molecular therapeutics with inherent computational function.

Dr. Yara Yingling, who was promoted from assistant to associate professor with tenure, joined the Department in 2007 from the National Institutes of Health, where she was a postdoctoral research fellow. Yingling's interests include multiscale molecular modeling and computer simulations of soft materials: polymers, biomolecules, nanoparticles, organic-inorganic composites; design and properties of nanomaterials; inorganic-organic interfaces and surfaces; biomolecular 3D structure prediction; effect of solvents and additives on materials properties; and interactions between nanoparticles and bio and polymeric materials.

Dr. Joe Tracy, who was promoted from assistant to associate professor with tenure, joined the Department in 2007 from the University of North Carolina at Chapel Hill, where he was a postdoctoral research associate. Tracy's interests include chemistry, physics, and toxicology of colloidal magnetic and metallic nanoparticles, and their applications in composite materials, devices, spintronics, biology and medicine.

PROMOTION AND TENURE FOR DOUG IRVING AND JACOB JONES

During the 2013-2014 Reappointment, Promotion, and Tenure process, two MSE faculty members were promoted and/or granted tenure.

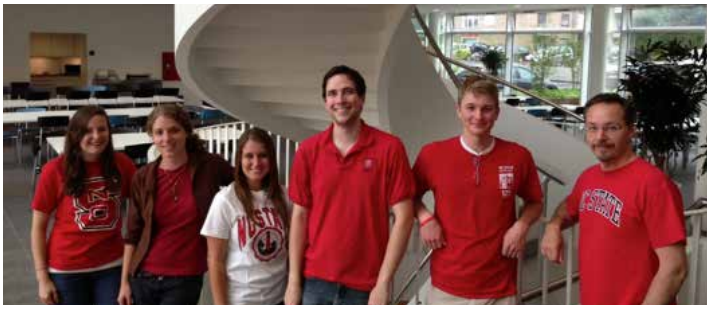
Dr. Doug Irving,who was promoted from assistant to associate professor with tenure, came to NC State in 2004 as a post-doctoral associate. He was later a research assistant professor and then an assistant professor in the Department. The overarching goal of the research in the Irving group is to strongly couple theoretical predictions with experiment such that these predictions ultimately become part of an integrated materials design framework. To accomplish this, Irving's research group implements multiscale, atomistic, and first principles simulation to develop a fundamental understanding of materials used in technologically important applications and processes. Current projects include electrical and optical properties of point defects in wide bandgap materials, epitaxy of oxide thin films, degradation of dielectrics in extreme environments, mechanical properties of high entropy alloys, the atomic structure of multi-component oxides, and tribology of electrical contacts in ohmic RF-MEMS. Irving holds a bachelor's degree in physics from Furman University and master's and PhD degrees in materials science and engineering from the University of Florida.

Dr. Jacob Jones, who was promoted from associate to full professor, came to NC State in 2013 from the University of Florida. He is also director of NC State's Analytical Instrumentation Facility. His research program develops structure-property-processing relationships in emerging functional materials through the use of advanced diffraction tools and techniques for in situ characterization. The primary functional materials under investigation include piezoelectric, ferroelectric, and multiferroic crystals, thin films, and ceramics, which have applications including but not limited to impact and displacement sensors, actuators, microelectromechanical systems, diesel fuel injectors, vibrational energy harvesting, sonar, and ultrasound. Jones holds bachelor's, master's and PhD degrees from Purdue University.

LaBean leads student trip to Denmark

Over the summer, Dr. Thom LaBean led a team of NC State students on a month-long visit to Denmark for an NSF-sponsored project in the International Research Experiences for Students (IRES) program. Three MSE graduate students – Jacob Majikes, Jessica Nash and Nicole Estrich – and two undergraduate students – Bethany Goodfred and Alexander Hoppe – traveled with LaBean to the Centre for DNA Nanotechnology (CDNA) in the Interdisciplinary Nanoscience Center (iNANO) at Aarhus University in Aarhus, the second biggest city in Denmark. At the CDNA, the IRES students worked on experimental research projects including design, synthesis, and examination of self-assembling DNA nanostructures; the fabrication of insulated molecular wires for electronics applications; and the use of CDNA instruments such as a solid-phase oligonucleotide synthesizer and atomic force microscopes. The team enjoyed stimulating research collaborations with several groups in the CDNA, especially Profs. Kurt Gothelf, Jørgen Kjems, and Ebbe Andersen. Exposure to Danish cultural events, museums, and social gatherings rounded out the time spent during the month. The team spent a weekend in Copenhagen, the capital and largest city in Denmark, and enjoyed visiting a variety of art and history museums. "Our trip to Denmark was my first time leaving the USA," Estrich said. "A month abroad showed me a new climate, a new culture, and introduced me to an extremely gifted group of scientists. I was able to transfer the skills I've learned at NC State to a similar set-up in a lab thousands of miles away, proving to myself that the concepts I've learned are transferable; the skills global. The trip also afforded me the chance to collaborate with groups whose expertise complements our lab's. After giving a presentation on my progress, a professor approached me with an idea for a new analytical technique with which to characterize my samples, and we will soon be sending some of our samples to Denmark for analysis, furthering both of our works. As was to be expected, leaving the bubble of home was stimulating, invigorating, challenging, and ultimately presented opportunities that wouldn't have presented themselves without going somewhere different." •

Undergraduate researcher Bethany Goodfred performing oligonucleotide synthesis chemistry in the fume hood at the CDNA laboratory in Denmark.



Pictured, from left, are: Jessica Nash, Nicole Estrich, Bethany Goodfred, Jacob Majikes, Alexander Hoppe, and Dr. LaBean.

MSE Senior Design Program offers real-world experience

The MSE Senior Design program continues to operate in the basic and successful model initiated in the late 1980s, in which teams of three to five students work on real industrial problems under the joint guidance of industry and academic advisors. This two-semester capstone experience has been very effective at teaching students practical, job-related teamwork and presentation skills.

For the 2013-2014 academic year, there were 33 seniors in the program with project sponsors that included AMKOR, the Army Research Office, ATI Allvac, Hanes, Lord Corporation, and NUCOR. The ARO and Hanes teams each partnered with teams from the College of Textiles TECS department. For the first time, a team worked through the NC State Engineering Entrepreneurs Program. Look for additional details on this team (Undercover Colors) in later department newsletters as they work to create a business from their project.

For 2014-2015, there are 29 seniors and as this newsletter is being prepared we are in the process of identifying company sponsors and projects. As the Department's undergraduate enrollment expands (there will be 51 seniors next year) it faces major challenges maintaining operation of the Senior Design program in its current format. The Department's future seniors would greatly benefit from the assistance of MSE alumni and friends identifying potential industry partners for sponsorship of projects. Please send any leads on senior design projects to Professor Mike Rigsbee at mrigsbee@ncsu.edu. •

NC State leads diversity in MSE workshop

Justin Schwartz addresses participants at the workshop.

In December 2012, NC State led a workshop aimed at improving ethnic diversity in materials science and engineering nationwide. The workshop's 125 attendees included graduate students, post-doctoral scientists and key voices in the field who took away new insights to implement across the discipline.

MSE Department Head Justin Schwartz said, "Our department is committed to improving diversity not only locally at NC State, but throughout the materials science and engineering discipline across the US. NC State was proud to play a leadership role in the workshop."

Schwartz chaired the event with active participation from Assistant Vice Provost for Faculty Diversity Marcia Gumpertz, MSE faculty Frank Hunte and Ramon Collazo, and MSE post-doc Sasha Ishmael. Funding for the workshop was provided by the National Science Foundation, the United States Department of Energy, the Materials Research Society Foundation, the University Materials Council, and NC State.

The workshop's main goals were to identify issues that deter diverse people from participating in MSE, and to launch initiatives that increase diversity among those pursuing MSE degrees and careers. In reaching these goals, participants hope to create new role models who will attract diverse scholars to the discipline. Keynote speeches, topical presentations, panel-led discussions, and breakout groups allowed participants to pinpoint underlying challenges and develop policy recommendations to address them.

These recommendations, alongside action plans, summaries of workshop sessions, and results from a preliminary survey, appear in a published workshop report. Both the workshop and published report are significant steps in raising awareness about challenges the materials community faces and sparking an important discussion about ethnic diversity within materials science and engineering. •

MSE faculty endow scholarship, professorship

Faculty members in the Department have made generous donations to give students opportunities and keep top faculty on campus.

Dr. Carl Koch and his wife recently established the Carl and Evelyn Koch Scholarship in Materials Science and Engineering. The scholarship will be awarded to students in the Department in their junior or senior year.

"I just decided it would be a useful thing to do," Koch said.

Koch, a Kobe Steel Distinguished Professor in the Department, came to NC State from Oak Ridge National Laboratory in 1983. He was recently elected to the National Academy of Engineering.

Last year, Dr. Michael Rigsbee and his wife established an endowed professorship to benefit the Department.

The Dr. J. Michael Rigsbee and Donna W. Rigsbee Distinguished Professorship in Materials Science and Engineering is designed to one day be used to bring a top faculty member in the field to NC State, or to convince one of MSE's top researchers to stick around for a long time.

Rigsbee received his bachelor's, master's and PhD degrees from NC State. He was professor and chairman of the Department of Materials and Mechanical Engineering at the University of Alabama at Birmingham before becoming department head of the MSE Department at NC State in November, 1998.

Dr. Michael Rigsbee

Dr. Carl Koch

"Our goal was to provide funds that can help professors achieve national and international recognition for their teaching, research and professional service," Rigsbee said. •

MSE takes home slew of conference awards

NC State MSE had a successful summer in 2014, receiving awards at the Microscopy and Microanalysis Conference and the Applied Superconductivity Conference.

The Department received four awards from the Microscopy and Microanalysis 2014 Conference in Hartford, Connecticut Aug. 3-8. Doctoral students Matthew Burch and Ali Moballegh won Presidential Scholar Awards for their works titled "Investigation of Local A-site Chemistry in Barium Strontium Titanate Using Aberration Corrected STEM, EELS ADS" and "Investigation of the Nature and Mechanism of Resistive Switching in TiO_{2-x}," respectively. Both are members of Professor Elizabeth Dickey's research group. In addition, Burch won 1st prize in Wednesday's poster session in the physical sciences category.

Post-doctoral Scholar Xiahan Sang and Assistant Research Professor Yang Liu won Presidential Post-Doctoral awards. Sang is a member of Professor James LeBeau's research group, and his work was titled "Putting a New Spin on Scanning Transmission Electron Microscopy." Yang Liu's award honored his research done at Sandia National Laboratory titled "In Situ Transmission Electron Microscopy (TEM) Study on the Lithium Ion Transport in Si-Ge Heterostructured Nanowires." All the awards were honored at Monday morning's plenary session and came with $1,000 travel stipends. In all, the department sent seven students, one post-doctoral researcher, one technical staff member, and two faculty members.

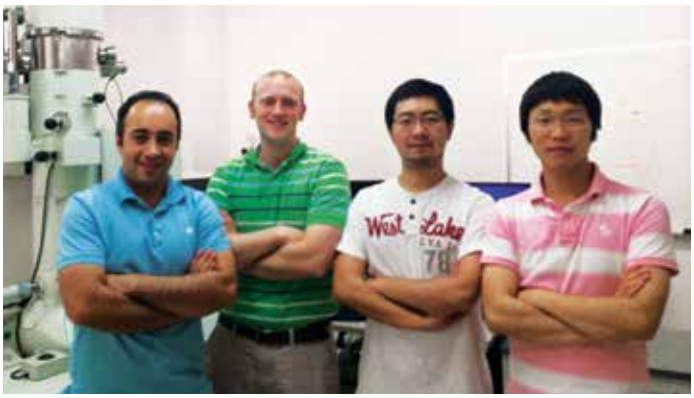
At the previous Microscopy and Microanalysis meeting, held in Indianapolis, IN, Houston Dycus was awarded a Presidential Scholar Award for his work titled "Resolving Ambiguities at the Bi_2Te_3/GaAs Interface with Atomic Resolution EDS." Dycus is a member of Professor James LeBeau's research group.

The Applied Superconductivity Conference is the largest international conference focused on applied superconductivity in the world. It meets every other year, moving around the United States.

Justin Schwartz won the IEEE Award for Continuing and Significant Contributions in the Field of Applied Superconductivity, which is the highest technical award given by the IEEE Council on Applied Superconductivity.

Department faculty, researchers and students won Van Duzer Prizes for 2012 and 2013, which were awarded at the 2014 conference. The IEEE Council on Superconductivity sponsors the Van Duzer Prize, awarded to the best contributed paper published in *IEEE Transactions on Applied Superconductivity* during each volume year.

The 2012 award was given to Schwartz and Wan Kan Chan, a research associate in Schwartz's group, for "A Hierarchical Three-Dimensional Multiscale Electro–Magneto–Thermal Model of Quenching in $REBa_2Cu_3O_{7-x}$ Coated-Conductor-Based Coils," which appeared in the *IEEE Transactions on Applied Superconductivity* (vol. 22, no. 5, article 4706010, October 2012).



From left, Ali Moballegh, Matthew Burch, Yang Liu and Xiahan Sang took home awards from the 2014 Microscopy and Microanalysis conference.

Marty Nisenoff, far left, and Alan Kleinsasser, far right, present the 2013 Van Duzer Prize on behalf of the IEEE Council on Applied Superconductivity to Golsa Naderi (second from left), Sasha Ishmael (third from left) Justin Schwartz (third from right) and Liyang Ye (second from right).

The 2013 award went to post-doctoral researcher Sasha Ishmael, Assistant Professor Frank Hunte, Schwartz, recent PhD graduate Golsa Naderi, PhD student Liyang Ye, NC State Electrical and Computer Engineering Professor John Muth, NC State Electrical and Computer Engineering PhD student Haojun Lee and industrial collaborators Marvis White and Dr. Andrew Hunt of nGimat. The work was funded by a Department of Energy Small Business Technology Transfer grant. "Enhanced Quench Propagation in $Bi_2Sr_2CaCu_2O_x$ and $YBa_2Cu_3O_{7-x}$ Coils via a Nanoscale Doped-Titania-Based Thermally Conducting Electrical Insulator" appeared in the *IEEE Transactions on Applied Superconductivity* (vol. 23, no. 5, article 7201311, October 2013).

Naderi received a Graduate Student Fellowship Award and won third place in the Materials category, 2014 Applied Superconductivity Conference Best Student Paper Prize. •

Dr. Mildred Dresselhaus of MIT delivered the annual Robert F. Davis Distinguished Lecture at the James B. Hunt Jr. Library on Centennial Campus.

Davis Lecture continues strong run

The annual Robert F. Davis Distinguished Lecture continued to attract some of the world's most prominent materials scientists and engineers to NC State in 2013 and 2014.

The 2013 lecture was presented by Dr. Mildred (Millie) Dresselhaus, Institute Professor and professor of physics and electrical engineering, emerita, at MIT. That was followed in 2014 by a lecture by Dr. Herbert Gleiter, professor and founding director of Karlsruhe Institute of Technology's Institute of Nanotechnology in Germany.

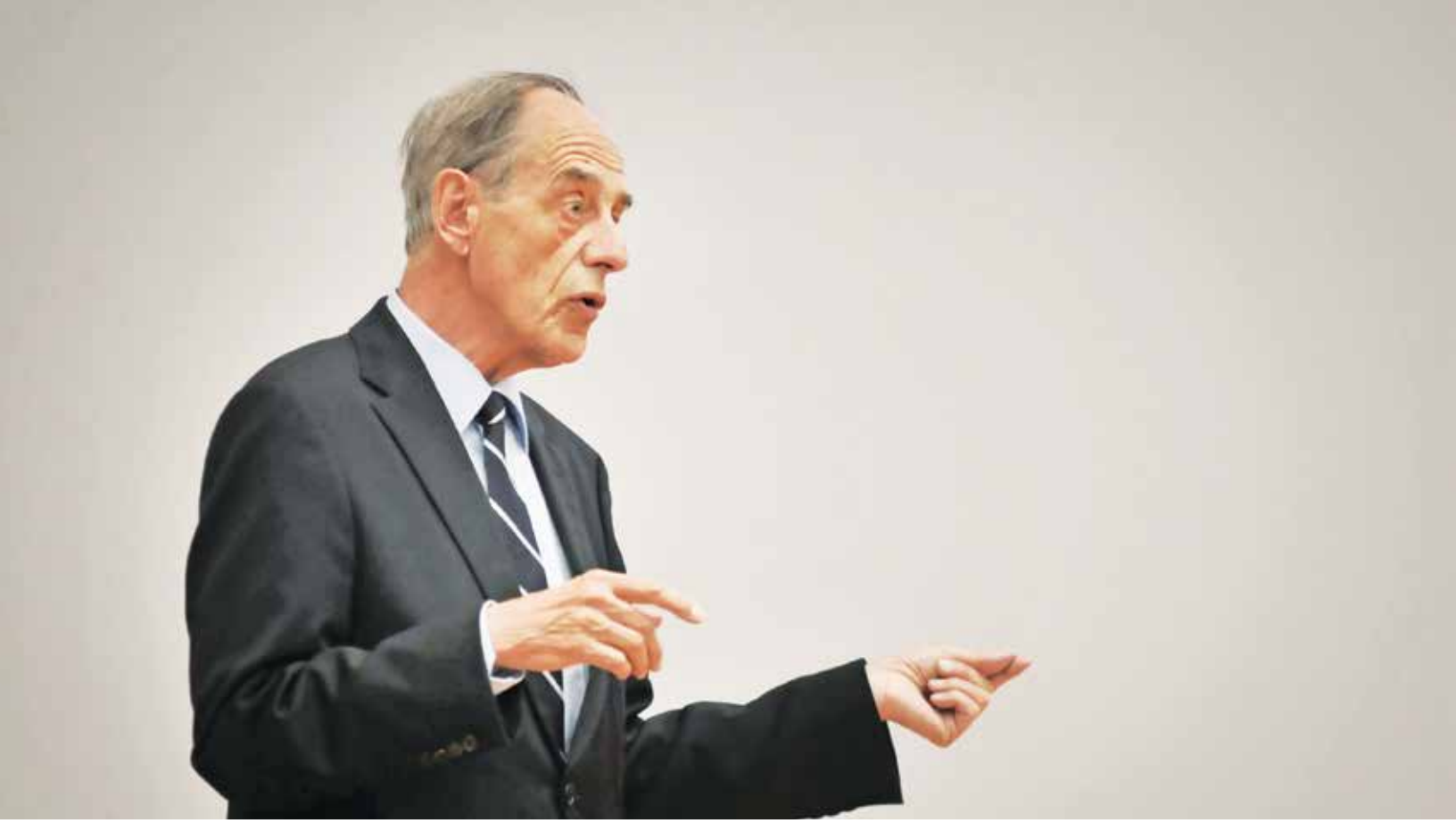
The Robert F. Davis Distinguished Lecture Series was created in 2010 to honor the accomplishments of Dr. Robert F. Davis, an internationally recognized semiconductor researcher who spent more than three decades as a faculty member in the Department. Davis established an endowment fund to support the lecture series and other emerging opportunities that will enhance the intellectual, curricular and research environment that the Department provides for its students and faculty.

Davis is a member of the National Academy of Engineering and a Fellow of the American Ceramic Society. He came to NC State in 1972 and was its first Kobe Steel Ltd. Distinguished Professor of Materials Science and Engineering. While at NC State, he received the Alexander Q. Holladay Medal for Excellence and the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension. He retired from NC State in 2004 as professor emeritus and began his current position as the John and Claire Bertucci Distinguished Professor of Materials Science and Engineering at Carnegie Mellon University.

Dresselhaus, who in the year 2012 alone authored or co-authored 39 papers, is hailed as the "Queen of Carbon" for her pioneering contributions in the field of carbon-related materials and her lecture focused on her discoveries related to carbon nanotubes, buckyballs, graphene and thermoelectric materials, and their impact on next-generation solid state devices and systems.

In 2012, she became the first sole recipient of the Kavli Prize in Nanoscience, which recognizes scientists for seminal advances in their field, and is present in cooperation and partnership with the Norwegian Academy of Science and Letters, and the Norwegian Ministry of Education and Research.

Among her many honors and memberships are the American Academy of Arts and Sciences, American Physical Society (APS), IEEE, and the American Association for the



Dr. Herbert Gleiter, a pioneer in nanocrystalline or nanostructured materials, delivered the 2014 Davis Lecture.

Advancement of Science (AAAS), and a member of the U.S. National Academy of Sciences (NAS). Her long list of awards includes the U.S. National Medal of Science; she is the recipient of 28 honorary doctorates. She has also played an active role in the public sphere, and has served as president of the AAAS and the APS, as treasurer of the NAS, and as chair of the governing board of the American Institute of Physics.

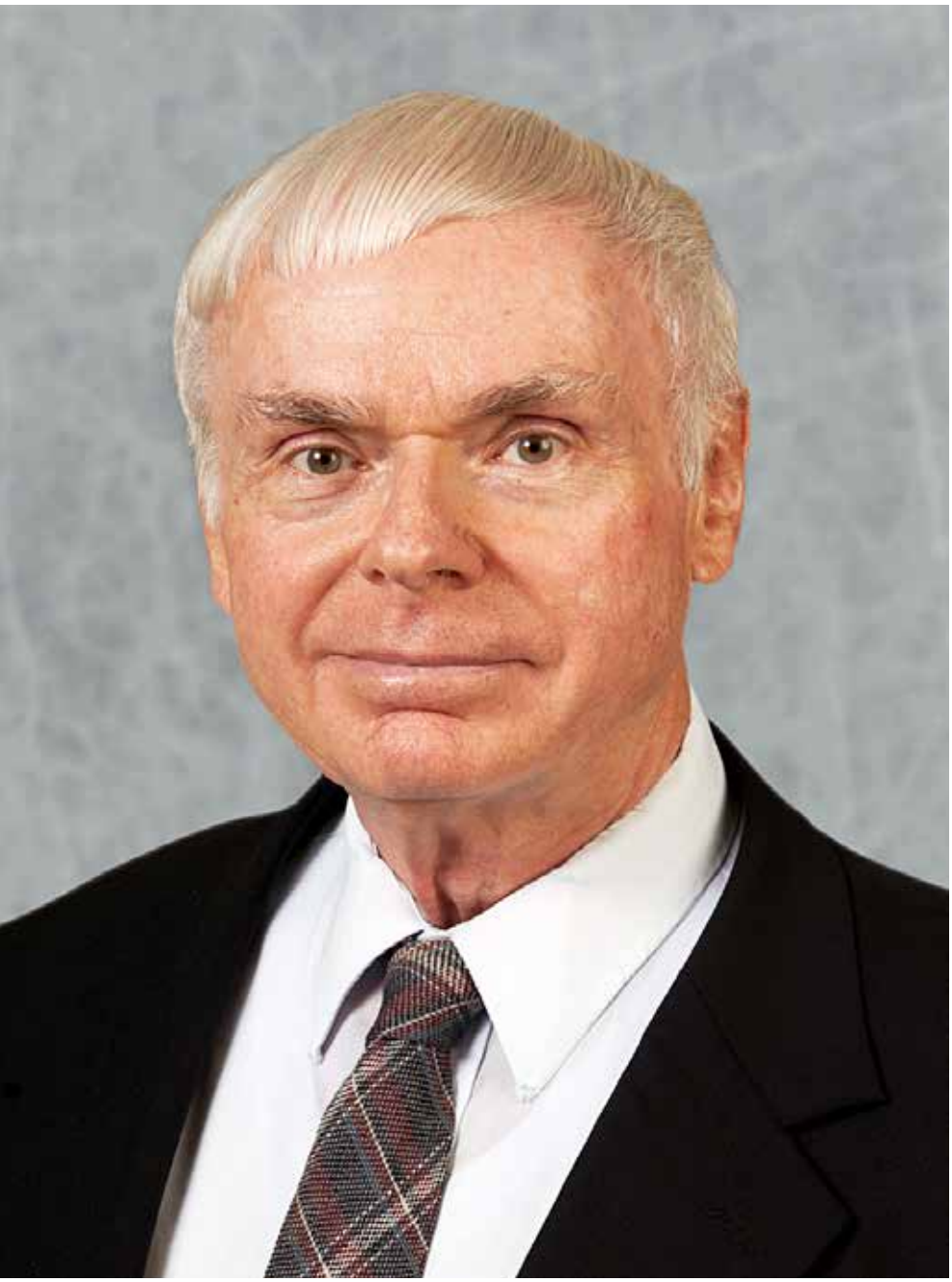
Gleiter is one of the pioneer researchers in nanocrystalline or nanostructured materials. In 1973, he became Chair Professor of Materials Science at the University of the Saarland in Germany. In 1994, he was appointed member of the Executive Board of the Research Center Karlsruhe, Germany, and four years later he became the Founding Director of the Center's Institute of Nanotechnology. In 2012, the Nanjing University of Science and Technology founded the Herbert Gleiter Institute of Nanoscience and appointed him as the Institute's founding director as well as Zijin Professor of the University.

In the late 1970s, he pioneered a new class of materials called nanocrystalline or nanostructured materials. The field has expanded rapidly; in 2011, more than 60,000 publications in the field of nano-materials were retrieved by the Web of Science. His present work focuses on a novel class of non-crystalline materials called nanoglasses and the application of methods developed initially in nanotechnology to probe the limits of quantum physics.

Among Gleiter's more than 40 awards and honors are the Masing Prize of the German Society for Metals (1972), the Leibniz Prize of the German National Science Foundation (1988), Max-Planck Research Prize (1993), Gold Medal of the Federation of European Material Societies (1995), Heyn Medal of the German Society for Materials Science (1988), Heisenberg Medal (1988) and Humboldt Medal (2006). His publications have been cited more than 18,000 times, and six universities in Europe and abroad have awarded him honorary doctorates.

Previous installments of the lecture series featured Davis, who delivered the first lecture in 2010; Dr. Arden L. Bement, inaugural director of Purdue University's Global Policy Research Institute and the David A. Ross Distinguished Professor of Nuclear Engineering at Purdue; and Dr. John W. Cahn, an Emeritus Senior Fellow at the National Institute of Standards and Technology and a winner of the Kyoto Prize in Advanced Technology. •

Koch elected to National Academy of Engineering



Dr. Carl Koch, Kobe Steel Distinguished Professor in the Department of Materials Science and Engineering, has been elected to the National Academy of Engineering. Koch is one of 69 new members and 11 foreign associates joining the academy this year. He is the 11th current NC State faculty member to be elected to the NAE, a private, independent nonprofit organization that provides engineering leadership in service to the nation. Election is considered one of the top professional distinctions in the field of engineering.

The new class of members means NAE now has 2,250 members and 211 foreign associates. Academy membership is extended to those who have made outstanding contributions to engineering research, practice or education, including significant contributions to literature in the field.

Koch, whose engineering career spans more than 50 years, is well-known for his achievements in research on amorphous and nanostructured materials. In 1983, he became the first researcher to create an amorphous metallic structure — which differs from a normal metal because of its disordered atomic makeup — from two separate elements through a process known as mechanical alloying.

His recent research has turned to creating nanocrystalline materials that have special mechanical and magnetic properties. In 2008, his research group produced an iron composed of tiny crystals that is far stronger than traditional iron. The new substance has a wide variety of potential applications, such as engine components that are exposed to high stress and temperatures.

Koch is a fellow of numerous professional societies, including the Minerals, Metals and Materials Society, which limits membership to 100 living fellows. At NC State, he has been recognized with the Alexander Quarles Holladay Medal for Excellence, the university's top faculty honor; the NC State Alumni Association Outstanding Research Award; and the R.J. Reynolds Award for Excellence in Teaching, Research and Extension.

Koch received his bachelor's, master's, and doctoral degrees in metallurgy from the Case Institute of Technology (now Case Western Reserve University) in 1959, 1961, and 1964, respectively. He was a research group leader with the Metals and Ceramics Division of Oak Ridge National Laboratory before joining the NC State faculty in 1983. •

Ivanisevic named associate editor of ACS Applied Materials and Interfaces

Dr. Albena Ivanisevic, a faculty member in the Department of Materials Science and Engineering, will serve as an associate editor of the journal *ACS Applied Materials and Interfaces*. The journal has an impact factor of 5.008 for 2012. The journal serves an interdisciplinary community of scientists and engineers who focus on new materials and interfaces for specific applications. Ivanisevic will be responsible for articles in biomaterials and bio-interfaces. She will be evaluating manuscripts submitted to the journal, identifying and contacting qualified reviewers and facilitating the revision process. As an associate editor, she will handle approximately 300 manuscripts a year assigned to her by the editor-in-chief. Ivanisevic has an active research program on surface modification, characterization, and patterning, and publishes on the subject each year •

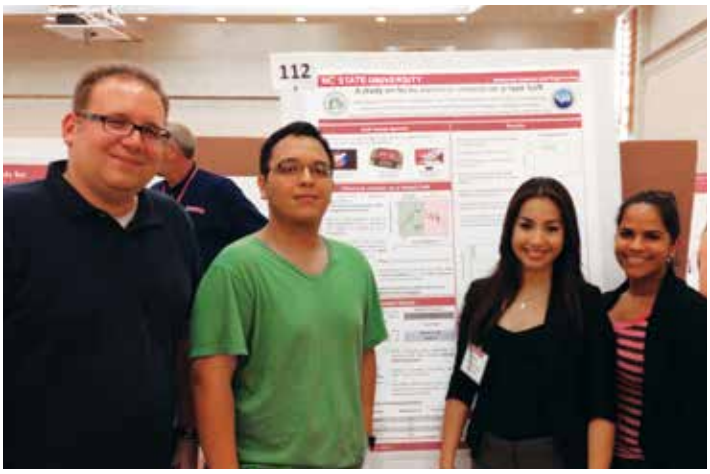
Research Experience for Undergraduates program proves invaluable

This past summer, 10 undergraduate students from across the country participated in the Research Experience for Undergraduates (REU) program. The REU program was hosted by MSE for the third consecutive year, with financial support from the National Science Foundation through the Advanced Materials Environmental Sustainability grant. The program is focused on materials research for environmental sustainability. The theme builds on faculty research interests at NC State while illuminating how fundamental materials research can impact environmental and human well being.

Tripp Hurt, a student at Furman University, participated in the program and worked with Professor Doug Irving and graduate student mentor Changning Niu on simulating the structure of transition metal high entropy alloys using the Exact Muffin Tin Orbital first principles approach coupled to the Coherent Potential Approximation.

Hurt fully maximized his time in the REU program while at the same time competing in the NCAA Division I regional and national track and field meets. He had one research presentation and is in the process of including some of his work in a publication that will be submitted this fall. There are also plans to write an additional paper on the results he generated during the program. Upon leaving the REU program, Hurt asked to continue his computational project remotely from Furman.

The REU program was my first research experience so it exposed me to what research is and what it includes," Hurt said. Before I thought it was more just about data collection, but now I realize all the intricacies of conducting successful research. I was also introduced to the size and workings of a large research university. I got to experience first-hand how large a university as big as NC State actually feels.



This REU group mentoring team includes Professor Ramon Collazo, first-year graduate student Luis Hernandez, REU participant Kiara Rivera-Rodriguez and senior PhD candidate Milena Bobea.

"My research project involved computational materials science and I thoroughly enjoyed my project. I had no expectations of what type of research I would be doing this summer coming into the REU program and I will admit I was a little disappointed at first at all of the computer time. I consider myself more of a hands-on person and the computations at first bored me because I was not able to understand the intricacies of what was occurring. However, as the program progressed, I was able to further understand my work and I began to appreciate what I was doing for the project." •

MSE faculty members bring home awards

MSE faculty members **Dr. James LeBeau** and **Dr. Linyou Cao** have been busy racking up awards. LeBeau and Cao, both assistant professors, have both received Faculty Early Career Development Awards from the National Science Foundation (NSF). Additionally, LeBeau received a research grant from The Air Force Office of Scientific Research's Young Investigator Research Program (YIP) and Cao has received a research award from the Army Research Office's Young Investigator Program.

The NSF CAREER Award is one of the highest honors given by NSF to young faculty in science and engineering.

NSF will provide $500,000 in funding over five years to support LeBeau's project, "Understanding Polar Surfaces and Interfaces Using Ultra-High Resolution Electron Microscopy and Spectroscopy." The research is supported by NSF's Ceramics Program in the Division of Materials Research.

James LeBeau

Linyou Cao

The project aims to advance the understanding of material interfaces, which will lead to exciting new electronic device functionality. Using state-of-the-art electron microscopy, LeBeau and his research team will study interface structure and bonding at an extraordinary level. The results will offer a new perspective on interface phenomena and will provide input to validate theoretical models.

The educational outreach component of the program combines microscopy with visual arts to attract new students to science and engineering. LeBeau and his collaborators will work with local museums and schools to create an exhibit that communicates advanced electron microscopy and materials science research through art, highlighting the inherent beauty of atomic structure symmetries.

LeBeau's $435,078 AFOSR YIP award will go toward his research project "A Transformational Approach to Quantify Chemistry at the Atomic Scale."

LeBeau's research group focuses on applying and developing transmission electron microscopy techniques to determine the atomic structure of material defects, thus providing insight into observed properties. This project centers on studying alloys deployed in extreme aerospace environments and how elements within these alloys interact, providing a critical step forward in new material development.

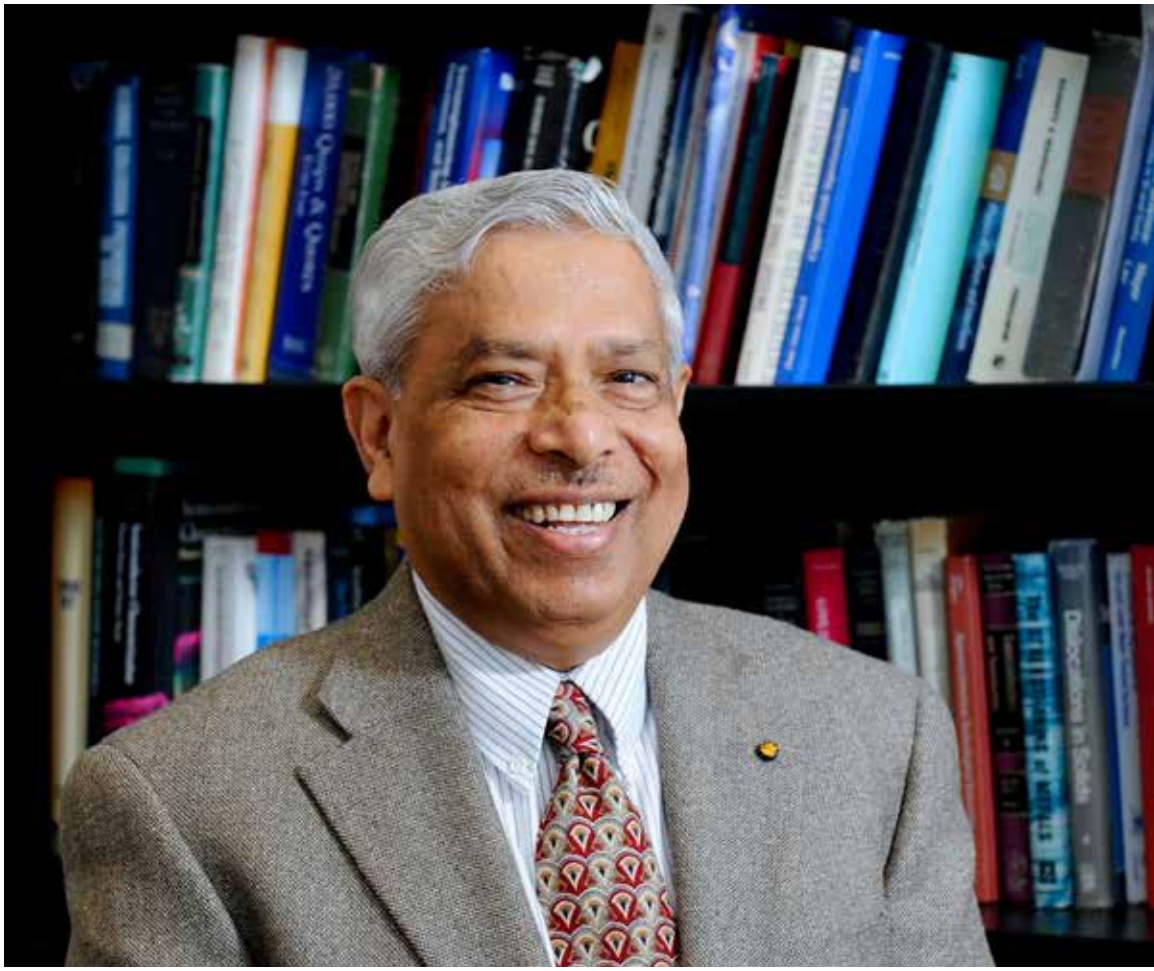
Cao's NSF award will provide $550,000 in funding over five years to support his project, "Van der Waals Epitaxial Heterostructures: Beyond 2D Materials." The research is supported by NSF's Electronic/Photonic Materials Program in the Division of Materials Research.

The project addresses fundamental challenges in an emerging cutting-edge area of materials science. Cao and his team will study the synthesis of large-area, uniform, and high-quality two-dimensional (2D) van der Waals epitaxial heterostructures with controlled band structures. Cao's long-term goal is to investigate new physical phenomena of 2D heterostructures for applications in optoelectronics. This could lead to unexplored opportunities in the fields of information technology, solar energy harvesting, light emission diodes, and flexible electronic/photonic devices.

Another goal is to help inspire students to pursue careers in the STEM disciplines and to enhance secondary school and university curricula in materials science by providing research training for undergraduate and graduate students and mentoring high school students to participate in pre-college scientific competitions and guest lectures in AP chemistry classes.

Cao's YIP award is funded at $150,000 over three years and will be used to support his research work on the electron-phonon coupling in two-dimensional materials. Electron-phonon coupling is one of the most fundamental many body interactions in condensed matter, and plays an important role in electronic and optical properties. The results of Cao's research have the potential to lead to next-generation lasers, light emission diodes and photo detectors that are important for defense needs. •

Narayan receives O. Max Gardner Award



Dr. Jay Narayan, John C. C. Fan Family Distinguished Chair Professor of Materials Science and Engineering, is the 2014 recipient of the O. Max Gardner Award – the most significant university-wide honor given to faculty by the University of North Carolina Board of Governors.

The award is presented each year to a faculty member from one of the system's 17 campuses who is recognized as having "made the greatest contribution to the welfare of the human race."

Narayan has made groundbreaking contributions to the field of materials science, most notably in domain matching epitaxy, a method of combining nanomaterials that reduces defects in the semiconductor materials that affect LED efficiency. This work led in turn to the development of high-efficiency LEDs that will save energy, reduce greenhouse emissions and contribute to our nation's energy independence.

Additionally, Narayan's work has led to the creation of microelectronics with increased functionality and the development of smart structures and sensors that can be used to detect bioterrorist threats, create smart grid technology and impact national security.

Narayan has published nine books and more than 500 papers in scholarly journals as well as 40 U.S. patents, and has been invited to present papers at numerous conferences, symposia and seminars.

In 2011, Narayan received both the R.J. Reynolds Tobacco Company Award, the College of Engineering's highest honor for excellence in research, teaching and extension, and the Acta Materialia Gold Medal and Prize for pioneering contributions and leadership in materials science worldwide. He received the Alexander Holladay Medal, NC State's highest faculty honor, in 2012, and is the 2014 recipient of the Robert Franklin Mehl Gold Medal, the pinnacle honor from The Materials Society for pioneering contributions in nanomaterials and nanotechnology leading to useful commercial products.

Narayan has mentored more than 65 PhD students and trained numerous postdocs who are employed in leading companies and universities. Since joining NC State's faculty in 1983, Narayan has developed eight graduate courses that are connected with his research, three of which are offered via NC State Engineering Online to engineers within the microelectronics and photonics industry.

Elected in 2008 as an Inaugural Fellow of the Materials Research Society, Narayan is also a Life Member and Fellow of The Materials Society, a Fellow of the American Association for the Advancement of Science, and Life Member and Fellow of the American Physical Society.

Born in India, Narayan received his bachelor's degree from, the Indian Institute of Technology in Kampur, and his masters and PhD from the University of California, Berkeley. He was named Distinguished University Professor in 1990, and John C. C. Fan Family Distinguished Chair Professor in 2002. •

Two department alumni find success on Texas A&M faculty

Two of the department's alumni are making an impact on science and education as part of the faculty at Texas A&M University, College Station.

Dr. Haiyan Wang is a professor in the Department of Electrical and Computer Engineering. **Dr. Xinghang Zhang** is an associate professor in the Department of Mechanical Engineering. Both are adjunct professors in the Department of Materials Science and Engineering. Both earned their PhDs from the MSE Department at NC State.

Haiyan Wang

Xinghang Zhang

Wang earned a bachelor's from Nanchang University in Nanchang, China in 1998 and a master's from the Institute of Metal Research in Shenyang, China in 1999. Wang worked with Prof. Jagdish Narayan on pulsed laser deposition of nitride films during her PhD studies (2000-2002) and won a MRS silver medal award in 2001. She was a director-funded postdoctoral fellow at Los Alamos National Laboratory (2003-2004) and became a technical staff member in 2005. She joined Texas A&M University as an assistant professor in 2006.

Zhang earned a bachelor's from Jilin University in Changchun, China in 1995 and a master's from the Institute of Metal Research in Shenyang in 1998. Zhang worked under Prof. Carl C. Koch on mechanical behavior of nanocrystalline Zn (1998-2001). He was awarded the director-funded postdoctoral fellowship by Los Alamos National Laboratory in 2002 and became a faculty member at Texas A&M in 2005.

Wang's research interests include nanostructured nitride and oxide thin film heterostructures for microelectronics; optoelectronics; magnetic, high temperature superconductors; solid oxide fuel cells; radiation tolerance; structural application and thin film solar cells; high resolution TEM and in situ TEM. She has published more than 300 journal articles, many of which are in high level journals including Nature Materials, Nature Communications, Advanced Materials, Advanced Functional Materials and others. Her research articles are widely read and cited over 6,000 times (per Google Scholar). She has been elected as a fellow of ASM International (class of 2014), and been awarded an ASM Silver Medal Award in 2011. She has been given numerous fellow awards by Texas A&M University, including TEES Fellow, Senior Fellow and Charles H. Barclay Jr. Fellow. She has won an NSF CAREER Award (2009), ONR Young Investigator Program Award (2008), Air Force Young Investigator Award (2007) and a Presidential Early Career Award for Scientists and Engineers 2008. She is currently on leave at NSF as the program director for DMR-Electronic Materials Program. Wang can be reached at **wangh@ece.tamu.edu** and her research website is at **engineering.tamu.edu/electrical/people/hwang**.

Zhang is an expert on radiation damage in nanostructured metallic materials, mechanical behavior of nanotwinned metals and metallic nanolayers, magnetic shape memory alloy thin films for actuator applications, and hydrogen storage in nanostructured metals. Zhang has published over 140 journal articles and received over 3,000 citations. He received an NSF CAREER award in 2007, is a TEES Fellow (2013), and won a College of Engineering Holleran-Bowman Faculty Fellow award (2014). He is also the holder of Gulf Oil/Thomas A. Dietz Career Development Professorship (2014). Several of Zhang's graduate students have become technical staff members at Los Alamos National Lab or professors in University China, including Peking University. Zhang can be reached at **zhangx@tamu.edu** and his research website is at **nanometal.tamu.edu/index.html**.

Wang and Zhang both attribute their career success to their solid training from NC State and are proud of being alumni of NC State. They are also excited to see the enormous growth in the College of Engineering. •

Schwartz reappointed as department head

Dr. Justin Schwartz, Kobe Steel Distinguished Professor, has been reappointed as head of the Department of Materials Science and Engineering by Dr. Louis A. Martin-Vega, dean of the College of Engineering.

Schwartz was named department head in 2009, replacing Dr. Michael Rigsbee, who had led the department since 1998. The reappointment approved this year is for five years.

"We have made tremendous progress toward our goal of being known as the top department of materials science and engineering in the United States, but there is more to do," Schwartz said. "All of our success starts with the department's outstanding faculty and the tremendous support we have received from the College of Engineering and the University, and I am excited about the opportunity to work with them for another five years."

During Schwartz's tenure, the department has increased its research expenditures, the number of tenure and tenure-track faculty, the number of degrees awarded and the number of both undergraduate and graduate students. The department is more diverse, has gained more national recognition and is performing better in nationally recognized metrics like the *US News & World Report* rankings.

The department's research expenditures grew from $5.5 million during the 2009-10 fiscal year to $8.1 million during the 2011-12 fiscal year and have more than doubled between 2007 and 2012.

New faculty hiring was aimed at reinvesting in departmental strength areas like electronic/optical materials, structural materials and simulation and theory while also hiring faculty that will allow the department to grow in research areas such as advanced characterization, polymeric and biomaterials and magnetic materials.

Schwartz came to NC State in 2009 from Florida State University, where he was the Jack E. Crow Professor of Engineering. He holds bachelor's and PhD degrees in nuclear engineering from the University of Illinois at Urbana and from the Massachusetts Institute of Technology, respectively. •

Dr. Barry Farmer joins MSE as an adjunct faculty member

Dr. Barry L. Farmer, chief scientist emeritus of the Materials and Manufacturing Directorate of the Air Force Research Laboratory (AFRL), has joined the Department as an adjunct professor.

Farmer joined the AFRL, Wright-Patterson Air Force Base, Ohio, in 1998 as senior scientist, ST, in polymeric materials. Prior to that, he was professor of materials science and engineering at the University of Virginia.

He is best known for his research in applying computational modeling tools to understand the structures and properties of polymers, most often closely coupled with his own experimental x-ray diffraction studies or with collaborators bringing other experimental methods to bear on the scientific question at hand. A very significant body of work was in fluoropolymers, including poly(vinlylidene fluoride) and related copolymers, polytetrafluoroethylene, and semifluorinated alkanes.

His computational results contributed significantly to the elucidation and understanding of the structures and phase behavior of these important materials, and in particular to the role of chemical defects on that behavior. The roles of defects on polymer properties carried into his work on the molecular mechanisms of mechanical relaxation processes in polyethylene having methyl branches and row vacancies in its crystal structure. These extended to studies of chain folding in polyethylene single crystals and to simulations of the mechanism of adsorption and incorporation of chain stems into the polymer single crystal.

"As an adjunct faculty member in MSE at NC State I would like to establish research collaborations with faculty members whose interests overlap with mine and to engage in hands-on research using computational tools to understand the structure-property relationships for soft materials (polymers, biomaterials, etc.) in the bulk, in solution, or at interfaces," Farmer said. "In addition, I hope to act as a mentor and to share my professional network with those who might find such a relationship useful."

He received a BS in chemistry (1969) and an MS (1972) and PhD (1974) in macromolecular science from Case Western Reserve University. He has authored more than 200 publications on his research, focusing on structure-property relationships of polymers and related materials using computational approaches and x-ray diffraction techniques.

Farmer is a fellow of the American Chemical Society and a fellow of the American Physical Society. He served for 20 years as secretary-treasurer and as a member of the executive committee of the APS Division of Polymer Physics. He is a past-chair of the American Chemical Society Division of Polymer Chemistry. •

The Applications Are Endless:
A Q&A with MSE Professor Jacob Jones

The MSE Department has been fortunate enough to bring in quite a few new world-class faculty in the two years since our last MSE magazine. To give you an idea of the quality of these new faculty, we sat down with Jacob Jones, a professor in MSE and director of the Analytical Instrumentation Facility (AIF), NC State's primary shared research facility for materials characterization. Jones joined NC State in August 2013 after seven years at the University of Florida.

MSE: What drew you to NC State?

Jones: How many pages do we have for this article? For brevity, let me hit the highlights: the people at NC State, the research infrastructure at NC State, and Centennial Campus.

I'll elaborate. In moving, I was looking to enhance the quality and impact of my research program through identifying new research opportunities with new collaborators and colleagues. I also wanted to support those activities with a strong research infrastructure (lab space, equipment, major analytical instrumentation, etc.). I found an opportunity at NC State to start working with many faculty members in MSE and beyond on several diverse topics.

These research areas include interacting with faculty in the new NSF-funded Center for Dielectrics and Piezoelectrics, working with local companies on Centennial Campus, and collaborating with excellent microscopists such as [MSE assistant professor] Jim LeBeau. Beyond MSE, I've also started working with Michael Dickey in Chemical and Biomolecular Engineering on a project related to 3-D printing of metals (recently funded by NSF).

On a personal note, the city of Raleigh also helped to draw me here; my wife and I love the city. The outdoor activities, including running trails, and its proximity to the mountains and the coast were also a big appeal.

MSE: What sort of research do you do, and what sort of applications does that research lend itself to?

Jones: As an academic, I have many different interests including crystallography, mechanics of materials, piezoelectric and ferroelectric materials, and phase transitions. [My research group's] projects are therefore pretty diverse. We now have projects on ceramics and metals, as well as bulk materials, powders, and thin films.

One common theme in my research group is the development and application of advanced X-ray and neutron scattering techniques to understand structure-property and structure-processing relationships. In brief, we can learn a lot about materials synthesis/processing and materials performance/properties by irradiating the materials in situ and interpreting the scattered patterns.

While many of our experiments can be done at the AIF at NC State, our group also uses the synchrotron source at Argonne National Laboratory and the spallation neutron source at Oak Ridge National Laboratory.

Because the application of X-ray and neutron scattering is so pervasive to many different material systems, the applications to which our research points is endless.

Our current projects are helping to develop high-temperature sensors for the petroleum industry, lead-free piezoelectric materials, new multiferroic materials and devices that can exploit unique magnetic-dielectric-strain interactions, piezo-microelectromechanical systems for microrobotics, and 3-D printing of metals.

MSE: In your brief time at NC State, what have the university and MSE done to help you succeed as a researcher?

Jones: I cannot overstate how much NC State has helped me succeed as a researcher. My first year at NC State was amazing – we've had more research activity and successes (as evidenced in projects funded and papers published) in that year than ever before in my career.

I attribute this productivity and impact to the research infrastructure available within MSE and the AIF, and the blossoming collaborations with my colleagues and the companies on Centennial Campus. I was also very fortunate to bring several of my PhD students and postdocs with me from Florida, which helped immensely in coming up to speed in our new home; I am in debt to them.

Several of our new research projects are the direct result of the new opportunities at NC State: One project is supported by the Center for Dielectrics and Piezoelectrics at NC State, a second project is in collaboration with a faculty member in CBE, a third project is resulting from interaction with the Eastman Chemical Center of Excellence, and a fourth project is a newly funded NSF project to send NC State undergraduate students to Australia for summer research experiences.

MSE: Overall, how many grants have you gotten since coming to NC State, and who have you gotten them from?

Jones: At NC State, I currently have nine sponsored research projects (and hope to have more by the time this goes to print). Five of these projects are sponsored by the National Science Foundation, one by the Army Research Office, two by private industry, one by the National Institute of Standards and Technology, one by the Center for Dielectrics and Piezoelectrics, and one by the American Chemical Society. Altogether, these projects total over $2.1 million.

MSE: Are you involved in any interdisciplinary initiatives at NC State? Which ones, and what is your role?

Jones: I am leading an interdisciplinary team that will compete at NSF for a Science and Technology Center (STC). The STC program is extremely competitive and supports major Center-level efforts across all areas of interest to NSF.

Most of the present STCs are interdisciplinary. Our STC is related to crystallography and atomic structure of matter and is collaborative with faculty members from MSE, mathematics and statistics, education, physics, chemistry, forest biomaterials, and soil science, among others.

It is important to acknowledge that interdisciplinary research is challenging. As our team has grown and we've continued to engage new people from different disciplines, the first conversations are always the most difficult. It is interesting to watch these conversations as researchers attempt to convey deep scientific concepts without aid of their disciplinary jargon.

I am still working to do this consistently and effectively myself; effective communication in an interdisciplinary setting requires a significant amount of situational awareness and adaption. Yet it is a skill that we should all learn.

It has also been interesting to see differences in culture between departments and disciplines, including differences in approaching proposal development and experiment design. Interacting with these individuals from across campus has been a highlight of the Spring 2014 semester! •

AWARDS & HONORS

Faculty Awards

Justin Schwartz, Kobe Steel Distinguished Professor and department head, wins several awards

Schwartz received the NC State Alumni Association Outstanding Research Award.

Schwartz also received the 2014 IEEE Council On Superconductivity Award for Significant and Sustained Contributions to Applied Superconductivity. He is the youngest recipient in the history of the award.

He also received the 2013 Van Duzer Prize, given for the best paper in the *IEEE Transactions on Applied Superconductivity*, IEEE Council on Applied Superconductivity. He received the award along with other NC State students and faculty: MSE Assistant Professor Frank Hunte, MSE post-doctoral researchers Sasha Ishmael and Xiaotao Liu, MSE PhD students Golsa Naderi and Liyang Ye, Electrical and Computer Engineering PhD student Hao-jun Luo, and Electrical and Computer Engineering professor John Muth. They were joined by industrial collaborators at nGimat Marvis White, Natalia Mandazy and Andrew Hunt.

He also received the 2012 Van Duzer Prize, given for the best paper in the *IEEE Transactions on Applied Superconductivity* by the IEEE Council on Applied Superconductivity. The award was awarded in 2014 to Schwartz and to MSE Research Associate Wan-Kan Chan.

Joe Tracy, associate professor, wins Alcoa award

Joe Tracy received a 2014 Alcoa Foundation Engineering Research Achievement Award from the College of Engineering at NC State. The award was given during the College's 2014 spring faculty meeting.

James LeBeau, assistant professor, wins K.F.J. Heinrich Award

The K.F.J. Heinrich Award is presented annually to an outstanding young scientist not yet 40 years old in the year of the award for distinguished contributions to the field of microanalysis. LeBeau was selected for the award, in part, because of his seminal work on making scanning transmission electron microscopy rigorously quantitative.

Elizabeth Dickey, professor, earns Early Career Achievement Award for Alumni of Materials Science and Engineering

The award is given by Northwestern University, where Dickey received her PhD in materials science and engineering.

"Professor Dickey is being honored particularly for her successful advancement of electron microscopy and spectroscopy to understand interfaces in ceramic and composite materials as well as the synthesis of nanostructured materials," according to Northwestern.

Douglas Irving, associate professor, receives two awards including Outstanding Teacher Award from NC State

Irving received the Outstanding Teacher Award, which recognizes excellence in teaching at all levels. Faculty must be recognized as an Outstanding Teacher before they can receive the Board of Governors Award for Excellence in Teaching and the Alumni Distinguished Professor Award. Upon being selected as an Outstanding Teacher, recipients become members of the Academy of Outstanding Teachers for as long as they are NC State faculty. Recognition is given at commencement, Celebration of Academic Excellence, and the Teaching and Learning Symposium.

Irving also received the 2014 MSE Outstanding Young Alum Award from the University of Florida. He holds master's and PhD degrees from the university.

Jay Narayan, John C. C. Fan Distinguished Chair Professor, wins award from The Minerals, Metals and Materials Society

Narayan received the TMS Robert Franklin Mehl Award. This pinnacle honor in materials science was presented at the 143rd TMS Annual Meeting in San Diego.

Narayan was also honored by TMS with the 2014 The Institute of Metals Lecture Award.

He delivered the lecture on Frontiers in Thin Film Epitaxy and Novel Nanostructured Materials in the Symposium on Frontiers in Nanostructured Electronic and Structural Materials and Their Applications, held in his honor at the 143rd TMS Annual Meeting in San Diego, February 16-20, 2014.

He also received the 2014 Mehl Medal from TMS Brazil.

Yuntian Zhu, Distinguished Professor, receives two awards

Zhu received the Albert Sauveur Achievement Award for 2014.

"This award, established in 1934 in honor of a distinguished teacher, metallographer and metallurgist, recognizes pioneering materials science and engineering achievements that have

stimulated organized work along similar lines to such an extent that a marked basic advance has been made in the knowledge of materials science and engineering," according to ASM International, which gives the award.

Zhu received the award, "For pioneering work on the fundamental understanding of deformation physics in nanocrystalline materials," according to his citation.

Zhu also received a 2014 Alcoa Foundation Distinguished Engineering Research Achievement Award from the College of Engineering at NC State.

Linyou Cao, assistant professor, wins two awards

Cao won the Ralph E. Powe Junior Faculty Enhancement Award for 2012 from Oak Ridge Associated Universities.

"The Ralph E. Powe Junior Faculty Enhancement Awards provide seed money for research by junior faculty at ORAU member institutions," according to the organization's web site. "These awards are intended to enrich the research and professional growth of young faculty and result in new funding opportunities."

Cheryl Cass, teaching assistant professor, wins Outstanding New Advising Award — Faculty Academic Advising from the National Academic Advising Association

Dr. Cheryl Cass, director of undergraduate programs and teaching assistant professor, was named the winner of the National Academic Advising Association's (NACADA) Outstanding New Advisor Award — Faculty Academic Advising.

The NACADA annual advising awards honor individuals and institutions making significant contributions to the improvement of academic advising. Cass, along with other award recipients, will be honored at an awards ceremony during the NACADA Annual Conference in the fall. She was also recognized at NC State's Advisor Appreciation Celebration in May.

Since joining the NC State faculty in 2011, Cass has focused on maintaining the quality and benefits of a small department as it tripled its undergraduate enrollment, including giving one-on-one attention to advisees and learning their specific needs and goals. With faculty support, she has increased the flexibility of the academic schedule to allow students time to take advantage of enrichment activities such as studying abroad or participating in a Co-op experience. She also has modernized the advising process by instituting an electronic calendar sign-up and has collected feedback from students close to graduation in search of ways to improve the undergraduate experience.

Ramón Collazo, assistant professor, named fellow

Ramon Collazo, assistant professor in the department, has been named a 2014 American Association of Hispanics in Higher Education Faculty Fellow.

The American Association of Hispanics in Higher Education works to address issues and concerns affecting Hispanics, with a focus on higher education. While the Hispanic population is the largest ethnic minority population in America, Hispanics are still highly underrepresented in the undergraduate and graduate enrollments and graduation rates.

Jerry Cuomo, Distinguished Professor, inducted into the National Academy of Inventors

Dr. Jerome Cuomo, co-inventor of the rewritable magneto-optic disk, has been elected to the National Academy of Inventors (NAI).

Election to NAI Fellow status is a high professional distinction accorded to academic inventors who have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and the welfare of society. Selected by their peers, nominees must be a named inventor on at least one patent issued by the United States Patent and Trademark Office and must be affiliated with a university, non-profit research institute or other academic entity.

Student Awards

E. Ben Callaway won the MSE Senior Award for Scholarly Achievement.

Anku Madan won the MSE Senior Award for Humanities.

Tyler Confrey-Maloney won the MSE Senior Award for Leadership and the Kalypso Wolfpack Innovator Scholarship.

Thomas Humble won the SPE Senior Scholarship Award.

Tedi-Marie Usher won the 2014 Ludo Frevel Crystallography Scholarship from the International Center for Diffraction Data. Usher is part of Dr. Jacob Jones' research group.

Post-doctoral researcher **Dr. Xiahan Sang** is the 2014 Microscopy & Microanalysis Post-Doctoral Award winner. He is part of Dr. James LeBeau's research group.

Golsa Naderi received a graduate fellowship from the IEEE Council on Applied Superconductivity and a best paper prize. She is a member of Dr. Justin Schwartz's research group.

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Structural Materials

Cuomo
carbon capture, material synthesis, thin film synthesis

Koch
nanostructured materials, high entropy alloys, superconducting materials

Rigsbee
physical metallurgy, structure-property relationships, electron microscopy, surface engineering

Scattergood
mechanical properties, nanostructured materials, defect modeling, tribology, precision machining

Zhu
gradient materials, nanostructured materials, nanocomposites, deformation physics, mechanical properties, modeling

Brenner, Dickey, Hunte, Irving, Jones, Patala, Narayan

Electronic, Optical and Magnetic Materials

Cao
2D materials, nanophotonics, catalysts, optoelectronics devices

Narayan
structure-property-processing relationships, thin films, modeling, microscopy, nanomaterials

Collazo
wide bandgap semiconductors, point defects, optics, semiconductor-bio interfaces, optoelectronics, power electronics

Reynolds
III-V and II-VI semiconductor materials and devices, epitaxial thin films, optoelectronics, nanostructures

El-Masry
growth and characterization of III-V and III-N materials, light emitting diodes, solar cells, spin-electronics

Rozgonyi
silicon integrated circuits and photovoltaics, impurity control, wafer defect analysis, mechanical property analysis of wafers

Hunte
correlated electron materials, magnetics, superconductivity, topological insulators, coatings

Schwartz
superconducting materials, magnetic materials, oxides, forensics

Johnson
compound semiconductors, crystal growth, optoelectronic devices, molecular beam epitaxy

Sitar
wide bandgap semiconductors, crystal growth, thin films, interfaces, optoelectronics, power electronics

Kasichainula
composite thin film deposition, multilayer structures, defects and interfaces, modeling thermal and electrical conductivity

Tracy
metal, magnet, and semiconductor nanoparticle synthesis, characterization, self-assembly, composites

Maria
complex oxides, thin film synthesis, plasmonics, transparent conductors, ceramics, ferroelectricity, dielectric materials

Cuomo, Dickey, Irving, Ivanisevic, Jones, Koch, LaBean, LeBeau, Zhu

Soft Materials and Biomaterials

Balik
polymer structure-property relationships, small molecule diffusion in polymers

Cass
engineering and science education

Ivanisevic
biological interfaces to inorganic materials and tissues, surface functionalization and characterization, sensors

LaBean
self-assembling molecular materials, structural DNA nanotechnology, biomolecular engineering

Loboa
regenerative medicine, tissue Engineering, wound healing, mechanobiology of human stem cells

Spontak
polymer morphology, multiphase polymer systems, polymer fibers, shape memory polymers, electron microscopy

Collazo, Tracy, Yingling

Structural Characterization

Dickey
microscopy, ceramics, dielectrics, interfaces

Jones
diffraction, scattering, dielectrics, ceramics, piezoelectric, mechanics

LeBeau
electron microscopy, structure/property relationships, defect analysis, technique development

Balik, El-Masry, Ivanisevic, Koch, Maria, Patala, Reynolds, Rigsbee, Rozgonyi, Scattergood, Spontak, Tracy, Zhu

Computational Materials Science

Brenner
nanostructured materials, clusters, surfaces, tribology, nuclear materials, potentials

Irving
point defects, surfaces/ interfaces, high entropy alloys, electronic materials, wide bandgap materials, oxides

Patala
structural materials, nanostructured materials, materials by design, interfaces

Yingling
self-assembly, surfaces and interfaces, morphology, nanoparticles, biomacromolecules, polymers, complex solvents

Collazo, Schwartz, Sitar

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