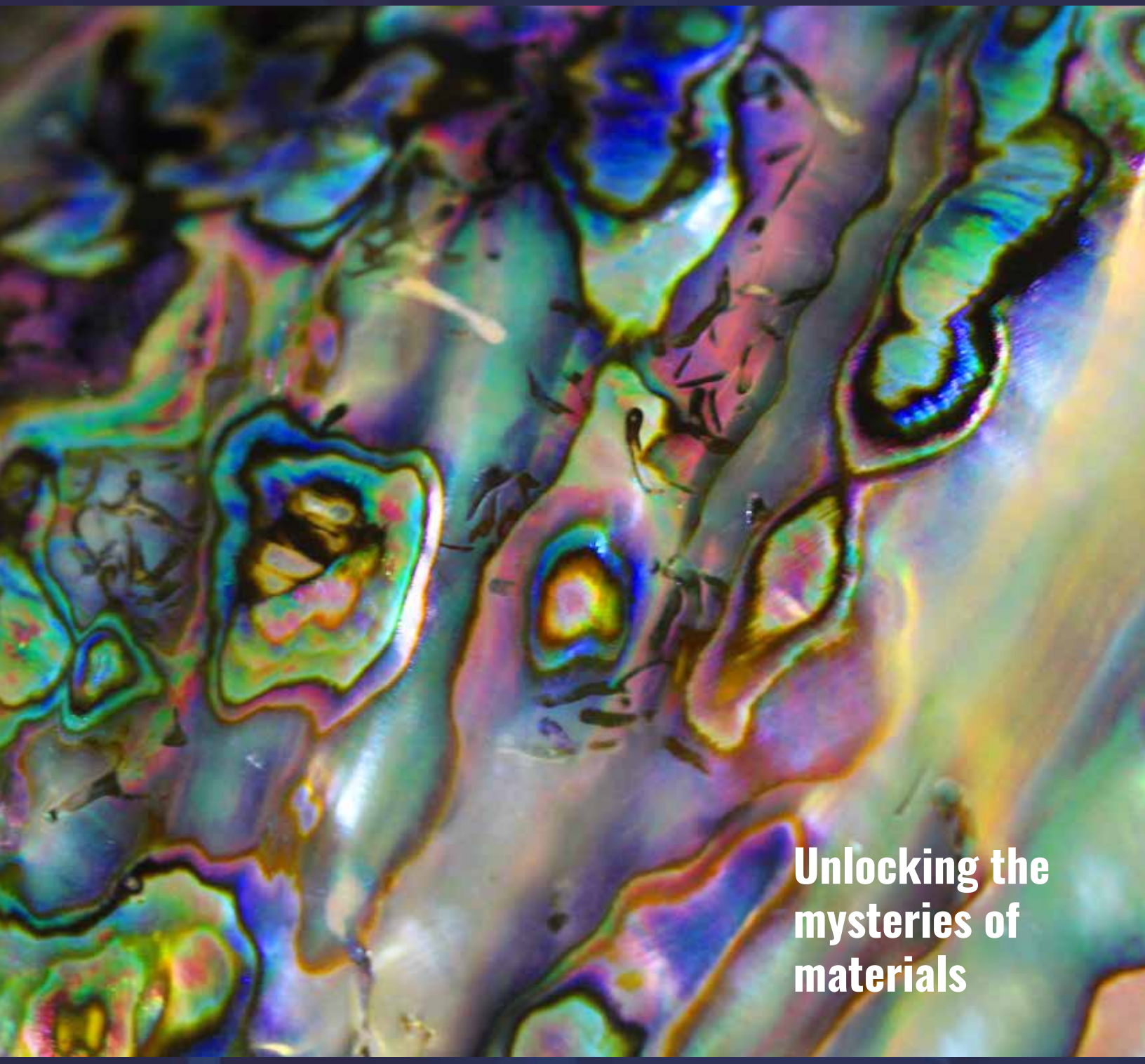
MSE*news*

COLLEGE OF ENGINEERING
MATERIALS SCIENCE & ENGINEERING
UNIVERSITY OF MICHIGAN



Unlocking the mysteries of materials

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Department Chair
Amit Misra

***MSE News* Editor**
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Front cover: Nacre–the rainbow-sheened material that lines the insides of mussel and other mollusk shells–is known as nature's toughest material. Now for the first time an international team of materials scientists and biologists, led by MSE Assistant Professor Robert Hovden, has revealed precisely how it is made.

Opposite page: Michigan Materials Society (MMS) students and faculty gather together at Dick Robertson's last MMS meeting before retiring. Last spring MMS won the College's Elaine Harden Award for outstanding student organization.

A note from the MSE Department Chair

Dear alumni and friends,

Year 2019 was another eventful year with notable milestones for MSE. Fifty years ago, in 1969, Michigan Engineering's Chemical and Metallurgical Engineering Department was split to create two new divisions: Chemical Engineering, and Materials and Metallurgical Engineering (MME), which became independent departments two years later in 1971 (MME eventually changed its name to the current MSE in 1984). It was also 50 years ago that Michigan Engineering initiated an Electron Microscopy Lab open to all users on campus. In 2019, I feel honored to be reappointed as chair of MSE for a second term, as the campus announced the launch of Michigan Materials Research Institute to be directed by Professor Alan Taub. In 2019, we welcomed new Assistant Professor Wenhao Sun, strengthening computational and data-driven materials research and curriculum in the department in support of the US Materials Genome Initiative. We celebrated the inspirational career of Professor Dick Robertson, who retired from teaching and advising undergraduates after decades of service to the department, and we mourned the passing of Professor Emeritus Robert D. Pehlke, who served as chair of MME department from 1973-84.

In September, we held the second annual Robert D. Pehlke Lectureship with featured speaker Diran Apelian from WPI, and were honored to have *in situ* transmission electron microscopy pioneer Frances Ross from MIT as our Van Vlack Lecturer to celebrate the 50 years of electron microscopy in Michigan Engineering. Dr. John F. Mansfield, who recently retired from the university, was recognized for his three decades of service to the electron microscopy lab on campus.

In 2019, our assistant professors were recognized with three NSF CAREER awards from DMR respectively to Ashwin Shahani (4D characterization of metal solidification), John Heron (entropy-stabilized electronic oxides) and Liang Qi (computational modeling of defects), and American Cancer Society Research Scholar award to Geeta Mehta (ovarian cancer), highlighting the diversity of our research portfolio.

We launched new initiatives in outreach and diversity, equity and inclusion (DEI) through a collaboration between faculty and students. Homecoming was especially busy this year with an alumni career panel and industry day added to the schedule of the MSE external advisory board meeting, creating more opportunity for MSE students to engage with alumni from all spectra of the materials engineering discipline. This year our students, staff and faculty witnessed distinguished lectures from some of our alumni recognized for their career accomplishments: Jim Yurko, Mark Nichols and Greg Hilmas.

On behalf of all MSE, I express our gratitude to MSE alumni who make us proud and enable us to achieve greater heights through their generous service and gifts to the department. Your engagement and support is highly valued. Thank you.

Go Blue!

Amit Misra

Amit Misra
Department Chair,
U-M Materials Science & Engineering

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Fifty years ago, Michigan Engineering's Chemical and Metallurgical Engineering Department was split to create two new divisions: Chemical Engineering, and Materials and Metallurgical Engineering (MME), which became independent departments two years later in 1971. (MME eventually changed its name to the current MSE in 1984.)

Amit Misra Reappointed MSE Chair

In June the U-M Board of Regents reappointed Professor Amit Misra chair of MSE for three years, through 2022.

"Amit is demonstrating our values, executing our mission and pursuing our vision," said College of Engineering Dean Alec Gallimore. "His leadership in fostering research growth, new resources, student support and outreach has made an impact."

"I am excited to contribute to the vibrant academic culture at the MSE department here at the University of Michigan...My personal mission will be to take classical concepts from thermodynamics and kinetics and apply them towards understanding the formation and synthesis of these advanced modern materials."

—Dr. Wenhao Sun

Dr. Wenhao Sun joins MSE faculty as assistant professor

MSE is pleased to introduce Wenhao Sun as our newest assistant professor; his term began January 1, 2020.

"The MSE department is excited to have Dr. Wenhao Sun join our faculty," said MSE Chair Amit Misra. "Dr. Sun is an expert in computational materials science of inorganic solids who uses high-throughput density functional theory, applied thermodynamics, and materials informatics approaches to guide materials synthesis."

Dr. Sun comes to U-M from Lawrence Berkeley National Laboratory, where he served in the Materials Science Division as a member of the Materials Project team and the EFRC: Center for Next-Generation Materials Design from 2016-18, and most recently as staff scientist. Dr. Sun earned two bachelor's degrees (Materials Science & Engineering and Engineering Sciences & Applied Mathematics) from Northwestern University in 2010. He went on to obtain his Ph.D. in MSE at MIT in 2016. He was a recipient of the 2016 International Union of Crystallography Young Researcher Award, and was a Materials Genome Initiative (MGI) Data-Mining Grand Challenge Winner.

Dr. Sun's research aims to accelerate materials discovery and design by building more quantitative insights into the synthesis-structure relationships of functional materials.

"I am excited to contribute to the vibrant academic culture at the MSE department here at the University of Michigan," said Sun. "The breadth of research in the MSE department spans a tremendous diversity of materials--advanced steels, ceramics, functional materials and soft materials. My personal mission will be to take classical concepts from thermodynamics and kinetics and apply them towards understanding the formation and synthesis of these advanced modern materials. I look forward to working with my faculty colleagues, along with the incredible graduate and undergraduate students, towards the realization of this vision."

U-M launches Materials Research Institute

MSE Professor Alan Taub has been tapped to lead the MRI, which is expected to support shared user facilities and catalyze breakthrough advances in new materials and processes. Earlier this year, U-M Engineering writer Gabe Cherry interviewed Taub to learn more.

Q: The center's goal is "Establish the new standard for innovative and collaborative materials research." Can you elaborate on that?

The Institute will act as an enabler for the university to establish large multi-disciplinary teams to respond to major funding opportunities with a materials theme. Today, pulling together appropriate faculty for a proposal is somewhat ad hoc. The Institute will act as a natural catalyst for assembling these teams. Through seminars and other means of seeding internal collaborations, the faculty will have a better understanding of synergistic capabilities their colleagues in the different schools and colleges offer.

Q: Why is this happening at U-M? Are there similar centers at other institutions and how is this one different?

Many of our peer universities have had long-standing materials research institutes. We established our initial structure based on a preliminary assessment of best practices at those other universities. During the initial phase of our Institute, we will execute a more formal benchmarking.

Q: Why is it important for so many disciplines to work together and why were those particular disciplines chosen?

The Institute will integrate the research involving discovery, design and production of new materials by identifying and proactively driving synergy across the faculty who are located in various departments within CoE and other colleges.

It is not surprising that research in advanced materials and processes is occurring in so many departments across the university. The study of materials science grew out of an amalgam of solid-state physics, metallurgy, and chemistry because the rich variety of materials properties cannot be understood within the context of any single classical discipline. By its very nature, then, research in this area requires a multi-disciplinary approach. With the advances in characterization and modeling, faculty in many other departments are now able to conduct world-class materials research.

Q: What will this center enable that isn't possible now?

Our vision is for the Institute to serve as the foundation that will, over the next decade, catalyze the formation of multiple multi-million dollar research centers, major instrumentation and infrastructure sponsored by federal agencies and industry, leading to Michigan's reputation as the best university in the U.S. for engineered materials research.

Q: How will the field be different in five years because of this center?

With materials research now being conducted in many departments across the university, we have lost some aspects of an integrated "materials research community." By identifying areas with synergy among those researchers, we expect to catalyze breakthrough advances in new materials and processes.

Sahar Farjami joins Van Vlack Lab staff

As Engineering Technician, Sahar Farjami is responsible for maintaining and repairing equipment, as well as training users on the proper use of Van Vlack Laboratory equipment. Sahar joined our team this year after completing her post-doctoral work at the University of Pittsburgh. Her research expertise with microscopy, spectroscopy, and calorimetry techniques and her teaching experience have come together to make her a valued asset to the faculty, staff, and students alike.

1. Professor Dick Robertson reacts to comments by former colleague Wayne Jones. 2. Professor Emeritus Wayne Jones shares an amusing anecdote. 3. Robertson's wife Pat laughs at a joke. 4. Professor Emeritus Ron Gibala talks about Robertson's accomplishments through the years. 5. Patti Vogel poses with Robertson. The two worked together in the undergraduate advising office for 12 years. 6. John Halloran regales the crowd with stories of Robertson.

Dick Robertson, 'gentleman and scholar,' retires

Robertson steps down from teaching and advising duties after three decades

On May 29, nearly 50 people – including 15 former students – gathered in Tishman Hall to celebrate the laudable teaching and advising career of Professor Dick Robertson.

Robertson earned his B.A. from Occidental College in 1955 and Ph.D. from California Institute of Technology in 1960.

After careers with General Electric and Ford Motor Company, Robertson joined the U-M faculty in 1986.

His fields of expertise include structure and mechanical properties of polymers and polymer-based fiber composites. He is noted for work on plasticity or ductile behavior of mainly glassy polymers (early career) and (later career) the fracture behavior and fractography of both thermoplastics and thermosetting plastics, and the stability and structural drift (physical aging) of glassy polymer structures.

"One of the things Dick was particulary well-known for was his theories on aging and relaxation of composites," said Professor Emeritus John Halloran, who then quipped, "Now that he's retired, he can can conduct experiments on the aging of graying professors and do some relaxing himself."

In addition to research and teaching, Robertson's U-M career also included serving as director of the Macromolecular Science and Engineering Ph.D. Program from 1995-2000, and MSE Undergraduate Program Advisor from 2005-2018.

An avid traveler, reader, and classical music connoisseur, Dick was also known for his 'erudite' interests outside of the classroom. "Dick always had time to talk about wine and restaurants and was extremely well-read and well-versed in classical music," commented Professor Emeritus Wayne Jones. "He has always been a true gentleman and scholar."

Alumni who came to celebrate Dick Robertson's retirement include: Gary Kogowski, Dave Norman, Dick Robertson, Kevin Cox, and Mark Nichols.

FACULTY NEWS

6.

Professor Dick Robertson makes some parting remarks at his retirement celebration on May 29.

FACULTY AWARDS & RECOGNITION

Michael Atzmon won the College of Engineering's 2019 T. Huebner Service Excellence Award.

Professor Emeritus **Wilbur Bigelow** was recently named one of eight members of The Microscopy Society of America (MSA) Class of 2019 fellows.

Sharon Glotzer was elected to the National Academy of Engineering (NAE), the nation's most prestigious engineering association.

Rachel S. Goldman won the 2019 Raymond J. and Monica E. Schultz Outreach and Diversity Award from the College of Engineering.

Jinsang Kim received the College of Engineering's Jon R. and Beverly S. Holt Award for Excellence in Teaching.

Emmanouil (Manos) Kioupakis was selected as the inaugural recipient of the Karl F. and Patricia J. Betz Family Faculty Scholar Award in Materials Science & Engineering.

Geeta Mehta was awarded a Research Scholar Grant from the American Cancer Society for her research project, "Ovarian Cancer Tumoroids to Study Heterogeneity and Chemoresistance."

Pierre Ferdinand P. Poudeu won the 2018-19 MSE Faculty Outstanding Accomplishment Award, given annually to a faculty member for his/her stellar performance in materials research, teaching, and service to the department.

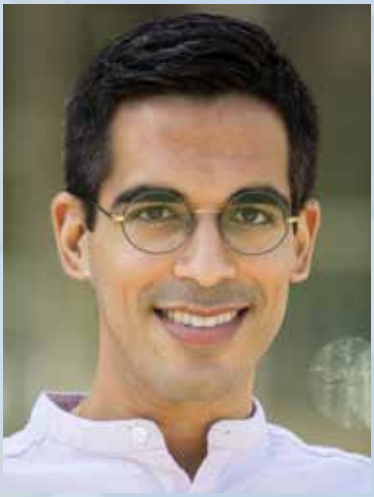
Alan Taub was named a 2019 Society of Manufacturing Engineers (SME) fellow, as well as a 2019 TMS fellow.

Steve Yalisove received the award for Outstanding Contributions to Materials Education at the 10th annual North American Materials Education Symposium (NAMES) held August 8-9 at Stanford University.

Steve Yalisove accepts the award for Outstanding Contributions to Materials Education from Mike Ashby at the 10th Annual NAMES in August 2019.

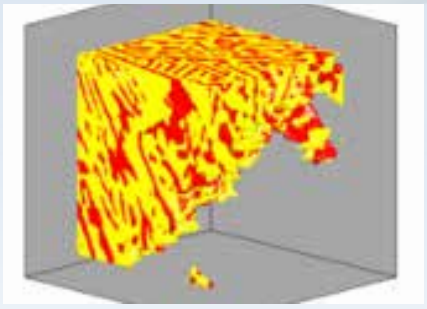
Three MSE faculty earn NSF CAREER Awards

Assistant Professors **Ashwin Shahani**, **John Heron** and **Liang Qi** all received CAREER Awards from NSF-DMR (Division of Materials Research) in 2019. Their award-winning research proposals are listed below.



Ashwin Shahani

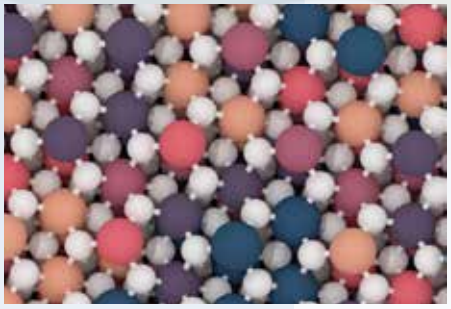
"Microstructure Formation in Chemically-Modified Eutectics: Bridging Real-Time Imaging, Machine Learning, and Problem-Based Instruction"



Dynamics of eutectic solidification: 3D reconstruction shown approx. 280 s after nucleation. The Al phase is represented in yellow and Ge is shown in red (the parent liquid is rendered transparent). Lamellar spacing, 10 μm.

John Heron

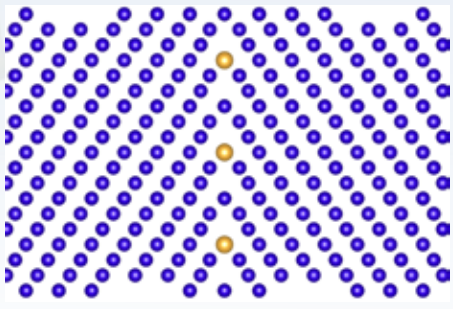
"Understanding disorder, defects, and dielectric properties of entropy-stabilized oxides"



Atomic structure of an entropy-stabilized oxide. The oxygen is represented by the white atoms. The multi-colored cations are randomly dispersed.

Liang Qi

"First-Principles Predictions of Solute Effects on Defect Stability and Mobility in Advanced Alloys"



Two iterations of a metal lattice meet at a "grain boundary" defect, with atoms of an alloying element fitting into the defect.

Faculty External Professional Service

John Allison

·TMS Materials Genome Initiative Ambassador
·TMS Materials Innovation Committee, Chair
·TMS Nominations Committee
·TMS ICME Committee
· TMS, Member, Fellow Committee
· Integrating Materials and Manufacturing Innovation, Editorial Board
· International Journal of Fatigue, Editorial Board (2015)
· ASM Gold Award Committee
· ASM Bronze Award (Mid-career) Committee
· Madrid Institute for Advanced Materials Studies- Scientific Board
· NAE, Chair, Peer Committee
· NAE, Member Committee on Membership
· NAE, Chair, Nomination Committee

Michael Atzmon

·Past President, International Mechanochemical Union (member Society of the International Union of Pure and Applied Chemistry)
·Steering Committee, International Symposium on Metastable, Mechanically Alloyed and Nanocrystalline Materials
· U.S. Advisory Committee, Bulk Metallic Glass International Conference (BMG XI)

Stephen Forrest

·Distinguished Visiting Professor of Electrical Engineering, Technion Israel Institute of Technology (2015-present)
·National Academy of Sciences Defense Acquisitions Board (2019-present)
· National Academy of Engineering Nanomaterials and
· Manufacturing Board (2017-Present)
· The Technion, Israel Institute of Technology Board of Governors (2012-present)
· Physical Review Applied, Lead Editor (2016-present)
· Nano Energy, Editorial Board (2014-Present)
· Applied Materials Board of Directors (2008-present)
· Universal Display Corp. Scientific Advisory Board (1994-Present)

Sharon Glotzer

· Member, National Academy of Sciences Board on Chemical Sciences and Technology, 2015-2021
· Associate Editor, ACS Nano, 2015-present
· Member, Awards Committee - American Institute for Chemical Engineers, 2017-present
· Rahman Prize Committee, American Physical Society

Rachel Goldman

· Chair, Scientific Advisory Committee, Center for Integrated Nanotechnologies, Department of Energy
· Chair Line, Division of Materials Physics, American Physical Society, 2019-2023
· Associate Editor, Journal of Applied Physics, 2017-present
· Editorial Board, MRS News, 2012-present
· Executive Committee, Electronic Materials Conference
· NAS/NAE Panel Extramural Basic Research at the Army Research Laboratory, 2019-2020
· Chair, Adler Award Committee, American Physical Society, 2019

John Heron

·Guest Editor of MDPI Materials special issue "Advances in Multiferroics," 2018-2019
·Lead organizer of ACerS EMA Meeting, "Frontiers in Ferroic Oxides: Synthesis, Structure, Properties, and Applications," Jan. 2020
· Lead organizer of MRS Spring Meeting, "Topological and Quantum Phenomena in Oxides and Oxide Heterostructures," 2020
· Member, American Ceramics Society, Materials Research Society, and American Physical Society

Robert Hovden

· DOE Proposal Review Board at the Lawrence Berkeley National Electron Microscopy Center and the Brookhaven National Center for Functional Nanomaterials.
· Symposium Chair for APS March Meeting 2020 Denver, Co., M&M 2020 Milwaukee, Wis., M&M 2019 Portland, Ore.

John Kieffer

· Board of Directors of the American Ceramic Society
· Conference Chair for Composites at Lake Louise, 2019

Manos Kioupakis

· Program Committee member and Session chair, 13th International Conference on Nitride Semiconductors (ICNS-13), July 7 -12, 2019, Bellevue, Wa.

Peter Ma

· Tissue Engineering and Regenerative Medicine International Society-Americas Meetings Committee Member
· International Chinese Musculoskeletal Research Society, Board Member, President-Elect
· Chinese Association for Biomaterials, Advisory board member
· International Advisory Committee, The School of Biological Science and Medical Engineering, Beihang University
· Grant reviewer: NIH, NSF
· International Advisory Committee, the Tissue Engineering and Regenerative Medicine International Society World Congress
· Scientific Committee, The 4th ICMRS International Musculoskeletal Research Conference (ICMRC), Shenzhen, China, 2019

(Continued on pg. 10)

Robert D. Pehlke

1933-2019

It is with tremendous sadness that we announce the passing of MSE Professor Emeritus Robert D. Pehlke on October 22. Professor Pehlke served the department for a total of 45 years.

A native of Michigan, Professor Pehlke received his B.S. from U-M in 1955 and an S.M. and Sc.D. from MIT in 1958 and 1960, respectively. He studied at the Technical Institute, now RWTH Aachen University (Germany), as a Fulbright Fellow during his graduate studies. Professor Pehlke joined the U-M faculty in 1960; he served as chair of the Dept. of Materials and Metallurgical Engineering from 1973-84.

Professor Pehlke made many key contributions to the science and technology of metallic materials. His early work clarified several of the critical reactions between liquid steel and gaseous elements and contributed important insights into steel making. Professor Pehlke was a pioneer in the computer modeling of metal casting processes. His work incorporated the modeling of heat transfer, the application of solidification theory, and the practical aspects of industrial casting processes, which were critical for the development of the commercial computer-aided design packages now used around the world. Professor Pehlke is well-known for his outstanding experimental research in liquid metal processing, and he is an internationally recognized expert in the continuous casting of steel.

In 2017, Professor Pehlke generously endowed two gifts for MSE: the Robert D. and Julie A. Pehlke Endowed Fellowship Fund for MSE graduate students and the Robert D. Pehlke Lectureship in Materials Processing, which brings in world experts on topics about or concerning materials processing. The first lectureship was held in September 2018 and featured Ron Radzilowski, a principal research engineer with AK Steel Corporation and former graduate student of Professor Pehlke. The second lectureship was held in September and featured materials expert Diran Apelian, who admired Pehlke both personally and professionally.

"Bob was responsible, committed, dedicated – a supreme professional," Apelian said. "You know, it's been said that you make a living by 'what you get,' but you really make a life by what you give, and Bob gave a lot to this department and to the community."

MSE Chair Amit Misra agrees: "Even after his retirement Professor Pehlke still gave back to the department. We will all miss Bob greatly but feel fortunate that we can continue to honor his extraordinary legacy through both the Robert D. Pehlke Lectureship and Robert D. and Julie A. Pehlke Graduate Fellowship."

Three from MSE win Michigan Engineering's 2019 incentive award


Yalisove


Hilgendorf


Richardson

Professor Steve Yalisove, MSE graduate program advisor **Renee Hilgendorf**, and MSE unit administrator **Todd Richardson** were all selected to receive Michigan Engineering's 2019 incentive award for consistently demonstrating the college's values in their work.

The 2019 Incentives recognized more than 90 faculty and staff who have gone above and beyond to advance the College's values and contribute to Michigan Engineering's culture through creativity, innovation, and daring.

Yalisove has been a member of the MSE faculty since 1991, Hilgendorf has been with MSE for 22 years, and Richardson joined the staff in 2014.

"This was a real honor to win," Hilgendorf commented. "It is always nice to be recognized and appreciated for your efforts."

Staff Service Awards

Three staff members earned the 2019 Staff Service Award, presented in December at the faculty/staff holiday party: (pictured below, left to right) **Patti Vogel** (undergraduate program advisor), **Renee Hilgendorf** (graduate program advisor), and **Ellen Hou** (contract and grant specialist).

Peter Ma (cont'd)

- International Advisory Board, "International Conference on Nano in Engineering, Science and Technology (i-NEST)," India, 2019
- International Scientific Advisory Committee, 24th International Biomedical Science and Technology Symposium,Turkish Society for Biomaterials and Tissue Engineering, Turkey, 2019
- International Advisory Committee, the Tissue Engineering and Regenerative Medicine International Society World Congress (TERMIS-WC), Maastricht, The Netherlands, 2021

Geeta Mehta

- Meeting planning for AACR: Advances in Ovarian Cancer Conference, 2019
- Session Chair and Abstract Reviewer for the BMES Annual meeting, 2019

Joanna Millunchick

- Big Ten Academic Alliance Leadership Fellow (2019-2020)
- Taubman College of Architecture and Urban Planning Advisory Board (2019-)
- Hedda Anderson Visiting Professor, Lund University, Sweden (2018-2020)

Amit Misra

- Materials Research Letters, Editor
- MRS Program Development Subcommittee
- MRS Bulletin, Editorial Board, Chair
- ASM, International: Technical Books Committee Member
- TMS Innovation Committee, member-at-large
- University Materials Council, vice-chair (2nd)
- Oak Ridge National Lab, Advisory Committee (Physical Sciences)

Becky Peterson

- Treasurer (2019-2021) and member of the Organizing Committee (2017-present), MRS Electronic Materials Conference Vice Chair (2020) and member of the Technical Program Committee (2016-present), IEEE Device Research Conference
- Sub-Committee for Optoelectronics, Displays and Imaging, IEEE International Electron Devices Meeting (IEDM) (2018-present)
- Chair, IEEE Southeastern Michigan Trident Chapter IV (Joint Chapter of Electron Device Society/APP/MTT/Photonics) (2018-present)
- Guest Associate Editor, APL Materials Special Topic Issue on Wide Bandgap Oxides (2018-2019)
- Committee of Visitors for the National Science Foundation Division of Materials Research (2019)
- Visiting Scientist, Paul Drude Institut for Solid State Electronics, Berlin, Germany (2019)

Ashwin Shahani

- Key reader, Metall. Mater. Trans. A, September 2018 to present
- Member of ASM Emerging Professionals Committee, August 2018 to present
- Member of TMS technical committees: Solidification Committee and Phase Transformations Committee (Materials Processing &

(Cont'd)

Ashwin Shahani (cont'd)

Manufacturing Division), March 2017-present
· Member of Proposal Review Panel for National Synchrotron Light Source II (2019-2022)

Don Siegel

· Affiliate member, U.S. DRIVE Hydrogen Storage Technical Team
· Member of the Directorate, Joint Center for Energy Storage Research

Alan Taub

· NAE - Council member and chair Audit Committee
· ASM - Awards Committee
· MIT Visiting Committee for MSE
· UC Davis – Strategic Advisory Board
· Member - Boy Scouts of America STEM Advisory Committee
· Chair, MainForum, Largest Mexican Automotive Conference, March 8-11, 2019

Katsuyo Thornton

· Technical Advisory Board, Center for Hierarchical Materials Design (CHi- MaD), an NIST Advanced Materials Center of Excellence (2014-present)
· Chair of Advanced Research Computing Advisory Team (ARCAT), providing guidance and advice to the Vice President and Chief Information Officer and the Associate Vice President for Advanced Research Computing on strategic directions relating to the advanced research cyberinfrastructure
· Contributor, Report on Creating the Next-Generation Materials Genome Initiative Workforce (TMS).

Gary S. Was

· Editor-in-Chief, Journal of Nuclear Materials, Elsevier
· Editorial Review Board, Metallurgical Transaction
· Selection Committee, Robert Cahn Award, Journal of Nuclear Materials and NuMAT
· Academic Advisory Committee, Versatile Reactor-based Fast Neutron Source (VFNS) Research and Development Initiative
· Independent Technical Review Committee, U.S. High Performance Research Reactor – Fuel Development
· Organizing Committee, International Conference on Environmental Degradation of Materials in Nuclear Power Systems – Water Reactors
· Originator and Organizing Committee, Conference on Materials in Nuclear Energy Systems
· Chair, International Atomic Energy Agency, Coordinated Research Project
· Member, Board of Directors, International Cooperative Group on Environmentally Assisted Cracking

Steve Yalisove

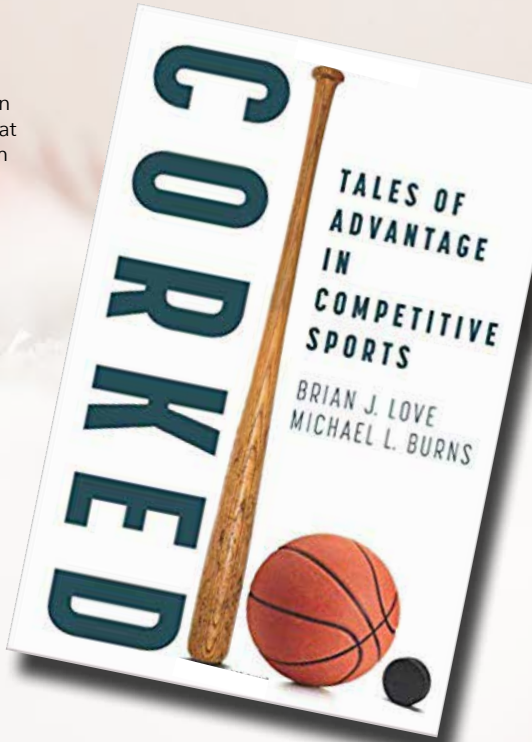
· MRS Academic Affairs
· Chair, MRS Education Sub-Committee Academic Affairs
· TMS Accreditation Committee
· ABET Volunteer
· Organizer, 9th annual North American Materials Education Symposium, August 2018

Brian Love's book, *Corked*, offers an analyst's perspective on competitive advantage in sports

This spring MSE Professor Brian Love and co-author Michael Burns published *Corked*, an anthology of 26 short stories linked with the notion that factors outside of player talent can affect a team's performance. The book features stories about mainstream sports (football, baseball, hockey, basketball, and soccer) as well as track and field, yachting, tennis, golf, curling, and cricket, among others. Corked offers a perspective on how fields, equipment, and other intangibles factor into winning.

"Today's rage is all about making the athlete a more superior performer through diet, exercise, practice, etc.," Love says. "As an aside, what if the fields, equipment, apparel, weather, and other intangibles also affected performance and you could engineer these interactions in favor of your team? [The book] is an analyst's take on the game and not a breathless endorsement of how exciting any one sport, team, player, or coach might be."

More information on *Corked* is available at corkedthebook.com or amazon.com.



Kirigami sensor patch could improve injury recovery, athletic training

Professor Max Shtein

Erin Evke

Inspired by MSE Professor Max Shtein's recovery after a cycling crash, an innovative patch could bring the assessment of human joints into the 21st century.

The patch uses electronic sensors to understand the functional range of motion as opposed to today's static measurements. Influenced by kirigami, the Japanese art of creating 3D structures from cut paper, the sensor can hug the curves of a joint and yet can be manufactured flat. "The shoulder in particular moves in a very complex way. It's one of the most well-articulated joints in the body," said Shtein, who collaborated with his students on the work.

"Nobody's really been able to track it properly with anything wearable, and yet it's key to so many activities in sports and daily life."

After breaking his collarbone, Shtein was dismayed to find that his physical therapist assessed the range of motion in his shoulder with a basic protractor. The method is prone to large errors, and he had no way of repeating the measurements at home.

He realized that a wearable sensor could have recorded the full scope of his motion and tracked his exercises, but it is expensive to build electronics onto curved structures. This sensor would need to be manufactured flat but still be able to follow the contour of a patient's shoulder.

He and Erin Evke, a doctoral student in MSE, came up with a solution inspired by kirigami. She laser cut a thin sheet of plastic into a labyrinth of concentric ovals. The shape pulls apart almost like a Slinky, and the cuts open into a lacework over the shoulder.

"If you take a sheet of paper and try to wrap it around a sphere, it's impossible to do so without folding or wrinkling the paper. This would significantly stress the sensors before your measurement even began," Evke said. "Our cut pattern avoids this problem."

Because these structures transform from a flat sheet to a wrinkle-free, 3D shape, they can be manufactured with existing, cost-effective technologies. Shtein estimates that the cost of individual sensors could be below $10, assuming mass production. That's much less than the cost of a single physical therapy appointment. It could be an inexpensive way to improve patient outcomes.

As a proof-of-concept, the team equipped the kirigami patch with two strain gauges—one along the corner of the shoulder to capture the raising and lowering of the arm, and the other at the back of the shoulder to measure cross-body movements.

Collaborating with researchers working under Deanna Gates, an associate professor of movement science at U-M, Shtein's team cross-referenced the data from the kirigami sensor with arm motions captured by a camera motion tracking system. The system uses reflective markers to track the angular positions of the arm and reconstructs them in a computer simulation.

"The shoulder in particular moves in a very complex way. Nobody's really been able to track it properly with anything wearable, and yet it's key to so many activities and daily life."

—Professor Max Shtein

The team envisions that this kind of inexpensive sensor could be given to physical therapy patients, enabling them to log exercises and see progress through a smartphone app. This could help keep patients honest about doing their exercises and also provide more detailed information to therapists about each patient's progress.

Evke, who competed in college track and field, also considers how it could be used to help athletes improve their form.

"Since you can tune the cut design to match the curvatures of all different parts of your body, you can generate a lot of data that can be used to track your form—for instance while lifting—as well as the amount of strain applied on your joints," she said. "The user could be alerted of improper form in real-time and therefore prevent injuries."

Shtein pointed out that we don't have good ways to measure joints and understand how to care for them. Recent work suggests that tears in the anterior cruciate ligament, a serious knee injury experienced by many athletes, occur as a result of cumulative stresses rather than a single excessive force. Similar issues occur with the shoulder joint. Inexpensive sensors could measure stresses so that athletes and trainers could recognize evolving problems and head off major injuries.

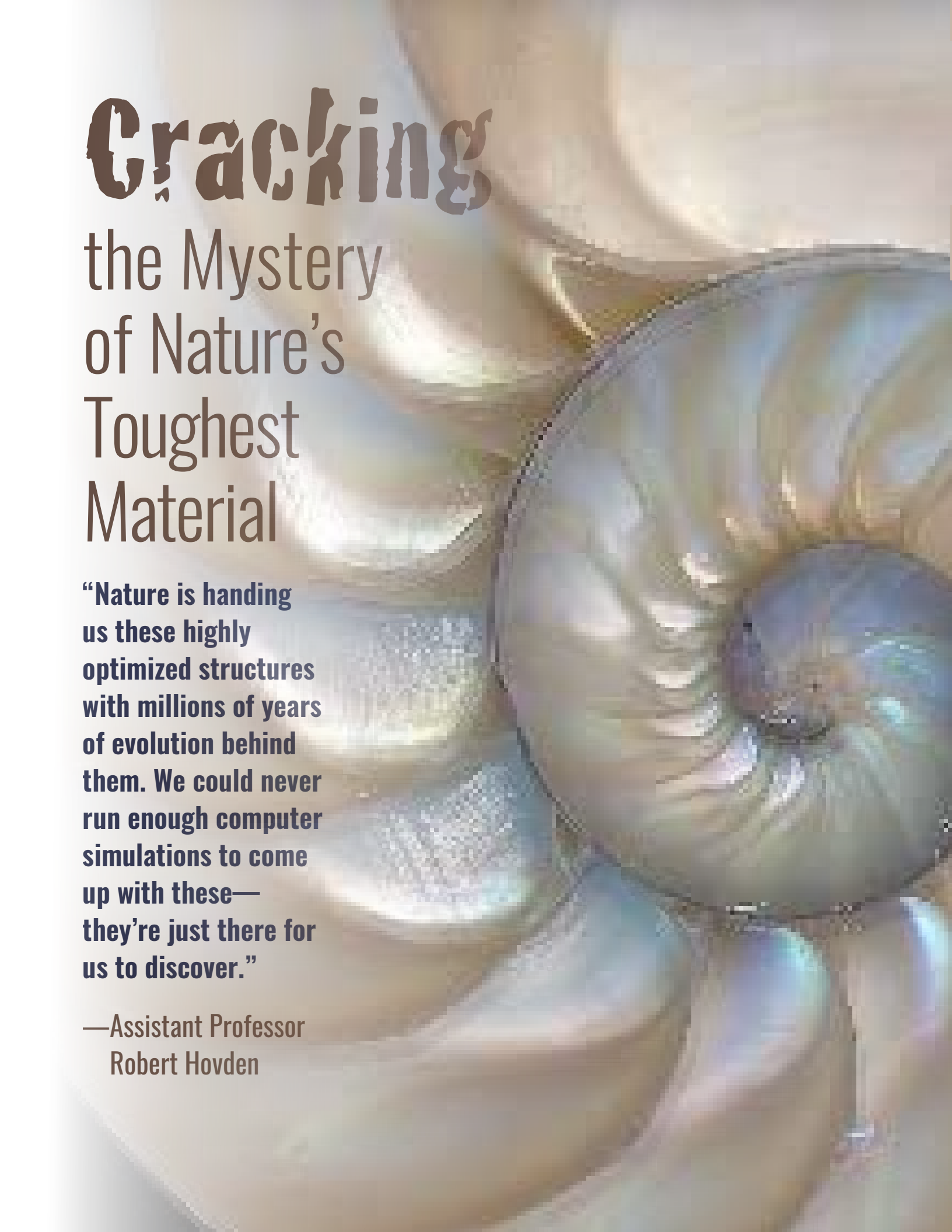
The study, "Developable Rotationally Symmetric Kirigami-based Structures as Sensor Platforms," is published in the journal *Advanced Materials Technologies*. The research was funded in part by the National Science Foundation.

Shtein is also a professor of macromolecular science and engineering, chemical engineering, and art and design. Gates is also an associate professor of biomedical engineering.

Erin Evke demonstrates how the cut patterns in the kirigami sensor open so that it follows the curve of her shoulder. This enables the sensor to be manufactured flat, which is crucial to making the device affordable. Photo by Levi Hutmacher, Michigan Engineering

RESEARCH NEWS

Cracking the Mystery of Nature's Toughest Material



"Nature is handing us these highly optimized structures with millions of years of evolution behind them. We could never run enough computer simulations to come up with these—they're just there for us to discover."

—Assistant Professor Robert Hovden

Nacre—the rainbow-sheened material that lines the insides of mussel and other mollusk shells—is known as nature's toughest material. Now, for the first time an international team of materials scientists and biologists, led by MSE Assistant Professor Robert Hovden, have revealed precisely how it is made.

More commonly known as mother-of-pearl, Nacre's combination of hardness and resilience has mystified scientists for more than 80 years. If humans could mimic it, it could lead to a new generation of ultra-strong synthetic materials for structures, surgical implants and countless other applications.

"How mollusks can make such a tough material in the natural environment of the ocean has baffled generations of scientists," said Hovden. "We humans can make tougher materials using unnatural environments, for example extreme heat and pressure. But we can't replicate the kind of nano-engineering that mollusks have achieved. Combining the two approaches could lead to a spectacular new generation of materials, and this paper is a step in that direction."

Using electron microscopy and micro-indentation techniques at U-M's Michigan Center for Materials Characterization, the materials scientists discovered a nanoscale architecture of organic and inorganic material that combines the best properties of layers and solids, hardness and resilience, into a nearly indestructible supermaterial. A paper detailing the new discoveries was published October 23 in *Nature Communications*.

Researchers have known the basics about nacre for decades—it's made of microscopic "bricks" of a mineral called aragonite, laced together with a "mortar" made of organic material. This bricks-and-mortar arrangement clearly lends strength, but nacre is far more resilient than its materials suggest. Hovden's team, which included U-M materials science graduate research assistant Jiseok Gim as well as biologists from Australia's Macquarie University and elsewhere, worked together to crack the mystery.

Using tiny piezo-electric micro-indenters, they were able to exert force on the shells while they were under an electron microscope and watch what happened in real time. They revealed a structure that bounces back from impact with more finesse than anyone imagined.

They found that the "bricks" are actually multi-sided tablets only a few hundred nanometers in size. Ordinarily, these tablets remain separate, arranged in layers and cushioned by a thin layer of organic "mortar." But when stress is applied to the shells, the "mortar" squishes aside and the tablets lock together, forming what is essentially a solid surface. When the force is removed, the structure springs back, without losing any strength or resilience.

This resilience sets nacre apart from even the most advanced human-designed materials. Plastics, for example, can spring back from an impact, but they lose some of their strength each time. Nacre lost none of its resilience in repeated impacts at up to 80% of its yield strength.

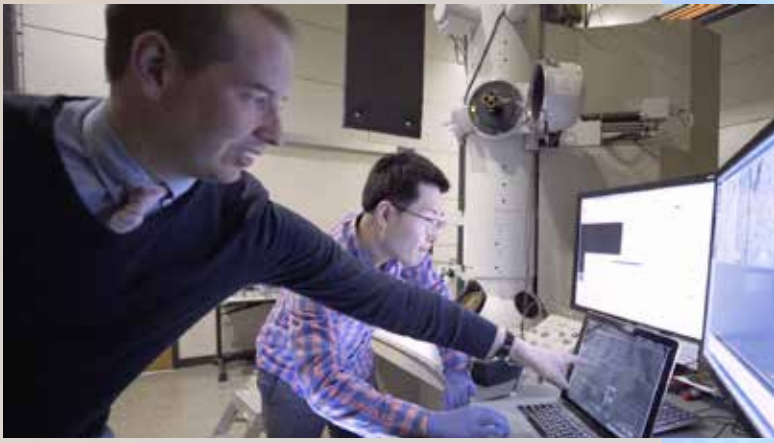
What's more, if a crack does form, nacre confines the crack to a single layer rather than allowing it to spread, keeping the shell's structure intact and enabling the mollusk to live another day.

"It's incredible that a mollusk, which is not the most intelligent creature, is fabricating such complex structures across so many scales," Hovden said. "It's fabricating individual molecules of calcium carbonate, arranging them into nano-layered sheets that are glued together with organic material, all the way up to the structure of the shell, which combines nacre with several other materials."

Hovden believes humans could use the mussel's methods to create nano-engineered composite surfaces that could be dramatically lighter and tougher than those available today.

"Nature is handing us these highly optimized structures with millions of years of evolution behind them," he said. We could never run enough computer simulations to come up with these—they're just there for us to discover."

The paper is titled "Nanoscale deformation mechanics reveal resilience in nacre of pinna nobilis shell." Other universities involved with the project include Université de Bourgogne Franche-Comté and Friedrich-Alexander-University Erlangen-Nürnberg. The research was performed on electron microscopy instruments at the Michigan Center for Materials Characterization. The Mediterranean Pinna nobilis mollusk studied is a protected species due to recent ecological threats.



Assistant Professor Robert Hovden and Ph.D. candidate Jiseok Gim conduct *in situ* TEM to study deformation of nacre.

Ice-proofing big structures with a "beautiful demonstration of mechanics"

Ice mitigation research (Tuteja lab) and fracture mechanics concepts (Michael Thouless lab) come together to advance the ability to ice-proof large structures like ships, airplanes, and power lines.

Associate Professor Anish Tuteja (above) and Professor Michael Thouless

A new class of coatings that sheds ice effortlessly from even large surfaces has moved researchers closer to their decades-long goal of ice-proofing cargo ships, airplanes, power lines and other large structures.

The spray-on coatings, developed at the University of Michigan, cause ice to fall away from structures—regardless of their size—with just the force of a light breeze, or often the weight of the ice itself. A paper on the research is published in Science.

In a test on a mock power line, the coating shed ice immediately.

The researchers overcame a major limitation of previous ice-repellent coatings—while they worked well on small areas, researchers found in field testing that they didn't shed ice from very large surfaces as effectively as they had hoped. That's an issue, since ice tends to cause the biggest problems on the biggest surfaces—sapping efficiency, jeopardizing safety and necessitating costly removal.

They cleared this hurdle with a "beautiful demonstration of mechanics." MSE Associate Professor Anish Tuteja described how he and his colleagues turned to a property that isn't well-known in icing research.

"For decades, coating research has focused on lowering adhesion strength—the force per unit area required to tear a sheet of ice from a surface," said Tuteja. "The problem with this strategy is that the larger the sheet of ice, the more force is required. We found that we were bumping up against the limits of low adhesion strength, and our coatings became ineffective once the surface area got large enough."

The new coatings solve the problem by introducing a second strategy: low interfacial toughness, abbreviated LIT. Surfaces with low interfacial toughness encourage cracks to form between ice and the surface. And unlike breaking an ice sheet's surface adhesion, which requires tearing the entire sheet free, a crack only breaks the surface free along its leading edge. Once that crack starts, it can quickly spread across the entire iced surface,

regardless of its size.

"Imagine pulling a rug across a floor," said Michael Thouless, the Janine Johnson Weins Professor of Engineering in mechanical engineering. "The larger the rug, the harder it is to move. You are resisted by the strength of the entire interface between the rug and floor. The frictional force is analogous to the interfacial strength. But now imagine there's a wrinkle in that rug. It's easy to keep pushing that wrinkle across the rug, regardless of how big the rug is. The resistance to propagating the wrinkle is analogous to the interfacial toughness that resists the propagation of a crack."

Thouless explains that the concept of interfacial toughness is well known in the field of fracture mechanics, where it underpins the mechanics of products like laminated surfaces and adhesive-based aircraft joints. But until now, it hadn't been applied in ice mitigation. The advance came when Thouless learned of Tuteja's previous coatings work and saw an opportunity.

"Traditionally, fracture mechanics researchers only care about interfacial toughness, and ice mitigation researchers often only care about interfacial strength," Thouless said. "But both parameters are important for understanding adhesion.

"I pointed out to Anish that if he were to test increasing lengths of ice, he would find the failure load would rise while interfacial strength was important, but then plateau once toughness became important. Anish and his students tried the experiments and ended up with a really beautiful demonstration of the mechanics, and a new concept for ice adhesion."

To test the idea, Tuteja's team used a technique he honed during previous coating research, which breaks with the traditional materials science "mix-and-see" approach. By mapping out the fundamental properties of a vast library of substances and adding interfacial toughness as well as adhesion strength to the equation, they were able to mathematically predict the properties of a coating without the need to physically test each one. This enabled them to concoct a wide variety of combinations, each with a specifically tailored balance between interfacial toughness and adhesion strength.

They tested a variety of coatings on large surfaces—a rigid aluminum sheet approximately 3 feet square, and a flexible aluminum piece approximately one inch wide and 3 feet long, to mimic a power line. On every surface, ice fell off immediately due to its own weight. It stuck fast, however, to the control surfaces, which were identical in size—one was uncoated and another was coated with an earlier icephobic coating. The team's next step is to improve its durability of the LIT coatings. Tuteja explains that LIT coatings tend to be thin and hard, unlike the thick, rubbery coatings that are designed for low adhesion strength. Making the thin coatings durable can be a challenge, but Tuteja is confident that the team will be able to dial in the right mix of interfacial toughness, adhesion strength and modulus for a variety of applications.

"The advantage of designing coatings based on their fundamental mathematical properties is that you don't end up with just one coating," he said. "You get more of a recipe, and you can then adjust that recipe to create a variety of slightly different coatings for different applications."

The paper is titled "Low Interfacial Toughness Materials for Effective large-Scale De-Icing." In addition to Tuteja and Thouless, the team included U-M macromolecular science and engineering graduate researcher Abhishek Dhyani and former U-M materials science and engineering PhD student Kevin Golovin. The research was funded by the Office of Naval Research, the Air Force Office of Scientific Research, and the National Science Foundation and the Nanomanufacturing program (grant #1351412).

Abhishek Dhyani, Macromolecular Science & Engineering Ph.D. student, sprays a low interfacial toughness (LIT) coating onto a surface. The coatings help shed ice effortlessly from large surfaces and could be used on cargo ships, airplanes, power lines, wind turbines, oil rigs, and commercial buildings.

Cancer is smarter than you think

A Q&A WITH ASSISTANT PROFESSOR GEETA MEHTA

Caymen Novak, PhD student researcher, pipettes a suspending gel to prepare a shear reactor experiment.

Earlier this year, Geeta Mehta published a paper detailing integrated cancer tissue engineering models, which study cancer not simply as masses of cells but as structured organs with multiple cell types that communicate with each other and interact with the body—much like your lungs or liver. U-M Engineering writer Gabe Cherry sat down with Mehta to learn more about her work.

DOES THIS PERSPECTIVE HOLD MORE BENEFIT FOR SOME TYPES OF CANCER THAN OTHERS?

No. All types of cancer should be viewed and studied as "cancer organs" including solid tumors, leukemia and lymphoma. But, just like actual organs, each type of cancer organ works differently.

HOW SIMILAR ARE CANCER ORGANS TO ACTUAL ORGANS? WHERE DO THOSE SIMILARITIES END?

Cancer organs and normal organs both have complex internal environments and a series of complex interactions that govern their behavior. Both are composed of many cell types that communicate dynamically with each other, and both have a specific three-dimensional structure that influences how they interact with the rest of the body.

One big difference is that actual organs are tightly regulated to maintain their integrity and stability. Cancer is not regulated this way—the environment inside a tumor promotes uncontrolled growth rather than stability.

HOW DOES LOOKING AT CANCER AS AN ORGAN CHANGE THE WAY YOU APPROACH CANCER RESEARCH?

Because the organ-like traits of cancer influence its response to treatment. Traditional cancer research mainly involves 2D slides and petri dishes that fail to recognize and incorporate these traits. These 2D cultures don't respond to treatments the same way as cancer inside the body, and that makes them less useful.

By viewing cancer as an organ, we can develop more realistic bioengineered models that replicate the conditions inside the body, including three-dimensionality, heterogeneous cell populations, and mechanical stimuli—reactions from physical forces the cells experience by virtue of being in the body. By taking these features into account, we can obtain more clinically relevant results, steer development of new therapeutics and accelerate clinical progress.

WHAT KINDS OF NEW TREATMENTS MIGHT WE SEE IN THE FUTURE AS A RESULT OF THIS APPROACH?

By designing cancer organ models, we hope to better understand how cancers progress and to understand the specific interactions that turn healthy cells into cancer. Then, we hope to develop targeted therapies that interrupt those interactions. This approach can also improve development of therapies that are tailored to individual patients.

WHAT'S ANOTHER BIG CHALLENGE IN CANCER RESEARCH THAT YOU'RE WORKING TO ADDRESS?

We're finding that not only does cancer work like an organ, but that the same type of cancer organ works differently in different patients. So we're developing three dimensional heterogeneous models that can recreate tumors from individual patient samples.

This enables us to look at differences between individual microtumors from a single patient, and at the differences in cell composition, gene expression and chemoresistance that occur from patient to patient.

Geeta Mehta is the Dow Corning Assistant Professor of Materials Science and Engineering, an assistant professor of both materials science and engineering and biomedical engineering, and head of the Michigan Engineering Engineered Cellular Microenvironments Lab. Earlier this year she received a Research Scholar Grant from the American Cancer Society.

Below and opposute page: Juan Lopez, MSE postdoc, engineers magnetic transitions in ferromagnetic semiconductors.

"The big excitement is our understanding of how this property works and how to induce it. We should be able to build it into any semiconductor including silicon and gallium arsenide, which opens the door to quantum devices that use changes in temperature and/or magnetic field to store information."

—Pierre Ferdinand P. Poudeu

Immortal switches, quantum computers could stem from new semiconductor

Switches that never wear out and quantum computers are two possible applications for a newly developed semiconductor whose conductive and magnetic properties change with its temperature.

The result of an accidental discovery, the material's electrons and holes—the subatomic building blocks of conductivity and magnetism—rearrange themselves as its temperature changes. This can create a separation of electrical charges across the material (polarity), which stops electrical current from flowing.

In contrast to existing solid-state switches, which undergo shifts in atomic structure, the atoms in this material remain in place. The development is detailed in a paper published recently in the *Journal of the American Chemical Society* (JACS).

"As a chemist, I didn't see this coming," said Pierre Ferdinand P. Poudeu, an associate professor of MSE and senior author on the paper. "People have seen this in other materials but they didn't know why it happened. We're the first to create a chemical pathway to this property and use it to our advantage."

At room temperature, the material's electrons and holes are evenly distributed throughout the material. But when part of the material is cooled below a critical temperature, its holes migrate to the hot side of the material while its electrons migrate to the cold side. This causes the cold side to take on a negative charge while the hot side takes on a positive charge. The separation of electrons and holes also prevents it from conducting electricity. The electrons and holes migrate back to a uniform distribution as the temperature evens out, and the transition can take place an unlimited number of times.

While the property has been theoretically predicted for years and has been observed a few times in the past, the new research marks the first time researchers have mapped out why it occurs and how to control it. The material, which is a mix of iron, tin, antimony and selenium, can be tailored so that the changes occur at a specified temperature, and can be triggered with a temperature change of as little as a fraction of a degree.

"The big excitement is our understanding of how this property works and how to induce it," Poudeu said. "We should be able to build it into any semiconductor including silicon and gallium arsenide, which opens the door to quantum devices that use changes in temperature and/or magnetic field to store information."

Juan Lopez, an MSE post doc and an author on the paper, believes the material could also be useful in electronics and switching. It could one day lead to a switch with no moving parts that shuts itself off at a given temperature, or a processor that uses minute temperature shifts to store information.

"Today, even solid-state switches and transistors rely on phase change, so they eventually fail," said Lopez, referring to changes in atomic structure—such as transitioning between amorphous and crystalline states. "This technology could be used to build a switch with only one component—it would be much simpler to manufacture and could last essentially forever."

Poudeu and Lopez made the discovery while experimenting with an earlier ferroelectric material made from a mix of iron, antimony and selenium. They substituted tin atoms for the antimony in hopes of increasing the material's conductivity. It didn't work—but it led to something far more interesting.

"Adding in the tin caused a charge imbalance, which is something we hadn't foreseen," Poudeu said. "Nature always finds a way to correct charge imbalances, and in this case it did that by oxidizing some of the antimony, resulting in a material with these unexpected properties."

Poudeu cautions that application of the discovery is likely several years off—for now, the team is focused on honing their understanding of the phenomenon, generalizing it to other compounds and finding the best ways to tweak its variables to fit specific applications. The team has applied for patent protection through the U-M Office of Technology Transfer.

The paper is titled "*Charge Disproportionation Triggers Bipolar Doping in FeSb2–xSnxSe4 Ferromagnetic Semiconductors, Enabling a Temperature-Induced Lifshitz Transition*." The research was supported by the National Science Foundation under award number DMR-1561008 and by the Department of Energy, Office of Basic Energy Science under award number DE-SC-0018941.

The "magic ratio" that could power future solar cells

A Q&A WITH PROFESSOR RACHEL GOLDMAN

Rachel Goldman's lab is working to produce "designer alloys" with carefully tailored electrical and light-absorbing properties. These materials could one day be used to build solar cells with double the efficiency of the flat-panel silicon cells that dot rooftops today. The new cells, called concentrator photovoltaics, use gallium arsenide semiconductors instead of the silicon-based semiconductors used in today's cells. Gallium arsenide could move us toward the utility-scale solar arrays we'll need to make solar energy a large part of our electrical infrastructure.

In her most recent paper, Goldman and her collaborators discovered how incorporating small fractions of nitrogen and bismuth in gallium arsenide semiconductors affects their structure and light-absorbing properties, creating a new map for bandgap engineering of designer semiconductor alloys. The advance could accelerate the development of concentrator photovoltaics, and could also lead to advances in semiconductor lasers and quantum computing.

How is your "magic ratio" useful in solar cells?

Concentrator photovoltaics will depend on the development of alloys that are safer and less expensive than those currently used in gallium arsenide semiconductors. In our earlier research, we developed alloys that use a combination of nitrogen and bismuth. Since then, we've been working to develop a more complete understanding of exactly how the nitrogen-bismuth combination functions, and how changing the proportion of those two elements affects the alloy's overall properties.

That research led us to the "magic ratio"—the precise proportion of bismuth to nitrogen that works best with a gallium arsenide substrate. We've found that by slightly tweaking that ratio within a certain range, we can control what bandwidth of light that the alloy absorbs.

What's the main hurdle standing in the way of concentrator photovoltaics?

Turning "near-infrared" light into electricity is one big challenge—this is light that's just outside the visible spectrum. A gallium arsenide solar cell consists of several thin layers of metal alloy sprayed onto a gallium arsenide substrate. It's these thin layers that turn light into electrical charge. Each layer absorbs only a specific wavelength of light. A wavelength that slips through one layer can be caught by the next.

The "magic ratio" should help researchers dial in the exact mix of an alloy to absorb whatever bandwidth of light they choose.

How were you able to do what others couldn't?

We had to start by acknowledging that the conventional way of thinking about alloy composition doesn't work for bismuth-nitrogen alloys.

Making an alloy out of individual atoms is a little like filling a box with a mix of differently-sized marbles. If you know the sizes of the marbles and the size of the box, you can calculate the combination of marbles that will fill the box exactly. Researchers can calculate the composition of most alloys by using x-ray diffraction to measure the "box" and then calculating the combination of atoms that fits.

That doesn't work with bismuth and nitrogen. Bismuth is very large and nitrogen is very small, so it's more like mixing sand and marbles. It's hard to measure the size of a single grain of sand and even harder to predict how it will flow around all those marbles.

So we worked with labs in New Mexico, Poland and Romania, as well as here at U-M, to develop a series of measurements that would each solve part of the puzzle. Then we brought them all together to precisely determine the ratio of nitrogen to bismuth in a wide range of sample alloys, and how that ratio affects light absorption properties.

Where else might these kinds of alloys be useful?

A better understanding of nitrogen-bismuth alloys could help us build more efficient infra-red lasers, which are widely used in fiber-optic communications and in the military. They could also be used in quantum computing, to build transistors that use the spin of electrons as a way to store information.

When will the results of this research go into widespread use?

There's still a lot of progress to be made. But this research opens the door to a better understanding of exactly how these alloys work and how to make them do what we want, in solar power and elsewhere.

Goldman's most recent paper is titled *"Mapping the composition-dependence of the energy bandgap of GaAsNBi alloys."* It is published in the August 23, 2019 issue of *Applied Physics Letters.* U-M graduate researcher Jordan Occena, T. Jen and J.W. Mitchell are also authors on the paper.

An earlier, related paper is titled *"Bi-enhanced N incorporation in GaAsNBi alloys."* It published in the June 15, 2017 issue of *Applied Physics Letters.*

EVENTS

Diran Apelian, the 2019 Robert D. Pehlke Lecturer, delivers his talk, "Aluminum Alloy Design Strategies for Enhanced Performance" on September 13. Apelian is Distinguished Professor, University of California-Irvine and Alcoa-Howmet Professor of Engineering and Founding Director of the Metal Processing Institute, WPI, Worcester, Mass.

ROBERT D. PEHLKE LECTURESHIP IN MATERIALS PROCESSING

Diran Apelian emphasizes importance of relationships, cites Bob Pehlke as ultimate role model

Bob Pehlke was a 'supreme professional,' Apelian said of the lectureship namesake.

MSE was honored to have Diran Apelian headline the 2019 Robert D. Pehlke Lectureship in Materials Processing on September 13. Apelian is a Distinguished Professor at UC-Irvine, Alcoa-Howmet Professor of Engineering, and Founding Director of the Metal Processing Institute (WPI) in Worcester, Mass.

At the lectureship dinner the evening before, Apelian praised MSE Professor Emeritus Bob Pehlke, who was in hospice at the time and who sadly passed away a month after the lectureship, on October 22.

"This isn't about me, this is really about Bob Pehlke's legacy," said Apelian, who first became acquainted with Pehlke while as a young professor teaching extracted energy from one of Pehlke's textbooks. "Bob was responsible, committed, dedicated – a supreme professional."

Apelian then segued to a message for graduate students using Pehlke as the ultimate example: "Always keep in mind," Apelian began, "accomplishments are great, but it's the relationships that you have with people – your colleagues, your peers, the president of the university – that really matters. It's been said that you make a living by 'what you get,' but you really make a life by what you give. And Bob gave a lot to this department and to the community. That's the legacy we're celebrating and I hope I will be able to add my contribution to that by the lecture tomorrow."

Apelian did not disappoint.

In his lecture "Aluminum Alloy Design Strategies for Enhanced Performance," Apelian discussed how the demand for lightweighting of our infrastructure and transportation equipment has seen a significant growth the last two decades, and how this need is expected to increase as the reduction of carbon footprints and energy consumption will be major drivers in the decades ahead. He argued that aluminum has played a pivotal role in this lightweighting movement and will continue to do so, as will the need for high performance Al alloys such as enhanced modulus, usage at elevated temperatures, and damage resistant alloys, etc.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1. Diran Apelian answers a question at the end of his talk on September 13. 2. MSE Chair Amit Misra presents the 2019 Robert D. Pehlke Lectureship Award to Apelian. 3. Professor John Allison, Diran Apelian and Professor Emeritus Wayne Jones pose after the lectureship dinner. All are former presidents of TMS. 4. Dave Pehlke delivers remarks on behalf of his father, Bob Pehlke, at the lectureship dinner on September 12.

Lawrence H. Van Vlack
LECTURESHIP
in
Materials Science & Engineering

1.

Van Vlack Lectureship celebrates Frances Ross, electron microscopy

An electron microscopy pioneer, Ross' visit coincided with 50th anniversary of EMAL

There was so much to celebrate when renowned electron microscopy expert Frances Ross visited campus this past fall as our 2019 Van Vlack Lecturer. On October 17 and 18 she presented two lectures: "Transmission Electron Microscopy in Motion" and "Visualizing dynamic processes in liquids in the electron microscope."

"We were so excited and honored to have Frances Ross as our 2019 Van Vlack Lecturer," said Katsuyo Thornton, the L.H. and F.E. Van Vlack Professor of Materials Science and Engineering. "Professor Ross is a pioneer in transmission electron microscopy. She transformed the field of *in situ* transmission electron microscopy to enable the observation of crystals as they grow and react in a wide range of environments."

Frances M. Ross received her B.A. in physics and Ph.D. in materials science from Cambridge University. Her postdoc was at AT&T Bell Laboratories, using *in situ* electron microscopy to study silicon oxidation and dislocation dynamics, after which she joined the National Center for Electron Microscopy, Lawrence Berkeley National Laboratory, where she studied processes such as anodic etching of Si using electron microscopy. She then moved to the IBM T. J. Watson Research Center where she imaged the growth of nanoscale materials using a microscope with deposition and focused ion beam capabilities and also developed liquid cell microscopy for visualizing electrochemical processes. She joined MIT in 2018. Her interests include nanostructure self-assembly, liquid cell microscopy, epitaxy and electrochemical processes.

The timing of Frances Ross' visiton campus couldn't have been better, as this fall marked the 50th anniversary of the founding of U-M's Electron Microbeam Analysis Laboratory (known as EMAL and now called Michigan Center for Materials Characterization, or $(MC)^2$).

Though there was no formal anniversary celebration, Ross' visit served as a catalyst for an impromptu reunion with those who were the backbone of EMAL in the early years, including founder Professor Emeritus Wil Bigelow, former manager John Mansfield, former research scientist Peggie Hollingsworth, and former graduate students John Mardinly (Chandler, Ariz.), Larry Allard (Knoxville, Tenn.) and Abhaya Dayte (Albuquerque, NM).

The annual Lawrence H. Van Vlack Lectureship was founded in 2001 in honor of Professor Larry Van Vlack, who was instrumental in establishing what would eventually become the current Department of Materials Science and Engineering. Van Vlack authored 12 books, including the iconic *Elements of Materials Science and Engineering*, which, through its more than 25 foreign editions and translations, has introduced millions of students worldwide to the discipline of materials science and engineering.

1. A packed crowd listens raptly to Ross' lecture on October 17: "Transmission Electron Microscopy in Motion" in the Johnson Rooms.

Katsuyo Thornton, L.H. and F.E. Van Vlack Professor of Materials Science and Engineering, presents Frances Ross with the 2019 Van Vlack Lectureship Award.


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2. Professor Emeritus Wil Bigelow is introduced at the Van Vlack dinner. 3. Laura Van Vlack, daughter of Professor Larry Van Vlack, explains how editing her father's famous textbooks was a family affair. 4. John Mardinly, the last graduate student to have Van Vlack as an advisor, makes remarks at the dinner. 5. Dr. Larry Allard, now at Oak Ridge National Lab, drove from Knoxville, Tenn. to be a part of the Van Vlack Lectureship and EMAL reunion.

PRISMS CENTER

Glenn Tarcea leads PRISMS software training at the center's fourth-annual workshop in August.

The Center for PRedictive Integrated Structural Materials Science (PRISMS Center) held its fourth annual workshop in August 2019 – and featured a great cast of invited and PRISMS Center speakers. The talks focused on understanding and predicting microstructural evolution and mechanical behavior of metals and alloys, with a focus on magnesium alloys. The workshop included three days of training on the latest PRISMS Software tools and the Materials Commons. The training was attended by 25 researchers. Over 60 researchers attended the two-day technical symposium that was held later in the week.

On the science side, we have made major advances over the past few years in understanding the influence of alloying on cyclic twinning, cyclic deformation and low cycle fatigue, the influence of grain boundaries on fatigue crack propagation and on precipitate evolution in Mg-rare earth alloys.

In addition, we have initiated new areas of research on complex alloy optimization, understanding corrosion and predicting grain size effects on strength.

To date, our four primary high performance open-source PRISMS software tools have been downloaded by over 1500 researchers worldwide and our information repository and collaboration platform, the Materials Commons, has over 275 users who have uploaded over 1.1 million data files. We make upgrades to PRISMS software annually and to Materials Commons almost monthly. These open-source tools are all available free—and we'd be pleased to help you use them in your research.

PRISMS is sponsored by DOE, Basic Energy Sciences.To join our mailing list and/or find additional information, please visit the PRISMS Center website at www.prisms-center.org.

MSE alum Dr. Aeriel Murphy-Leonard teaches a session at the August technical symposium, which was attended by 60 researchers.

Professor Dallas Trinkle of the University of Illinois delivers an invited lecture at the PRISMS Workshop in August.

Electron Microscopy Lab—now known as (MC)²—turns 50

(MC)² had a lot to celebrate this year, including a Golden Anniversary.

A brief history of EMAL

MSE Professor Emeritus Wil Bigelow founded the Electron Microbeam Analysis Laboratory (EMAL) in 1969 following the acquisition of an electron microbeam x-ray spectrochemical analyzer (Microprobe) in 1967 and a scanning electron microscope in 1969. Researchers from all over campus were welcomed to use EMAL's facilities, and they were assisted in the use of its instruments, mainly by a group of four students who were largely responsible for the laboratory's early success: Larry Allard, John Mardinly, Steve Krause and Peggie Holingsworth. In 1987, Bigelow stepped down and Dr. John Mansfield took the helm. In 2015 the lab was renamed the Michigan Center for Materials Characterization (MC)², and Associate Professor Emmanuelle Marquis came on board as director.

Now, fifty years later, (MC)² supports a diverse multi-disciplinary user base of more than 450 users from across U-M, 100+ internal research groups, and over 20 non-academic companies.

The center recently acquired aThermo Fisher Helios G4 PFIB UXe, a high-resolution SEM with an Xe plasma focused ion beam, and a Thermo Fisher Talos F200X G2, a 200 kV FEG scanning transmission electron microscope (S/TEM). They also recently welcomed two new staff members: Dr. Nancy Muyanja, x-ray tomography and spectroscopy expert, and Dr. Tao Ma, transmission electron microscopy expert.

"Thanks to decades of dedicated individuals, (MC)² is poised to continue its unparalleled contributions to the field of materials characterization," said Marquis.

Dr. John Mansfield, Dr. John Mardinly, Dr. Peggie Hollingsworth, Professor Emeritus Wil Bigelow, Dr. Larry Allard and Dr. Abhaya Datye at the Van Vlack Lecture, which served as a catalyst for an informal gathering in celebration of EMAL's 50th anniversary.

John Mansfield retires after 3 decades of service

Dr. Nestor Zaluzec poses with John Mansfield at his retirement celebration June 24.

On June 24, family, friends, and former colleagues gathered together to celebrate the remarkable 31⁺-year career of Dr. John Mansfield.

Originally from Worcestershire, England, Mansfield received his B.Sc., M.Sc., and Ph.D. degrees from the University of Bristol in 1979, 1980, and 1983, respectively. Dr. Mansfield was a visiting scientist at the Microelectronics Center of North Carolina in 1986. He joined the U-M faculty as an assistant research scientist in 1987, and was promoted to associate research scientist in 1994.

Dr. Mansfield's research focused on the application of advanced microscopy techniques to the chemical, morphological, and crystallographic characterization of a wide variety of materials. He served as laboratory manager of the Electron Microbeam Analysis Laboratory (EMAL) from 1987-2005, then as the laboratory manager and associate laboratory director from 2005-15. In 2015 he was promoted to director of education and engagement, a position that he held until his retirement.

Throughout his U-M career, which included teaching the introductory electron microscopy course MSE562, Mansfield taught, mentored, and collaborated with over 6,110 undergraduate students, graduate students, and postdoctoral researchers in the field of nanoscale materials characterization. His efforts were always focused on student success and have ensured that graduate practitioners in advanced materials characterization are among the most proficient in the field.

"It's been a blast and I thank you all," Mansfield remarked at his retirement party, adding that he plans to stay active in retirement traveling and serving as editor-in-chief of *Microscopy & Microanalysis*, a major microscopy journal.

Dr. John Mansfield receives a standing ovation at the end of his retirement party, held June 24.

A Discover Engineering participant blows on smoke created by liquid nitrogen during a cryogenic ice cream activity.

OUTREACH

Sharing the wonders of materials science

Outreach activities in 2019 engaged a variety of ages in the hopes of increasing the future pool of materials scientists and engineers.

K-12 Outreach

The MSE graduate student outreach arm received a $4,000 grant from the Ceramic and Glass Industry Foundation (CGIF) to fund ceramics-related K-12 science outreach activities. As part of the program, students traveled to middle and high schools in the area to run lessons on materials science concepts. Interactive demos ranged from mixing concrete composites, to chocolate bar fractography, to pulling Jolly Rancher fiber optics. The activities were engineered to fit in with teachers' existing lesson plans and to spread knowledge about what materials and ceramics engineers do.

Xplore/Discover Engineering

Over the summer, the Van Vlack Lab was bustling with kids engaged in hands-on materials science activities during the College's annual events, which again this year drew hundreds of alumni families to campus. In June, 4th-6th graders visited MSE with Xplore Engineering, and then in August, 8th-10th graders came with Discover Engineering. If you have a child interested in participating in either camp, contact hinesone@umich.edu.

Summer School for ICMEd

MSE held the ninth annual Summer School for Integrated Computational Materials Education (ICMEd) June 3-14.

Founded in 2011 by MSE Professor Katsuyo Thornton, Summer School for ICMEd spends 10 days training faculty, postdocs and graduate students who intend to teach computational MSE to undergraduates.

ASM Teachers' Camp

This past July, high school and college teachers came from across the country to develop their knowledge of MSE content, master new lessons and experiments to bring back to their own students, and see the cutting edge of materials science scholarship and research. The camp was led by ASM Master Teachers Debra Goodwin and Todd Bolenbaugh.

"It is our hope that these teachers will bring this understanding to their students, preparing them to explore the world of materials beyond their high school years," said Tim Chambers, MSE instructional lab supervisor.

STUDENTS

Michigan Materials Society (MMS) has award-winning year

Luis Rangel DaCosta, Evan Raeker, Nathan Ng, Rishav Choudhury, and Jacob Pietryga accept the MA Chapter of Excellence Award at MS&T.

In the spring, MMS was honored by CoE with the 2019 Elaine Harden Award, presented annually to an engineering student organization that best exemplifies dedicated leadership and service to the community. Then in the fall, MMS was recognized at the MS&T conference with the MA Chapter of Excellence Award. MMS is dedicated to supplementing the undergraduate experience with academic, professional and social opportunities. With support from the MSE department and CoE, students were able to attend conferences: MS&T and MRS in the Fall of 2019, and TMS and ANTEC in the Spring of 2020. Undergraduates also heard from companies such as General Mills, Medtronic, and BASF in our weekly Friday luncheons. We hosted several social events such as apple picking, movie night and fall picnic. Externally, MMS volunteers at outreach events to introduce younger students to MSE. Thank you to everyone who has donated to MMS and everyone that has supported the department through the dedication of time and resources—your help is invaluable. If your company would like to speak at one of our weekly luncheons, please email mmsboard19-20@umich.edu. For more information about MMS, go to **mms.engin.umich.edu.**

Undergraduate student awards

Nathaniel L. Field Scholarship
Dilara Meli

Richard A. Flinn Scholarship
Bethany DeMarco

Fontana-Leslie Scholarship Fund
Katie Ferguson

James W. Freeman Memorial Scholarship
David Allen, Alexandra Lillig

John Grennan Scholarship
Noel Boland

Jack J. Heller Memorial Engineering Scholarship Fund
Serena Day

William F. Hosford Scholarship
Anna Chambers, Lauren Hamp, Hailey Kuntz, Malhar Kute, Evan Raeker, Deborah Reisner

Schwartzwalder Memorial Scholarship
Kayla Byrd, Kori Maxie

Clarence A. Siebert Memorial Scholarship
Rishav Choudhury, Dhruv Tatke

Alfred H. White Memorial Scholarship
Nathan Ng

James P. Lettieri Undergraduate Award
Charles Moore

CoE Distinguished Achievement Award
Sahil Dagli

2019 graduates: Sahil Dagli, Zach Lewandowsky, Luis Rangel DeCosta, David Frank, Leah Hummel, Olga Kim, Tanvi Gupta, Morgan Meade, Cole Schneider, and Jed Forster.

MSE goes Down Under with 2019 Solar Car Team

Two MSE undergrads were part of this year's Solar Car team, which finished third (the only American team to cross the finish line) in the Bridgestone World Solar Challenge this past October in Australia. The 5-day race covered 1,800 miles.

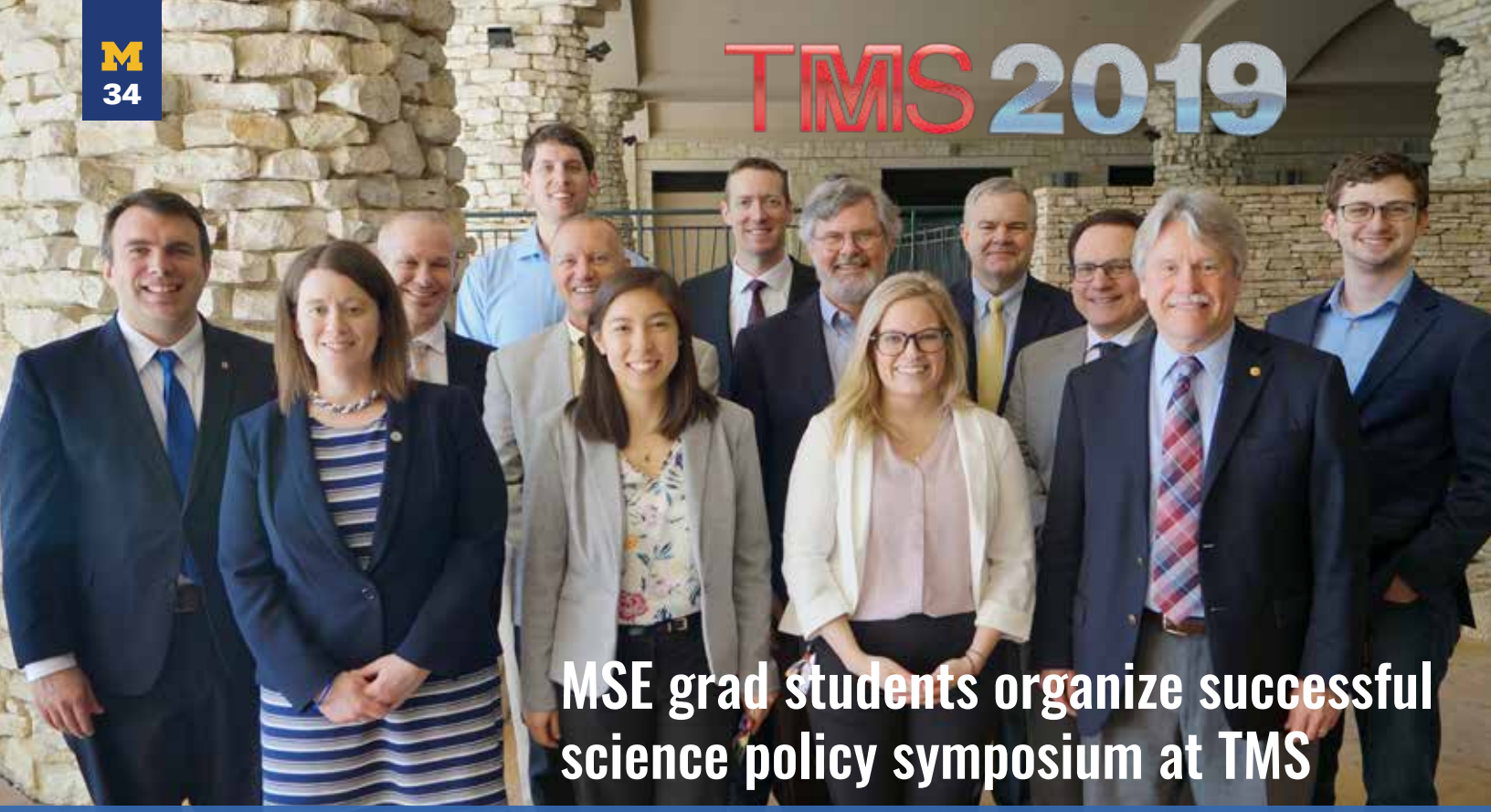
Matt Karls

"Being on the Solar Car Team allows me not only to practice the MSE skills I learned in the classroom, but also to expand my knowledge of the surrounding fields. I took the composite materials class with Dr. Sevener in Winter 2019 and learned about this class of materials. Solar Car allowed me to use this information for the benefit of the team. While I am responsible for the entire process, from creating a CAD drawing, laying carbon fibers, all the way to testing the performance of the parts, I also have to take into account everything else happening within the team. This collaborative experience has been invaluable to me as an engineer and a structurally focused MSE. Composites is not the only area MSE students can contribute and impact! The MSE department offers an incredibly robust degree that allows MSE students to work in the mechanical, battery, operations, or even the array division of Solar Car."

Grace VanRenterghem

"I was the composites engineer for Electrum, our 2019 Solar Car. I did structural design and analysis for all major composite components (chassis and exterior body), selected the materials for composite parts, and wrote and executed all the composite manufacturing plans. I enjoyed working with engineers from other disciplines to integrate the suspension, array, battery, brakes, and microsystems with the composite structures. The manufacturing of the chassis was the biggest challenge as there were over 30 layers of carbon in specific patterns. I ended up working from 4 am to 4 pm for a few weeks while another group worked 4 pm to 4 am in order to meet the deadline.

During the 3,000 km race, I was a race mechanical and fixed any on-road issues. I also performed all composite repairs, such as when Electrum ran over a lizard and I had to stay up all night in the middle of the Outback patching and smoothing the fairing with adhesives. At the end of the race, I was able to meet all the composite engineers from the other best solar car teams in the world. It was fun exchanging design and manufacturing tips as well as our craziest Outback stories. Thank you to the MSE department for supporting this amazing experience! I will treasure this adventure and all I learned along the way."



MSE grad students organize successful science policy symposium at TMS

Science Policy within the Materials Research Community session participants: (back row, left to right) Max Powers, U-M; Scott Litzelman, Advanced Research Projects Agency-Energy; (middle row) James Warren, National Institute of Standards and Technology; John Vetrano, DOE Office of Basic Energy Sciences; MSE Professor John Allison; MSE Professor Alan Taub, LIFT; and Peter Meisenheimer, U-M; (front row) Edward Herderick, The Ohio State University; Alexis Lewis, NSF; Kathleen Chou, U-M; Ashley Hilmas, U-M; and Iver Anderson, Ames Laboratory and the University of Iowa.

"We were excited that the sessions were so well attended all day. The crowd appeared to be a mixture of students, professionals, and academics, so we are glad that the topic was interesting to a breadth of conference attendees."

—Peter Meisenheimer, PhD candidate

Four MSE graduate students - **Kathleen Chou, Ashley Hilmas, Peter Meisenheimer** and **Max Powers** - organized a symposium on Science Policy Within the Materials Research Community at The Minerals, Metals and Materials Society (TMS) Annual Meeting in San Antonio in March. TMS implemented the experience a few years ago to give graduate students the opportunity to be active contributors to the conference, engage with leaders in the field, and gain valuable experience for organizing a conference symposium. The symposium planning rotates universities every year, so 2019 was U-M's year.

The session consisted of speakers from various universities, funding agencies, and national laboratories, including MSE Professors Alan Taub (invited speaker) and John Allison (panelist). The symposium focused on the interconnection between the scientific community and science policies, the common obstacles that should be addressed in order to move forward with future research, and how science policy decisions affect the various scientific and engineering communities.

"Having the chance to organize a symposium as graduate students was a tremendous opportunity, both to get experience in the logistics of putting together a symposium and to contribute to the TMS meeting in a new way," said Chou. "We wanted to choose a topic that would benefit both student and professional attendees, and science policy seemed to be a topic that would be interesting and relevant."

Added Meisenheimer: "We were excited that the sessions were so well attended all day. The crowd appeared to be a mixture of students, professionals, and academics, so we are glad that the topic was interesting to a breadth of conference attendees. The invited speakers were incredibly willing to share their expertise and experiences with the community and we heard talks ranging from forming industry-academic partnerships to developing and managing huge initiatives like the materials genome initiative. The organizing process, as well as the session itself, was a valuable experience and we are thankful for the opportunity."

Graduate student awards

Kenneth and Judy Betz Fellowship
Sam Frisone, Chen Jiadong

CoE Dean's/Named Fellowship
Sam Frisone, Chen Jiadong, Matthew Higgins, Brendan Miles, Alexandra Moy, Vishal Subramanian

CoE Graduate Fellowship
Juliane Scholtz, David Speer

Dean's Challenge Fund Fellowship
Chung Man Lim

Harry Ferrari Fellowhip
John Kim

Robert D. and Julie A. Pehlke Fellowship
John Kim, Joonsoo Kim

Rackham Block Grant
Michael Tong

Rackham Merit Fellowship
Nicholas Etrick

Frederick N. Rhines Fellowship
Joonsoo Kim, Chung Man Lim

Materials Research Symposium

The 4th annual Materials Research Symposium was held November 22, 2019. The symposium was open to graduate and undergrads across campus who are engaged in materials research.

Oral Presentations winners

Gold: Ben Derby (Misra) and **Peter Meisenheimer** (Heron)
Silver: Krystal Acosta (AERO - Inman), **Wonjin Choi** (Kotov), **Mohammad Kazemi** (AERO - Shaw), and **Kelsey Mengle** (Kioupakis)

Poster Presentations winners

Gold: Saman Moniri (Shahani)
Silver: Kathleen Chou (Marquis), **Catherine Snyder** (Tuteja/Mehta), **Li-Jen Yu** (Marquis)
Best undergraduate poster: Alexandra Pine (Love)

Materials Research Symposium oral presentation finalists: Kelsey Mengle (MSE), Ben Derby ((MSE), Peter Meisenheimer (MSE), Wonjin Choi (MSE),Krystal Acosta (AERO), and Mohammad Kazemi (AERO).

Grad students earn College, national, and international recognition

Talia Barth (Marquis lab) won a Graduate Excellence in Materials Science (GEMS) Award from ACerS Basic Science Division at the annual MS&T Meeting.

Kyle Bushick (Kioupakis lab) received a DOE Computational Science Graduate Fellowship, as well as an NSF Fellowship.

Kathleen Chou received the Richard F. and Eleanor Towner Prize for Academic Achievement. Also, the Graduate Society of Women Engineers (GradSWE) at Michigan, led by **Chou** and **Erin Evke**, was named an Outstanding Group by the global GradSWE community.

Brian Macdonald (Tuteja/Mehta labs) received an NSF Fellowship.

Peter Meisenheimer (Heron lab) won the MRS Fall 2019 Graduate Student Silver Award.

Kelsey Mengel (Kioupakis lab) received a Rackham Predoctoral Fellowship, as well as the Richard and Eleanor Towner Prize for Outstanding Ph.D. Research.

Bryan VanSaders (Glotzer lab) won a Rackham Predoctoral Fellowship.

Michael Wang (Sakamoto lab) received a Rackham Predoctoral Fellowship.

GRADUATIO

The 2019 MSE Graduation Awards Dinner took place on April 14 in the East Room of Pierpont Commons. Following dinner and a brief talk by the Spring 2019 Distinguished Alumni Lecturer, Mark Nichols, the following annual awards were presented to undergraduates, graduate students, and faculty.

PHD Conferrals

The following students graduated with his/her Ph.D. in December 2018, Spring 2019 or Summer 2019.

Beck Andrews
Advisor: Thornton
"Phase Field Simulations of the Coarsening of Complex Microstructures"

Erik Hanson
Advisor: Thornton
"Evolution and Impact of Microstructure in Functional Materials"

Yipeng He
Advisor: Taub
"Carbon Nanotube Alignment: Electromagnetic Field and Shear Force"

Justin Hesterberg
Advisor: Was
"Processes Responsible for the Mitigation of IASCC Susceptibility Following the Post-Irradiation Annealing of Austenitic Stainless Steels"

Juan Lopez
Advisor: Poudeu
"Tailoring Magnetic and Electronic Phenomena in Fe1-xSnxBi2Se4 and FeSb2-xBixSe4 Ferromagnetic Semiconductors"

MMS Anvil Award: Nathan Ng

MMS Distinguished Members: Tanvi Gupta & Andra Chen

Alpha Sigma Mu Distinguished Member: Kaitlyn Sallans

The Brian Worth Prize: Luis Rangel DeCosta

MSE Faculty Outstanding Accomplishment Award: Pierre Ferdinand P. Poudeu

Karl F. & Patricia J. Betz Family Faculty Scholar: Manos Kioupakis

Graduate Student Council (GSC)

Ben Derby, Aaron Gladstein, Sid Borsadia, Ashley Hilmas, Duncan Greeley, Keara Saud

Graduate Recruiting

Julia Lenef, Kyle Bushick, Taylor Repetto, Thomas Maulbeck, Geordie Lindemann

Maya Nath
Advisor: Taub
"Microstructure and Surface Characterization of Incrementally Formed AA 7075"

Ji Young Kim
Advisor: Kotov
"Asymmetry of Inorganic Nanostructures"

Aeriel Murphy-Leonard
Advisor: Allison
"The Effects of Alloying and Grain Size on Fatigue Life Behavior, Cyclic Stress-Strain Behavior, and Microstructural Evolution of Unalloyed Mg and A Mg-Al Alloy"

Jordan Occena
Advisor: Goldman
"Surface Dimer Engineering and Properties of GaAs(N)(Bi) Alloys"

Sarah Snyder
Advisors: Mehta/Tuteja
"Biological Applications of Surfaces with Extreme Wettabilitie"

Bryan VanSaders
Advisor: Glotzer
"Reconfiguring Colloidal Solids with Defects Using Active Matter"

Logan Williams
Advisor: Kioupakis
"First-Principles Calculations of the Thermodynamic, Structural, Electronic, and Optical Properties of Compositionally Disordered Semiconductor Materials"

1. EAB member Dan Gamota makes a joke at the start of the alumni panel. 2. EAB member Jody Hall introduces herself to students. 3. Alumni Merit Award winner Jim Yurko talks about his background during his presentation. 4. MSE senior Brendan Warren moderates the alumni panel. 5. EAB board member Jonathan Madison talks about opportunities at Sandia National Labs with a student at Industry Day. 6. Students wait in line to talk with Industy Day reps.

Alumni return to campus and share meaningful advice with students

Homecoming highlights included an Alumni Panel, Industry Day, and a presentation by 2019 MSE Alumni Merit Award winner Jim Yurko (BSE '97).

Homecoming on October 4 was again a packed and interactive day for both MSE students and alums.

The day kicked off with an EAB meeting, where board members got an update from the undergraduate and graduate committees, and discussed ways to bolster department fundraising efforts and undergraduate career development, among many other topics.

Following the meeting, this year's MSE Alumni Merit Award winner, **Jim Yurko (BSE '97)**, gave a presentation to an eager audience of students, faculty and staff. Currently the director of materials at Apple, Yurko shared his background and career path before giving students a glimpse into the materials magic behind some of their favorite Apple products.

"It's been an incredible journey," he told the audience, "and I wouldn't change a minute of it."

Immediately after his talk, Yurko joined several other EAB members on stage for a panel discussion, where the assembled alums fielded questions and dispensed career advice to students.

The day ended with an Industry Day with nine companies: AK Steel, Applied Process, BASF, Bocar, Eaton Corp., Hanon Systems, KLA, Sandia National Labs, and Thixomat/nanoMAG. About 100 students took advantage of the opportunity to talk one-on-oine with industry reps.

"In all, Homecoming was an amazing day," said MMS president Nathan Ng. "Students enjoyed interacting with alums and getting their career questions answered by those with real-world MSE experience. We truly appreciate all the MSE alums who took time out of their busy schedules to come to campus and share their important and highly valued 'words of wisdom' with us."

2019 Alumni Merit Award winner Jim Yurko (BSE '97), talks about how it was one of his childhood dreams to attend U-M.

HOM


6.

Chris Hewitt of BASF chats with students at Industry Day on Oct. 4.

Industry Day Participants

AK Steel
Applied Process
BASF
Bocar
Eaton Corp.
Hanon Systems
KLA
Sandia National Laboratories
Thixomat/nanoMAG

ECOMING '19

Distinguished Alumni Lectureship Award 2019

MSE's Distinguished Alumni Lectureship Award was established in 2016 to recognize our many alumni who are taking the lead in research and making seminal contributions in the field of materials science and engineering.

Mark Nichols (BSE '87, PHD '92)

After receiving his B.S.E. from U-M in 1987, **Mark Nichols** went on to earn an M.S. from the Univ. of Illinois in 1989, followed by a Ph.D. from U-M in 1992. All his degrees are in MSE. Dr. Nichols joined the Ford Research Laboratory in 1992 to work on the durability of elastomers. His current research is focused on automotive coatings. Topics of particular interest include: coating weatherability, corrosion, the fracture behavior of coatings and films, color science, and functional surfaces. In addition, Dr. Nichols is the Editor-in-Chief of the Journal of Coatings Technology and Research. Dr. Nichols is the co-author of two books; Mechanical Properties of Coatings, 2nded., and Organic Coatings: Science and Technology, 4thed.; has published over 75 peer-reviewed research papers; and holds 13 U.S. patents. Dr. Nichols was the 2008 recipient of the Henry Ford Technology Award, Ford's highest technical achievement, for his role in the development and implementation of a 3-wet paint process at Ford. Dr. Nichols has won several external awards from the American Coatings Association including the Industrial Excellence Award, the Roon Award, and the Distinguished Lecturer Award.

Mark Nichols accepts the Distinguished Alumni Lecture Award from Professor Emeritus Dick Robertson at the Graduation Awards Dinner on April 14.

Greg Hilmas (PHD '93)

Greg Hilmas is a Curators' Distinguished Professor of Ceramic Engineering and Chair of the Department of MSE at Missouri S&T. He received his BS in MSE from the University of Minnesota in 1986, his MS in Ceramic Engineering from The Ohio State University in 1989, and his PhD in MSE from U-M in 1993. He was a post-doctoral researcher at U-M from 1994 to 1995. Prior to joining Missouri S&T in 1998, he worked at Advanced Ceramics Research, Inc. in Tucson, Ariz.

Prof. Hilmas' research expertise is in the area of processing-microstructure-property relationships in structural ceramics and ceramic matrix composites, including ultra-high temperature ceramics (UHTCs). He has been awarded >$24M in research contracts from more than 30 different funding agencies and private companies. He has coauthored 148 journal papers, 65 conference proceedings papers, >470 invited and contributed presentations, and holds 12 U.S. patents. His current research, predominantly funded by DOE, NSF, ONR, DOE/NNSA, and private industry, involves the development of UHTCs for aerospace applications. He also has active research programs in welding of ceramics and additive manufacturing of ceramic and bioceramic materials.

2019 Distinguished Alumni Lecturer Greg Hilmas with daughter Ashley, who, following in her dad's footsteps, is currently an MSE Ph.D. candidate.

DONORS

Tim Chambers points out a clue on the SEM display to help a student guess the identity of a mystery specimen during a Discover Engineering activity in the Van Vlack Lab in August.

Following is a list of our generous donors from 2014-2019, organized by giving category.

Named Academic Fellowships/Awards/ Scholarships

Arden L Bement, Jr. Endowed Scholarship Fund
Dr. and Mrs. Arden L. Bement, Jr.

Brian Worth Memorial Account
Dr. David P. Adams and Dr. Michelle L. Griffith
Dr. Matthew J. Daniels
Mr. and Mrs. Edwin M. Worth

Da Ke and Rui Endowed Fund
Dr. John Q. Cheng and Ms. Jingxiao Zhang

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Dr. Janine J. Weins
Dr. Michael J. Weins

Karl & Patricia Betz Family Faculty Scholar Award Fund
Mr. and Mrs. Karl F. Betz

Kenneth and Judy Betz Fellowship Fund
Mr. Kenneth D. Betz
Kenneth D. Betz Trust

Nathaniel L. Field Materials Science and Engineering Scholarship Fund for Metals Research
Mr. Nathaniel L. Field III

Neil A. Weissman Fund for Materials Science and Engineering
Mr. and Mrs. Neil A. Weissman
Wells Fargo Foundation

Robert D. and Julie A. Pehlke Endowed Fellowship Fund
Professor Robert D. Pehlke

Schwartzwalder Memorial Scholarship
Intel Corporation
Mr. Kyle A. Luck and Ms. Heather N. Arnold

Wilbur C. Bigelow Materials Science and Engineering Scholarship Fund
Wilbur C. Bigelow Trust

William F. Hosford Scholarship Fund
Ms. Carol Stansbury and Mr. Roy K. Stansbury
Ms. Gwendolyn J. Chung and Mr. Gary R. Chung
Professor Emeritus William F. Hosford, Jr.
G.K. & E.M. Rasmussen Trust

Faculty Research

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American Lightweight Materials Manufacturing Innovation Institute
The Marsha Rivkin Center for Ovarian Cancer Research
Mercedes-Benz of North America, Inc.
Mercedes-Benz Research & Development North America
Michigan Ovarian Cancer Alliance
Semiconductor Research Corporation (SRC)
Shear Stress Modulates Invasiveness, Tumorigenicity
Mr. William A. Thompson
VentureWell
Mr. and Mrs. Marshall L. Weingarden

Materials Science & Engineering Fund

Materials Science & Engineering Fellowship Challenge Fund
Dr. Kevin H. Chang and Ms. Kwanwen Teng
Dr. John W. Norton, Jr. and Dr. Jessica R. TerBush
Dr. and Mrs. Obiefune K. Ezekoye

(Continued on pg. 44)

New equipment enhances Van Vlack Lab

A student in MSE360 prepares to cast aluminum test specimens using the large-capacity air melt furnace. Before this in-house capability, the class would take a field trip to Joyworks to get this metalcasting experience.

It's been another excellent year in the Van Vlack Laboratory. We've brought in several new tools to support broader opportunities for our students to engage in Maker activities and conduct mechanical testing on their many creations. On the making side, we've acquired a Haas VF-1 five-axis CNC machine and an Objet24 stereolithography 3d printer. These tools will help students prototype and fabricate custom-designed parts for their design classes, research, student project teams, and more. On the testing side, we've just installed a new Instron 3382A load frame for mechanical testing. The 100kN capacity of this frame combined with its high sensitivity extensometry and video capture tools enables students to collect qualitative and quantitative data on stronger, stiffer, and tougher materials than ever before.

In November, the MSE360 class melted aluminum in the new large-capacity air melt furnace, which was generously donated by the Keough Family Foundation.

"All of the new equipment significantly increases our lab capabilities in terms of opportunity for students to create and test their own alloys and to make metal components in their design and research projects," said Tim Chambers, MSE360 instructor and instructional lab supervisor.

> "All of the new equipment significantly increases our lab capabilities in terms of the opportunity for students to create and test their own alloys and to make metal components in their design and research projects."
>
> —Tim Chambers

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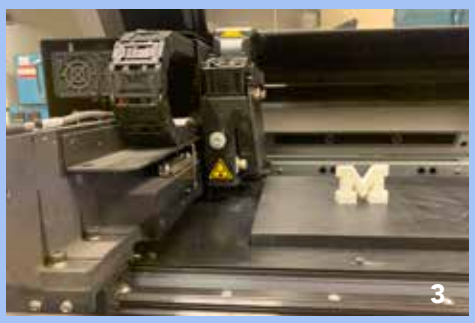

3.

New equipment in the Van Vlack Lab: 1. A new HaasVF-1 five-axis CNC machine. 2. A new Instron 3382A load frame for mechanical testing. 3. An Objet24 stereolithography 3d printer.

Materials Science & Engineering Discretionary Fund

Mr. Usama K. Abdali and Ms. Kisook Park
Dr. Evan M. Anderson and Ms. Annalise K. Anderson
Apple Inc.
Mr. and Mrs. Robert P. Badrak
Mr. and Mrs. Bruce A. Barth
Dr. T. P. Battle and Dr. M. M. Battle
Dr. William M. Boorstein
Mr. Branimir Botic
Professor Keith J. Bowman
Dr. and Mrs. John E. Brokloff
Mr. Robert A. Carnahan
Dr. Kevin H. Chang and Ms. Kwanwen Teng
Ms. Shirin Chaphalkar
Dr. Liya Wang and Dr. Huiqing Chen
Mr. Adam D. Cheslin and Mrs. Suzanne M. Guise Cheslin
Ms. Lori J. Classert
Mr. and Mrs. Tomas Cohn
Mr. and Mrs. Daniel E. Cullen

Ph.D. student Catherine Snyder explains her research poster "Fabrication of non-spherical and multiphasic particles with independent control of particle size, shape and chemistry" at the Materials Research Symposium on Nov. 22.

Dr. and Mrs. William E. Dowling, Jr.
Dr. Stephen C. Crump and Ms. Lisa A. Eichler
Dr. Amy W. Ferguson and Mr. Carl H. Ferguson
First Solar PAC
Mr. James D. Flasck and Ms. Nancy Flasck
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Ms. Michelle N. Kosovec and Mr. Matthew R. Kosovec
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MSE faculty and staff with the 2019 spring graduates at the MSE Graduation and Awards Dinner April 14. As the MSE Distinguished Alumni Lecturer, Dr. Mark Nichols (front row, center), was the evening's guest speaker.

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