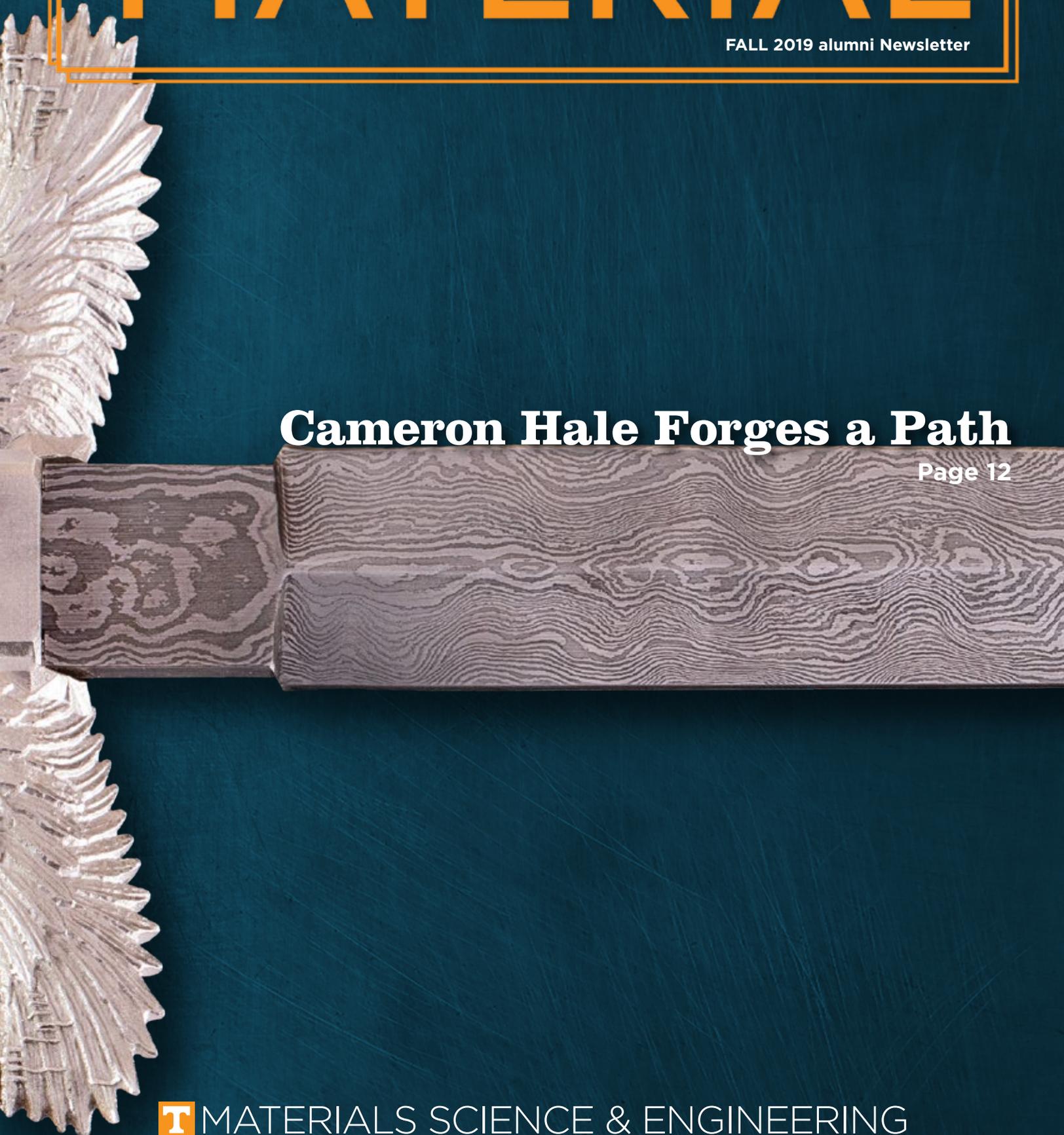


# MATERIAL

FALL 2019 alumni Newsletter

## Cameron Hale Forges a Path

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**T** MATERIALS SCIENCE & ENGINEERING

Inside: A Material Advantage | The Future of MSE | Senior Design Showcase | MSE Goldwater Scholar

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**Photography**  
Randall Brown  
Steven Bridges  
Jack Parker  
Betty Myers

**Printer**  
University Printing and Mail

**On the Cover:** This knife was forged by UT's Bladesmithing Club and won a Most Beautiful Blade Award.

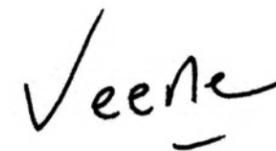
## A Message from the Department Head

What an amazing year it has been for the MSE department! Our students and faculty have gathered multiple accolades and recognition, new faculty members have come on board, our department is soaring in the rankings...there is an undeniable buzz of excitement everywhere you look in UT's materials world!

As department head, there is no greater pride than watching our undergraduate students as they grow into successful scientists and engineers, and be a firsthand witness to their triumphs and achievements. Goldwater Scholar Ian Greeley, Pride of the Southland band member Sara Wonner, and "blacksmith" Cameron Hale are just a handful of the amazing students we can call "ours". Students are the heart of our department, and I am honored to feature some of their amazing stories.

Along with new staff members Tonya Goins (accounting specialist), Tracey Mandrekas (financial specialist) and Gerald Egeland (laboratory manager and safety officer), we proudly welcome three new faculty members to our department: Mahshid Ahmadi, Eric Lass, and Kate Page. Along with their recently hired colleagues Mariya, Haixuan, and Dustin, they show that the future of MSE at the University of Tennessee is indeed very bright!

Please stop by when you're in the neighborhood and witness our excitement for yourself. Not only is it a great time to be in MSE, we are all having a great time!



Dr. Veerle Keppens  
Chancellor's Professor and Department Head  
Department of Materials Science and Engineering



# A Material Advantage

By David Goddard.

Everything made in the world today comes from carefully chosen resources; supplies that have been put to the test at the smallest levels long before hitting the market.

As technology rapidly evolves, it is important for materials researchers to stay ahead of the curve and pave new pathways in everything from medicine to energy. The Department of Materials Science and Engineering (MSE) holds a key place at this frontier of innovation, impacting—in some way or another—not only every other field of engineering, but also humanity itself.

Now celebrating 35 years as an official department at UT, MSE has seen a wave of significant growth and an expansion of research, much of it coming in just a few short years.

## Labs and Equipment

State-of-the-art facilities at the Joint Institute for Advanced Materials, shared between scientists and researchers at UT and Oak Ridge National Laboratory, have helped boost its research portfolio by creating avenues for partnerships in functional materials and devices, structural materials, and hybrid materials.

The acquisition of new equipment has also helped bolster the department, highlighted by the \$3.5 million purchase of two state-of-the-art microscopes. One, a transmission electron microscope, is powerful to observe materials at the atomic level, while the other, a crossbeam microscope, can magnify objects to a scale of 100,000.

## A Rise in the Rankings

MSE surged 14 spots in the 2019 US News and World Report rankings to become the 24th-ranked MSE department among public institutions in the US, tying the likes of UMass and Arizona State University. That ascent was fueled by a rise in peer assessment, the only measure used by US News and World Report in rankings at department levels.

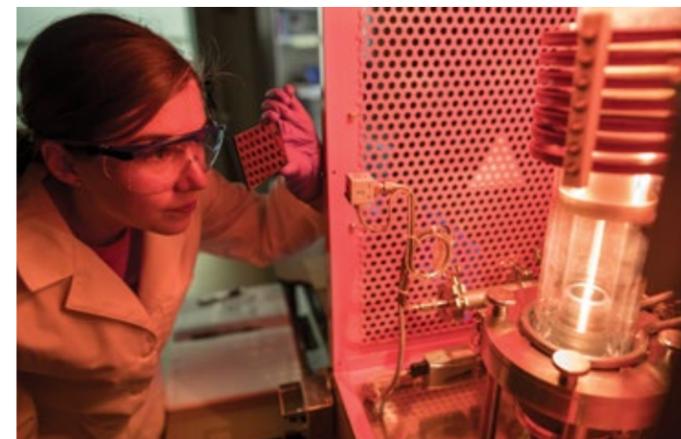
## An Expanding Student Population

The department, like the rest of the college, has seen its student population more than double in the last decade. While graduate enrollment saw a modest increase, undergraduate numbers in materials science have nearly quadrupled, going from 30 in 2005 to 111 in 2018. In addition to growth through traditional channels, the Transfer Success Co-Design in Engineering Disciplines (TranSCEnD) program, spearheaded by faculty from MSE, has helped community college students make the transition to the college.

## Faculty Recognition

In addition to housing the number-one-ranked metallurgy program in the country (p.3), MSE also houses significant research thrusts related to advanced functional materials, materials modeling, and crystal growth, contributing key faculty members to UT's renowned Scintillation Materials Research Center (SMRC). Assistant Professor Mariya Zhuravleva (p. 6) and Research Associate Merry Koschan, who both work with SMRC, were recently named president and secretary, respectively, for the American Association for Crystal Growth.

MSE's expertise is also often seen in the number of times work in the department has been cited by researchers elsewhere, with Jerry and Kay Henry Endowed Professor David Mandrus annually making the list of most cited researchers in the world.



## UT's Metallurgical Expertise Ranked First in US, Sixth in World

The department recently picked up a major recognition when the Academic Ranking of World Universities named its metallurgical engineering discipline the top program in the US and sixth in the world for the second year in a row.

"It is always nice to gain recognition for the hard work that our researchers have done," said Department Head Veerle Keppens. "This is validation of our faculty's efforts in this important field."

Students can take metallurgy-related classes at both the undergraduate and graduate levels, with coursework including phase transformations, mechanical behavior, and welding metallurgy.

The department is barely outside the top five worldwide—just one point in total score behind Northwestern Polytechnical University in Xi'an, China. The next highest ranked US institution came in at 11.

The rankings are based off of several criteria: the number of papers authored and published in top journals, the ratio of papers cited to the average citation of papers, the number of international collaborations, and the number of significant awards won by faculty.

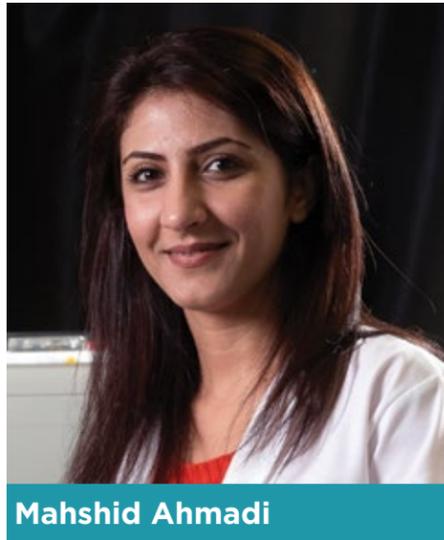
While the department did well across the board, it was number one in the world in the citation category with a score of 100, outperforming the Massachusetts Institute of Technology, Germany's University of Bochum, China's City University of Hong Kong, Taiwan's National Tsing Hua University, and Russia's Belgorod State University.

"The recognition the ranking brings is nice enough, but to have our work cited by so many other experts shows that we're a leader in this area, with faculty that others turn to for expertise," Keppens said. "Together, they have helped position us as a key player."

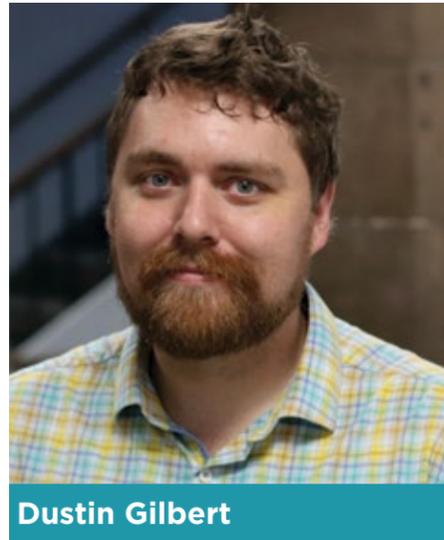
The Academic Ranking of World Universities is now in its 16th year and is recognized in the higher education community as a trusted source for comparing academic offerings.

# THE FUTURE OF MATERIALS SCIENCE

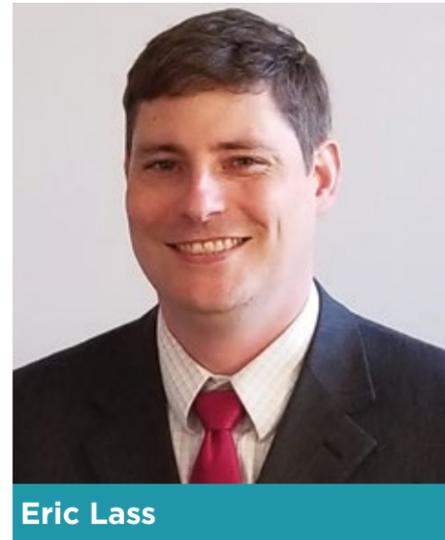
# & ENGINEERING



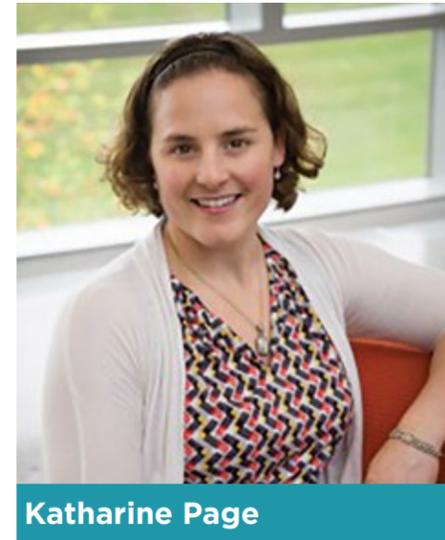
**Mahshid Ahmadi**



**Dustin Gilbert**



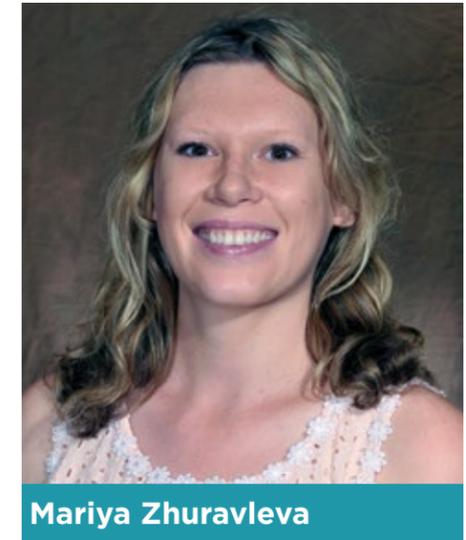
**Eric Lass**



**Katharine Page**



**Haixuan Xu**



**Mariya Zhuravleva**

*By Randall Brown.*

The roster of junior faculty in MSE shows off waves of new expertise in materials at UT.

Assistant Professor **Mahshid Ahmadi** joined MSE in 2015 as a postdoctoral researcher and has moved up the ranks to tenure-track assistant professor in 2019. Her vision is to harness the potential of the hybrid organic-inorganic perovskites for optoelectronic applications via understanding their fundamental physics and chemistry and learning how to synthesize them and use them for device designs.

“I’m very passionate about transforming technologies through the development of new high-performance and non-conventional materials with the potential to change the way we architect opto- and electronic devices,” she said.

Ahmadi works with research colleagues in MSE and at ORNL aiming to accelerate the discovery rate for hybrid organic-inorganic perovskite material by laboratory robotics systems. She also looks for ways to involve students in her research and inspire them toward innovation as she has felt inspired by her own teachers and colleagues.

Assistant Professor **Dustin Gilbert** came to MSE in 2018 from a position with the neutron scattering facility at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland.

“Outside of NIST and school, I worked at Seagate building hard drives and the US Naval Postgraduate School building railguns,” he said.

Gilbert brings this varied background to his current work in nanotechnology, focusing on magnetism and spin phenomena. He uses neutron scattering and X-ray spectroscopy as specialized tools to glean detailed information about these materials.

“This field impacts your daily life in the development of hard-drive technologies and permanent magnets (for generators and electric motors) and will continue to impact it with new fields, such as spintronics, quantum computing, and topological materials,” said Gilbert.

**Eric Lass** is one of two new assistant professors to join MSE this fall. Like Gilbert, he comes to UT from NIST, where he spent 10 years, first as an NRC postdoctoral research associate, then as a member of the permanent staff.

Lass researches phase transformations and microstructural evolution, primarily in metals and alloys, applying computational thermodynamic and kinetic modeling tools to understand why and how materials microstructures develop. The knowledge gained from such investigations is then applied using an integrated computational materials engineering approach to design alternative processing protocol for existing materials and entirely new materials with improved performance or novel combinations of materials properties.

In his career, Lass earned the Henry Marion Howe Medal from ASM International and the MPMD Young Leaders Professional Development Award from TMS. He held an NRC Postdoctoral Fellowship from 2009 to 2011 and is a member of TMS, ASM International, and the Materials Research Society.

**Katharine Page** joined the department in August as an assistant professor whose research is situated at the intersection of functional energy materials research and the advancement of x-ray and neutron scattering methods. Before joining UT, she worked at the Spallation Neutron Source at ORNL.

Page is particularly interested in exploring the boundaries of modern materials characterization and its roles in the discovery and optimization of new materials phenomena. She has a passion for mentoring undergraduate researchers, aiming to involve students of all levels in multidisciplinary research within her lab.

Page received a 2019 Presidential Early Career Award (p. 10), a 2015 DoE Office of Science Early Career Research Program Award, the 2018 Neutron Scattering Society of America Exceptional Service Award, and has published in numerous professional journals.

Associate Professor **Haixuan Xu** joined MSE in 2013 after working as a postdoctoral researcher with ORNL’s Center of Defect Physics in Structural Materials.

Xu is the recipient of Early Career Awards from both the DoE and NSF. He investigates defect evolution and deformation mechanisms in advanced structural alloys, electromagnetic coupling and flexoelectric effects in heterostructured complex oxides, materials for neuromorphic computing, and mesoscale simulations methods.

Assistant Professor **Mariya Zhuravleva** joined MSE as a research assistant professor in 2011, and was named assistant professor in 2015. She teaches an undergraduate course on thermodynamics and an introduction to materials science and engineering, and a graduate course on scintillator materials and crystal growth.

Her work on the development of novel functional materials uses innovative growth techniques such as the micropulling-down technique (p. 6). Her research has important applications in areas from radiological medicine to nuclear security.

“I have been very fortunate to have colleagues like Chuck Melcher and Merry Koschan at the SMRC,” said Zhuravleva. “They provide a fantastic environment, with a team of faculty, research staff, and students all working together on cutting-edge research projects. This experience has allowed me to perfect my expertise in crystal growth and scintillation materials, and to become a successful researcher.”



## Crystal Clear Improvement

By David Goddard. Photography by Jack Parker.

**Getting a job after college is just a mundane next step in life for many.**

**For Assistant Professor Mariya Zhuravleva, it was a bit more exciting.**

“It was my dream come true to come here to UT and work in the Scintillation Materials Research Center,” Zhuravleva said. “SMRC has a strong reputation in our field, so I jumped at the opportunity to come here and do post-doctoral work, develop my skills, and work with the people whose papers and research I had studied.”

The center is an internationally recognized research facility for the discovery, synthesis, and characterization of new materials for use in radiation detection.

Now in her eighth year working at MSE and with SMRC, Zhuravleva has helped strengthen and extend UT’s reputation through her work in crystal growth.

Historically, one of the biggest impediments to the improvement of crystal development is the slow nature of how they form, but Zhuravleva and her coworkers are working hard to change that.

One of her notable achievements at UT has been introducing—for the first time in any US academic setting—a technique known as micro-pulling-down, something that could reduce crystal growth times for exploratory research.

“Most growth techniques have limited applicability to complex materials systems, but micro-pulling-down takes advantage of gravity to greatly speed

up the process and to uniformly distribute ions into crystals, which is important to discover the desired characteristics of the crystals,” said Zhuravleva, who was recently named an NSF Early Career Award winner for the breakthrough.

She is working toward advancing the field of crystals growth of emerging functional materials that could not be previously synthesized using conventional methods.

One element that sets UT apart from other institutions and facilities around the world is that both the testing and characterization research and technology exists in the same space at SMRC.

“When I was doing my doctoral work in Japan, we had to send our samples to the Czech Republic for testing,” Zhuravleva said. “That was obviously not ideal, and it is that way in a number of locations. Because the machinery, technology, and expertise are all housed together at UT, we can significantly increase the rate of development because we can test what we are doing pretty much as we are doing it. That’s a major advantage.”

The crystals Zhuravleva and her colleagues grow feature a property known as scintillation, meaning they emit light when in the presence of radiation, giving them promise in areas as diverse as radiological medicine and nuclear security.

Their goal is to develop next-generation materials to help better detect and protect against possible terrorist acts, meaning Zhuravleva’s improved production rate doesn’t just save time, but could also save lives.

## Marching Toward Success

By Adria Amos. Photography by Betty Myers.

When Sara Wonner auditioned for the UT Pride of the Southland Marching Band and the Lady Vols’ Basketball Pep Band, she didn’t anticipate her band experience would help with her MSE studies. But pursuing a demanding undergraduate degree while also playing trumpet in the prestigious program forced Wonner, now a senior, to be intentional with her time.

“Over the past three years, my time management and organizational skills were tested by my commitment to band, and because of this challenge, my skills in these areas improved,” she said.

She has played the trumpet about ten years, starting in middle school in Dickson County, Tennessee. As high school graduation approached, she found she wasn’t ready to leave music, and the community that comes with being in band, behind.

“I’m glad I decided to do band in college because the friends and experiences I have made throughout my years in band have shaped who I am today. It is 100 percent one of the best decisions I’ve ever made,” she said.

Wonner, who is also pursuing a minor in mathematics, said the MSE department has been very supportive of her participation in band. When she pointed out a scheduling conflict between a required class and band practice, which would have prevented her from playing in the band her senior year, Department Head Veerle Keppens worked with faculty and staff to get the class rescheduled.

“The department going to that length to accommodate me speaks volumes, and I will always be so thankful for the department for granting me my final year in Pride,” Wonner said.

Band and engineering classes aren’t the only demands on her time. In the spring, Wonner joined UT’s Materials Bowl team and competed at the Minerals, Metals &

Materials Society’s Annual Meeting. The team fought its way to the final round, where it lost to the defending champions from Colorado School of Mines. She said achieving second place was still “an amazing moment” and the team hopes to take home first-place in 2020. She also is a member of Tau Beta Pi, the engineering honor society.

In addition, she spent this summer interning at Oak Ridge National Laboratory as part of its Science Undergraduate Laboratory Internship program. She worked in the nuclear structural materials group in the materials science and technology division studying tungsten-steel laminate composites, which consist of alternating layers of tungsten foil and steel foil.

“I was primarily involved in the fabrication process. The composites that I helped fabricate will eventually be machined into tensile test bars to be evaluated,” she said.

The internship has inspired her current post-graduation plans. She intends to pursue a PhD in either MSE or nuclear engineering. Whichever path she chooses, she said she will study nuclear materials in the context of their use in reactors.

Until graduation, though, you will find Wonner pursuing both her passions in engineering classrooms, Neyland Stadium, and Thompson-Boling Arena.



# Military Vets Maneuver *into Materials*

Writing and Photography by Randall Brown.

Jeremy Long and Jared Floyd traveled the world while serving in the US military and both were drawn to materials science and engineering for their post-military careers.

Long, a sophomore, was a machinist's mate auxiliary man on the USS Connecticut. He came to know the submarine extremely well.

"I worked on pumps, valves, piping, and everything else that went along with keeping those systems running," he said. "Keeping the boat habitable for people while we were underwater."

He popped up in some very different scenarios during his multiple deployments, sometimes literally.

"In the Navy, I went on two West Pacific deployments and ICEX 2011, where I surfaced at the North Pole," Long said. "Going from a submarine, which is claustrophobic for most people, and just enclosed at the best of times, to the Arctic surface, which is mostly flat ice as far as you can see, was jarring and beautiful."

Long enjoyed his work, but "crawling all over a submarine" for years took a physical toll on him. He decided to go back to school, give his body a rest, and let his brain do more of the work. Materials engineering caught his imagination.

"As I learned how materials was all on the cutting edge of research, I knew that was where I wanted to be," he said.

Long's interest is in biomaterials, and he sees a likely future in industry. He also doesn't rule out an academic or research institute career, wherever that might take him.

"It's more important to me to be doing work that is important to me and helpful for the future than where I am," said Long. "I've loved living in Knoxville, but I'm happy just about anywhere and I'm interested in living overseas if the opportunity presents itself."

Floyd, a senior from Concord, North Carolina, spent nine years in the Air Force and finished as a Staff Sergeant. He saw deployment in both Afghanistan and South Korea.

"My job was repairing anything metal or composite—fiberglass, carbon fiber, etc.," he said. One memorable repair took place after an aircraft was hit by a mortar at Bagram Air Base, Afghanistan.

"We were in a remote enough place that we could not get many supplies or equipment needed, other than the parts



(L-R) Jared Floyd and Jeremy Long.

that had to come from the manufacturer of the aircraft," he said.

Even in the tough location, Floyd was able to complete the repairs ahead of schedule and with limited resources. These repair experiences built his curiosity about the materials used to get aircraft back off the ground.

"I worked with all kinds of materials," said Floyd. "I got tired of asking 'why are we using this material for this repair?' and being told 'just because,' or 'that is what the engineers say,' or worse. I decided to become one of those people that tells others what to use but also to tell them why."

His journey to becoming one of those people led him to his current research focus on thermoelectric functionally graded materials.

"I would not mind getting a job in some kind of production role," said Floyd. "I have worked with some metal 3D printing and powder metallurgy while doing my research on functionally graded materials."

Beyond that, he maintains an open range of interests for applying his MSE education.

"Working in material testing also interests me," he said. "Testing breaking loads for new materials for bridges, or testing the capabilities of new armor for military and law enforcement personal. Or something with nuclear fuel, however that may be achieved."

Both gentlemen move forward with a strong blend of practical field knowledge and in-depth research to represent MSE and the Vol Spirit as proudly as they served their country.

# Engineering Vols Compute the Switchgrass Harvest

By David Goddard.

Researchers who work in a computational setting don't often get to enjoy a field day. However, a group of Engineering Vols recently found a way to step away from their screens and get up close and personal with some organic materials.

MSE Professor David Keffer and team use computational modeling to offer complementary insight into the processing-structure-property-performance relationships of the materials in an ongoing study spearheaded by Professor David Harper at the UT Center for Renewable Carbon within the Herbert College of Agriculture.



Dayton Kizzire and Lu Yu hands-on harvested switchgrass for their research on developing high-value materials from renewable resources.

Harper, who has a joint faculty position in MSE, seeks to develop high-value materials from renewable resources, including switchgrass and other lignin-based feedstocks. In recent years, his group has synthesized nanostructured carbon composites for use in such applications as battery anodes.

Keffer's graduate research assistants joined their ag-campus colleagues in a day of switchgrass harvesting to get a more tactical feel for the data.

"Harvesting switchgrass was definitely a different experience from what I normally do," said Valerie Garcia-Negrón. "It made me realize how exciting and important it is to be in the field doing hands-on activities. Working with switchgrass helped our group obtain a holistic view of the project's processing phases: harvesting plants, extracting lignin, converting lignin into carbon products, and modeling the carbon samples at the atomic- and meso-scales."

Dayton Kizzire felt an "overall completeness" in the hands-on harvest in a way that doesn't always output in computational work.

"Protecting the environment has always been a passion of mine," said Kizzire. "Using sustainable resources to solve energy needs by growing and harvesting our own switchgrass to create high-performance battery parts has been very rewarding."

Lu Yu enjoyed the outdoor activity, collaboration, and face-to-face interaction with her MSE colleagues.

"It is work but lots of fun," said Yu. "We told jokes, played some music, and also took funny pictures. We cut and chopped really quickly and also came across some problems with the machine. But we worked together and solved them with the help from center staff."

The experience also served as a team building activity for the group, and a motivation to continue performing innovative research.

"Overall, we had lots of laughs and fun while harvesting switchgrass," said Garcia-Negrón. "Also, I realized that my grass-cutting skills need improvement—trimming bushes at home is nothing compared to cutting switchgrass; however, with the help of Lu and Dayton, we were able to manage the work by taking turns. In the end I was impressed with how quickly we gathered the switchgrass."



Valerie Garcia-Negrón gathers an armload of switchgrass for renewable carbon research. She is working to determine how the choice of different feedstocks, including switchgrass, impacts composite structure and thus battery performance.

# Faculty News



Recent work from Assistant Professor **Mahshid Ahmadi** was published in the Energy and Environmental Science Journal, a leading peer-reviewed scientific journal. The published paper, “Deep levels, charge transport and mixed conductivity in organometallic halide perovskites,” is the result of a joint project with a physics research group at Charles University in Prague.



Jerry and Kay Henry Endowed Professor **David Mandrus** was one of eight people at UT to make Clarivate Analytics 2018 list of the world’s most cited researchers. He also made the list in 2017. Mandrus leads a group focused on discovering and characterizing new quantum materials and holds a joint appointment with ORNL.



Assistant Professor **Katharine Page** received a 2019 Presidential Early Career Award, the highest honor given by the US government to outstanding scientists and engineers beginning their independent careers who show exceptional promise for leadership in science and technology. She received the award for her work in “determining the effects of nanoparticle size and shape on local short-range atomic structure using neutron total scattering data, which has opened new frontiers in the understanding of the unique properties of these materials.”



**Haixuan Xu** has been promoted to associate professor with tenure. Xu is director of the Ocean group, which focuses on the fundamental understanding of structure-property relationships and computational design of materials for various energy applications. In 2018, Xu was one of 84 scientists from across the nation to receive a DoE Early Career Award in support of his research. He also received an NSF Early Career Award in 2017.

## New Staff Join MSE

By Kathy Williams.  
Photography by Randall Brown.



**Tonya Goins** joined the department last September as an accounting specialist II. Her peers are what Goins likes best about working in MSE.

“We have amazing students, faculty, staff, and upper management in the department.”

Before coming to UT in 2016, Goins was a low-income housing property manager for 15 years. In her spare time, Goins enjoys reading her bible, spending time with her family, and tending to her organic garden.



**Tracey Mandrekas** joined the department last November as a financial specialist I.

“It is a pleasure to work with the awesome staff, students, faculty, and department head in this department.”

“Before moving to Tennessee in October 2015, and beginning employment with UT in February, 2016, I was an employee at the University of Florida for 15 years, but don’t hold that against me! My husband and I love Tennessee.”

Mandrekas enjoys taking nature walks, reading and spending time with her family.

## 2019 MSE Department Awards

At the MSE Awards Banquet this spring, faculty, students, and alumni were honored for their significant dedication to service, teaching, research, and the profession.

### Awards presented:

Faculty Award for Excellence in Teaching:  
**Dustin Gilbert**

Faculty Award for Research:  
**Haixuan Xu**

Faculty Award for Service:  
**Claudia Rawn**

Outstanding Staff Award:  
**Hannah Swan**

Joseph E. Spruiell Award for Excellence in Research:  
**Yongtao Liu and Wei Zhang**

Graduate Student Award for Excellence in Service:  
**Camera Foster**

Graduate Student Award for Excellence in Teaching:  
**Grace Pakeltis**

Raymond A. Buchanan Award for Outstanding Junior:  
**Ian Greely**

E. Eugene Stansbury Award for Outstanding Senior:  
**Bradley Straka**

Roberto S. Benson Undergraduate Student Award for Excellence in Research:  
**Logan White and Sabrina Schwerzler**

Undergraduate Student Award for Excellence in Service:  
**James Lee and Natalie Wieber**

Extracurricular Excellence Award:  
**Cullen Pearson**

Hall of Fame Inductee:  
**John Banker**



Professor Yanfei Gao, who accepted an award for Wei Zhang, poses with Camera Foster, Grace Pakeltis, Yongtao Liu, and Department Head Veerle Keppens.



Professor and Associate Department Head David Keffer, Natalie Wieber, Logan White, Sabrina Schwerzler, Cullen Pearson, and Keppens.



Keffer and Keppens pose with faculty award winners Claudia Rawn, Haixuan Xu, and Dustin Gilbert.

## MSE Faculty and Staff Receive College Awards

Several MSE faculty and staff received awards at the Tickle College of Engineering’s Spring Banquet. Award recipients were:

Outstanding Support Staff Award:  
**Carla Lawrence**

Leon and Nancy Cole Superior Teaching Award:  
**Hahn Choo**

TCE Outstanding Faculty Service Award:  
**David Keffer**

TCE Research Achievement Award:  
**Bin Hu**

TCE Professional Promise in Research Award and Dean’s Junior Faculty Research Excellence Award:  
**Mariya Zhuravleva**

TCE Research Achievement Award:  
**Peter Liaw**

TCE Award for Translational Research:  
**Chuck Melcher**

## Keppens Named Chancellor’s Professor

Department Head Veerle Keppens has been selected as a University of Tennessee, Knoxville, Chancellor’s Professor. The appointment began September 1, and will continue for her remaining tenure at UT.

This professorship is the highest lifetime honor that can be awarded to a UT faculty member and recognizes individuals with distinguished records of research or creative achievement as well as a record of excellence in teaching and service to the university.

The appointment includes a one-time research stipend of \$20,000 that Keppens plans to use to upgrade equipment in her lab, and she will meet periodically to advise the Chancellor, Provost, and Vice Chancellor for Research and Engagement on matters of concern to the campus.



# Forging A Path



*By Cameron Hale. Photography by Steven Bridges.*

Like many students, I would occasionally day-dream in class, and I remember one day when we were discussing the Iron-Carbide phase diagram and forging in my Introduction to Materials Science class. Naturally, my mind began to wander to blacksmithing, and the idea stuck with me for days, weeks, even months. I began to look up forging videos, ordering books on blacksmithing, and even doing quick sketches until one day my sophomore year, I impulse-bought a small gas forge online.

At this point, I had no experience and no other equipment, but I began to purchase the minimal amount of equipment for the cheapest amount I could and started to make knives in my garage out of pieces of scrap steel. I then joined the Clinch River Blacksmithing Guild, which meets every month in Knoxville and allowed me to see, in person, what a professional blacksmith looks like. However, their emphasis on bladesmithing was weak and I was still curious.

After a few months, I decided I'd ask around the MSE department to see if anyone else was into blacksmithing and Senior Lecturer Chris Wetteland directed me to fellow student Cullen Pearson. Cullen had been forging for years and was enthusiastic about someone else sharing the interest. He also discussed the frustration of not having any good groups or outlets to forge at in Knoxville. Around the same time, there was some hype about the Minerals, Metals & Materials Society (TMS) conference, specifically their bladesmithing competition, and I expressed interest in it. Cullen suggested that we assemble a group here and compete, which I loved.

We spent the next semester or so getting all the administrative and technical aspects sorted out and finally created the Bladesmithing Club at UT! The goal was to participate in TMS and submit a blade that UT could be proud of, while simultaneously creating a place where students who are interested in metalworking could try it out. The reception was massive, and around forty students showed up to our first meeting. With the help of Fuad Accawi, a master bladesmith who works in Oak Ridge, we were able to forge a beautiful blade for TMS, winning the Most Beautiful Blade Commendation at the conference.

## Faculty Q&A: An interview with Philip Rack

By MSE Grad Student Grace Pakeltis. Photography by Randall Brown.

**Philip D. Rack is a professor, the Leonard G. Penland Chair, and associate department head of MSE. A UT faculty member since 2001, he investigates emergent properties of nanoscale materials and devices, combinatorial thin film processing, fabrication of nanoscale devices, and nanoscale-focused electron, ion, and photon beam induced processing.**

### How did you get interested in materials science?

I guess you could say the apple does not fall far from the tree as my dad is a retired MSE professor at Clemson University. I actually declared mechanical engineering as a freshman, but took a one-hour introduction course (in materials science) out of curiosity and I was hooked.

### What interests you most about materials science?

I think the thing that intrigues me the most about MSE is that it is the conduit of the pure sciences to the engineering disciplines. Thus, I get to struggle with some very fundamental aspects of chemistry/physics/biology and apply this understanding to solve real world problems.

### What part of your job do you find most rewarding?

Definitely the “ah-ha” moments. Whether it is something I have studied for 25 years, or watching a student finally ‘get it’ in my Introduction to Materials Science and Engineering course, or the graduate student who has a breakthrough in his/her research. Seeing the lightbulb go off is very invigorating.

### What do you consider your biggest research accomplishment so far?

Wow, this is a tough one—almost like asking me which of my seven children are my favorites. Probably one of the areas our group has made the biggest impact in is nanoscale-focused electron-beam-induced synthesis. From computer modeling and detailed experimental work to industrial applications with companies like Intel Inc., this area has been a good ride. It is an interesting story, however, about not despising small beginnings (cf Zechariah 4:10); but that is another story.

### What do you do in your spare time?

Most of my spare time is spent with my family. As I mentioned my wife, Karen, and I have seven kiddos ranging from 22 to 4—our oldest just graduated from UT nursing. We are also very involved in our church,



Pakeltis and Rack

Cornerstone Church of Knoxville, and I am also the faculty sponsor for the campus ministry Volunteers for Christ. Beyond that, I also try to exercise daily, which encompasses some weights, jogging, and chasing after my kids.

### What have been the highlights of being in the MSE department?

Well, one of them just happened recently as our department was ranked the 24th best public MSE department in the nation. This represents a lot of hard work by our faculty and staff and it is very rewarding to finally have our department’s excellence be recognized by our peers. Beyond that, I am very thankful for my colleagues and students, as I love my job. Our department is particularly collegial and close-knit—probably because we are a smaller department.

### Of the classes you’ve taught, which one was your favorite?

I still enjoy teaching our Introduction to Materials Science and Engineering course. I enjoy going back to the basic building blocks and trying to lay a strong foundation for the students. While it is a tough course for the students because of the depth and breadth of the material, it is fun to help them see the impact that MSE has and will continue to have on our world.

## Rui Feng:

In Pursuit of what’s new  
—and useful



By Meghan McDonald. Photography by Randall Brown.

“I have a curious heart,” Rui Feng said. The natural curiosity that drives Feng to look beneath surface appearances has served him well as a PhD candidate in MSE. For the past five years, Feng has investigated novel high-performance materials called high-entropy alloys (HEAs). These materials, which could potentially overcome age-old challenges in alloy development, offer Feng numerous avenues to seek new knowledge.

Feng came to Tennessee from China, where he completed his masters and worked as a research assistant at Shanghai Jiao Tong University. He chose to pursue a PhD because, he said, “I wanted to learn new things and, more fundamentally, how to control and tailor material to be useful ... [so that] it can compete with conventional materials.”

In a stroke of good timing, Feng started his PhD at about the same time that HEAs were becoming a hot spot in research. “I’ve experienced the whole period,” he said.

“Since the Bronze Age, humans have been altering the properties of materials by adding minor alloying elements into a base element,” he explained.

Using this method, the options for new materials are limited. In contrast, HEAs are typically made with roughly equal amounts of four or more elements.

“With this new strategy,” Feng said, “we have more choice, more opportunity to design new materials. My key research work is to develop a new generation of energy-efficient, low-cost, and light-weight alloys for high-temperature applications by utilizing the concept of HEAs, which can compete with the traditional nickel-based superalloys,” he said.

Feng prioritizes materials with real-world applications, and this certainly fits the bill.

“The importance for reducing energy consumption and the emission of CO<sub>2</sub> has never been greater,” he said.

Feng’s research group combines experimental and modeling approaches in order to understand materials from the atomic scale up to the macro—and so more effectively tackle the ever-present challenge of making materials that are simultaneously light, strong, and ductile.

Feng has done modeling, but he mostly works on the experimental side and manages the Mechanical Testing Lab (MTL), where they run tests including tension, compression, fatigue, and creep.

“We have huge opportunities here to learn,” Feng said, giving credit to UT’s facilities and its proximity to ORNL. “If we have some new idea, we can directly demonstrate it.”

Feng used the ORNL Spallation Neutron Source in research that earned him the international Ludo Frevel Crystallography Scholarship in 2019. He also noted the importance of the people he works with:

“Many very excellent collaborators encourage and support me. My advisor, Peter K. Liaw, also always supports me.”

As Feng nears completion of his dissertation, he’s thinking about what’s next.

“I would like to do research and development,” he said, “but it doesn’t matter if it is academic or in industry if it can make some difference to material development.”

# Student News

**Yuan Li** (PhD) won this year's TMS Best Paper Award, which will be presented at the TMS 2020 Annual Meeting and Exhibition in San Diego, California, next February. The title of his paper is "In-situ real-time neutron diffraction studies of dynamic recrystallization and texture evolution during friction stir processing of a Mg alloy."



**Natalie Wieber** (Sr.) received the 2020 Materials Processing and Manufacturing Division Scholarship from TMS, which will be awarded at the TMS Conference next February in San Diego, California. The \$2,500 scholarship is awarded to students majoring in metallurgical and/or materials science and engineering with an emphasis on manufacturing from product design to production, integrating process control technology into

manufacturing, and basic and applied research into key materials technologies that impact manufacturing processes. Weiber also received the Battelle Matching Scholarship, which matches technical division TMS scholarships dollar for dollar. She will receive a Battelle Materials Graduate Student Award if she attends graduate school and continues studies in a materials-related field.



**Logan White** (Jr.), who works with Associate Professor Hahn Choo, won the 2019 Robert L. Snyder Student Travel Award sponsored by the International Centre for Diffraction Data. The award allowed White to attend this year's Denver X-ray Conference where he gave an oral presentation. The title of his talk was "In-situ synchrotron x-ray computed microtomography and diffraction investigation of deformation and fracture behavior in a laser powder bed fusion processed 316L stainless steel."

## MSE Team takes 2nd

This spring, a team of MSE undergraduate and graduate students won second place in the TMS Materials Bowl and received \$500 for their Material Advantage student chapter. The materials-themed knowledge and trivia

competition was held at the TMS Annual Meeting in San Antonio, Texas. Team members were **Sarah Wonner, Rakesh Kamath, Eli Darby, and Connor Stephens.**

PhD students **Dayton Kizzire**, Bernadette Cladek, Valerie Garcia-Negron, and Clifton Sluss presented their research at the 2019 Meeting of the Southeastern Theoretical Chemistry Association in May. Kizzire's poster was selected as a winning poster in the competition.



## MSE Undergraduates Awarded for Excellence

Three MSE undergraduate researchers received an Award of Excellence at the Exhibit for Undergraduate Research and Creative Achievement (EURCA) poster competition this spring. Awardees were:

**Quinton Wright**, "Synthesis and Characterization of High-Entropy Perovskite (GdLaNdSmY)MnO<sub>3</sub>" advised by Department Head Veerle Keppens.

**Logan White**, "Investigation of the effect of laser power on defects, texture, and tensile behavior of additively manufactured 316L stainless steel using in-situ synchrotron x-ray computed tomography and diffraction", advised by Professor Hahn Choo.

**Cotton Pekol**, "Developing a Method for Testing Tackiness of Bituminous Tack Coats", advised by Senior Lecturer Chris Wetteland.

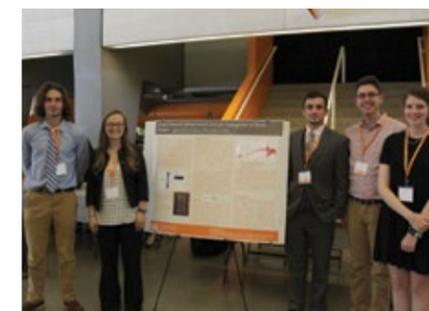
# Students Participate in College-Wide Senior Design Showcase

**Five teams of engineering students from MSE participated in the college's inaugural Senior Design Showcase at Thompson-Boling Arena on April 24. Over 125 team projects, representing all eight engineering departments, were on display at the event.**

**The showcase provided an opportunity for students, faculty, sponsors, and guests to come together and celebrate the completion of the open-ended projects our students have worked on.**



Susan Schickling, Amy Godfrey, Codi Ferree, Hannah Robinson, and Andre Hillsman.



Cody Knight, Samantha Trimble, Austin Henson, Andrew Howell, and Emma Berry.



Sabrina Schwerzler, Bradley Straka, Nicholas Carter, and Briar Faulkner.

## Material Characterization of Flexible Packaging Thin Film Polymer Composites

**Team Members:** Maryam Alsukairi, Mohammed Alhejaili, Samantha Solis, Samuel Cormany, Breanna Ellis

**Advisor:** Kurt Sickafus

**Sponsor:** Sonoco Products Company

**Summary:** The team developed a tool through material characterization to aid machine operators in the determination of adequate tension and heat settings for the printing of thin film polymer composite flexible packaging.

## TixZr(1-x)N Thin Films for Advanced Plasmonic Materials

**Team Members:** Susan Schickling, Codi Ferree, Andre Hillsman, Amy Godfrey, Hannah Robinson

**Advisors:** Philip Rack, Jason Fowlkes

**Sponsor:** The Joint Institute for Advanced Materials

**Summary:** The team utilized combinatorial reactive thin film sputtering to create a TixZr(1-x)N thin film for the application of advanced plasmonic materials. This was accomplished by characterizing the as-deposited composition, nanostructure, and optical properties of a TiN and ZrN binary and TixZr(1-x)N ternary ceramic films.

## The Waterphone: A Study of Processing-Structure-Property-Performance Relationship

**Team Members:** Nicholas Carter, Briar Faulkner, Sabrina Schwerzler, Bradley Straka

**Advisor:** David Keffer

**Sponsor:** Department of Materials Science & Engineering

**Summary:** The team investigated the properties that affect the sound of the waterphone. The waterphone had to be affordable and appealing to look at.

## Determining the Effect of a Humid Environment on Cable Aging

**Team Members:** Max Neveau, Cameron Hale, Ethan Blount, Darby Ker, Jeremiah Petty, Noah Schaftlein

**Advisor:** Kurt Sickafus

**Sponsor:** Analysis and Measurement Services Corporation

**Summary:** The team examined cable insulation made from cross-linked polyethylene (XLP) and ethylene propylene rubber (EPR) to provide a better understanding of the mechanisms behind cable aging, embrittlement, and other environmental failures. They performed high and low humidities testing to simulate light water nuclear reactor environments.

## Deployment of Strain Gauges for In-situ and Permanent Monitoring of Pressure Experiments

**Team Members:** Alyssa Lindsey, Andrew Howell, Austin Henson, Cody Knight, Emma Berry, Samantha Trimble

**Advisors:** Claudia Rawn, Veerle Keppens

**Sponsor:** Oak Ridge National Laboratory

**Summary:** The team selected a set of gauges and a corresponding adhesive that was used to compose an active feedback system. The system was assembled into a bridge circuit and utilized the Control System Studios (CSS) computer interface as a means of communication. The final product aimed to measure the forces of cryogenically exposed pressure cells as they are in the ORNL Spallation Neutron Source.

By David Goddard. Photography by Randall Brown.



Ian Greeley has been ever-present during his time with MSE, helping out in various research capacities, with the Scintillation Materials Research Center (SMRC), and by working on developing methods of energy storage.

As a sign of his prowess as a scholar, Greeley was named a Goldwater Scholar, widely thought of as the most

prestigious undergraduate scholarships in STEM-related fields—one of only two so honored at UT for 2019–20.

“I was, obviously, very happy when I found out I had been selected,” said Greeley, now a senior. “This whole process has helped not only validate the work I’ve done, but has also given me focus on what I want to do in the future.”

Greeley credited the opportunity to work on departmental projects as a major factor in helping him earn the award, noting that the hands-on experience with equipment was something he found invaluable to understanding classroom concepts.

“I think the trust that this department gives to its students to conduct experiments, to use state-of-the-art machinery and instruments, and to take on research is fantastic,” Greeley said. “And it isn’t just that they let you do those things, but rather that they encourage you to do them. I learned a lot thanks to that trust.”

With SMRC, Greeley focuses on novel scintillators—materials that glow in the presence of radiation—making his research valuable across a spectrum of fields. Now in his third year with the center, he is working to optimize the ability of scintillators to collect light.

Greeley also interned with ORNL where he worked on a project involving lithium ion batteries.

“I’m interested in exploring new materials for use in storing energy and in energy applications” he said. “Beyond that, I’m also interested in how public policy shapes the development of new materials, and how those materials influence new policies, in turn.”

Greeley’s older brother Duncan was also an MSE student at UT, and both participated in summer camps.

“My first introduction was through the materials camp which made me strongly think about coming here,” the younger Greeley said. “After that, I did Governor’s School for the Sciences and Engineering, which was located here at UT and heavily involved MSE. That sold me.”

Greeley and fellow student Carl Edwards, a computer science major, were UT’s Goldwater Scholarship representatives this year, chosen from more than 5,000 applicants nationwide. The scholarship program was established by congress in 1986 to honor US Senator Barry M. Goldwater and provides up to \$7,500 annually to cover tuition, fees, books, and room and board.



## The Toll of a **Material World**

By Laura Tenpenny.

A nuclear power plant is only as strong as its weakest part or, in this case, cable. At Analysis and Measurement Services Corporation (AMS), known for its nuclear engineering testing and instrumentation services, Trevor Toll (BS/MSE '12) is an expert in testing electrical cables that power utilities, manufacturers, and other facilities. Aging cables are a major concern for these clients, since their replacement costs significant time and money and impacts long-term operation.

“To help address these concerns, we have performed extensive research in the area of cable and insulation polymer aging and use a wide variety of electrical, mechanical, and thermal-chemical condition monitoring tests to determine the aged condition and provide remaining useful life estimates for industrial cables,” explained Toll.

A recent \$3.5 million project from the Department of Energy, led by AMS in conjunction with ORNL and Pacific Northwest National Laboratory, aims to develop criteria and monitoring techniques to help determine when essential cables may need repair or replacement.

“It’s already garnered a lot of interest from the Nuclear Regulatory Commission, the Electric Power Research Institute, and nuclear power plant utilities,” said Toll. “Project results will provide important information on the overall health of in-service cables’ insulation polymers, inform maintenance practices for future cable replacements, and offer potential justification for continued operability.”

Toll played a major role in this project. Shortly after joining AMS five years ago, he led the charge to establish the lab in which these tests take place.

“Since then, the AMS Materials Testing Laboratory has grown significantly and been instrumental in giving us the knowledge and capabilities needed to perform aging assessments of industrial cables and other polymeric materials,” said Toll.

Amid his busy professional life, Toll hasn’t forgotten the labs at UT where he got his start. He has stayed involved with his alma mater, serving on the advisory board of UT’s Center for Materials Processing and coaching a senior design group in 2017 which took on a project for AMS to discover and test materials that could mitigate the effects of various environmental stressors on cables.



“When I was at UT, the senior design project was divided into three smaller projects,” said Toll. “Now it includes one in-depth project about a specific R&D topic, which gives the students a chance to solve real-world, complex engineering problems together. Solving problems is what led me to pursue engineering.”

That interest in solving problems also led to Toll’s first patent, one of the highlights of his career.

“The patent is for a degradation monitoring system designed for thermal protection system materials used in spacecraft,” Toll said. “The system uses embedded sensor technologies to track degradation through these materials.”

Toll’s innovations spring from what boils down to simple enjoyment.

“I know it’s cliché but working at a job you enjoy makes a huge difference,” Toll said.

A huge difference indeed—an oft-dismissed cliché has resulted in world-saving solutions, from spacecraft safety to ensuring electricity for nuclear power facilities.

# Alumni News



## John Banker Joins MSE Hall of Fame

By Laura Tenpenny and Kathy Williams.

John Banker, sometimes referred to as the father of the explosion cladding industry, is the newest member of the MSE Hall of Fame and was officially inducted during the department's spring awards dinner.

After graduating from UT in 1969 with a BS in metallurgical engineering, Banker moved to Colorado to work at DuPont in explosion welding, leading to an expansive career in this specific field and making him a specialist in explosion metalworking.

During his career, Banker held managerial and engineering positions at DuPont and spent a few years working in metallurgy development at Oak Ridge National Laboratory. After DuPont closed their R&D operations, Banker and a colleague from the DuPont team merged the company's explosion welding division, Dupont Detaclad, with Explosive Fabricators, to form what is now Dynamic Materials Corporation. The company is the world's expert in explosion welding and the largest manufacturer of explosion welded class products.

In 2010, Banker received the ASTM International William J. Kroll Zirconium Medal, recognizing his outstanding achievement in the scientific, technological or commercial aspects of zirconium production and utilization.

He credits his time at UT for setting the foundation for his knowledge and successful career.

"The greatest value of education at UT in those years was that we were taught to understand the basics of metals and their basis in physical chemistry and physics," said Banker. "There was less push for us to become experts in the common metals of the era. This has served me well, as there is nothing common about my bimetallic world and the exotic materials that I enjoy working with."

Now retired, Banker enjoys spending time with his family on his 250-acre, Colorado property exploring the land and riding horses.

## Around the Department

### ● 2019 MSE Kickball Tournament

Photography by Hannah Swan.

Undergraduate and graduate students joined the faculty and staff in the department's first annual kickball tournament. The "Ferris Filaments" faced off against the "JIAM Jewels" in the double-header with both teams winning a game.



Associate Department Head and Professor David Keffer goes for the kick that resulted in a pop out to shallow left field.



Down by three in the top of the last inning, the JIAM Jewels gathered their collective courage and resolved not to go down without a fight.



Department Head Veerle Keppens races for home.

Join Jeffrey.  
Join the Journey.

"With its close ties to ORNL, the Tickle College of Engineering has offered me a world-class research experience, partnering me with mentors for collaboration and networking. While in Knoxville, one of my favorite activities has been hiking the Great Smoky Mountains; plus, coming from the military has given me an endless supply of campfire stories to tell at the end of a long day. Thanks to the generosity of donors, the Tickle Fellowship has enabled me to focus on my studies and research, while staying engaged in my local community."

—Jeffrey Brookins  
Tickle Fellow Recipient

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and throughout  
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*big orange. big ideas.*

**Junior Faculty  
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