SETUREUS COLLEGE OF ENGINEERING MATERIALS SCIENCE & ENGINEERING UNIVERSITY OF MICHIGAN



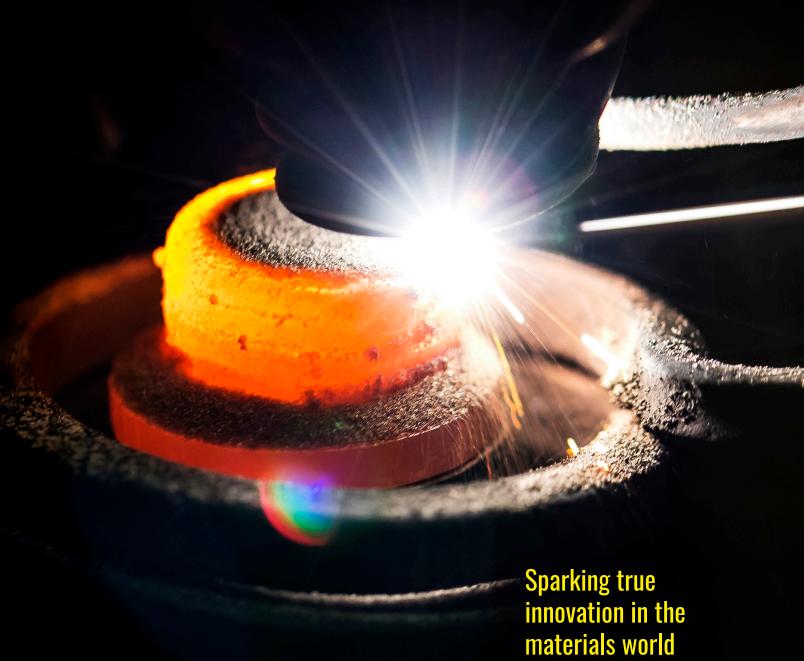


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Front cover: Laser-based direct metal deposition of advanced metallic alloys (Professor Jyoti Mazumder). Photo by Joseph Xu, Michigan Engineering





A note from the MSE Department Chair

Year 2018 was a whirlwind year of notable events and happenings for MSE. In faculty news, we were saddened by the recent death of Professor Emeritus William Hosford. In the spring, Professors Katsuyo Thornton and John Allison each earned chaired professorships, while Kathy Sevener started a new appointment as DEI Lecturer in MSE. We celebrated the inspirational career of Professor John Halloran, and at the end of the fall term, Professor Dick Robertson retired from



teaching and advising undergraduates after decades of service to the department.

In September, we held the annual Van Vlack Lectureship with featured speaker Subra Suresh, plus

inaugurated a new annual distinguished lectureship in MSE from a generous endowment from Professor Emeritus Bob Pehlke, with the inaugural lecture presented by Dr. Ron Radzilowski.

Our degree programs continued to rise in

excellence, and we expanded our efforts in diversity, alumni engagement and outreach through active collaboration between MMS, GSC, staff and faculty.

Homecoming was especially busy this year with an alumni career panel and career fair added to the schedule, creating more opportunity for MSE students to engage with alumni from all spectrums of the materials field.

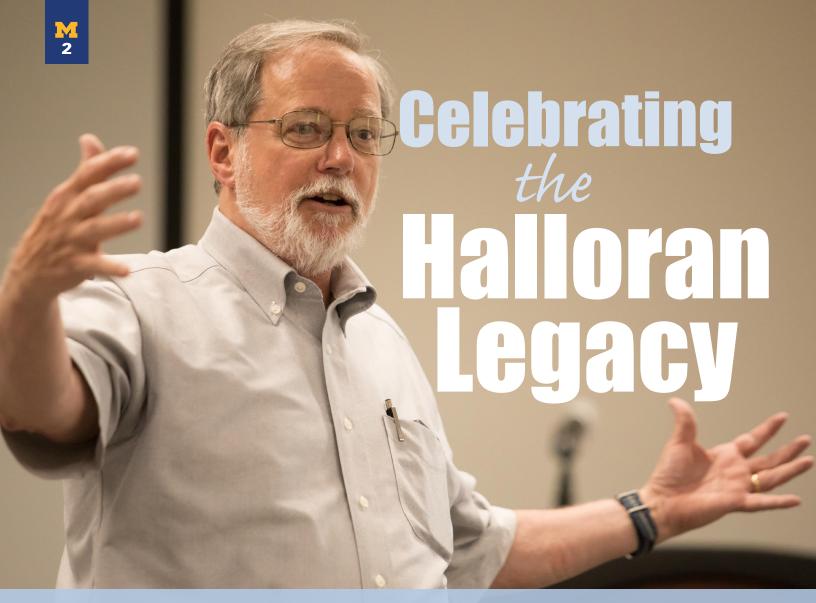
We look forward to continued teamwork and collaboration between alumni and faculty in 2019 as we attempt to boost our research infrastructure, degree programs and DEI initiatives, building on the expertise of MSE faculty.

As always, I welcome our alumni and friends to reach out to me and visit us anytime. Your engagement and support is highly valued.

Go Blue!

And Mine

Amit Misra Department Chair, U-M Materials Science & Engineering "We look forward to continued teamwork and collaboration between alumni, faculty and staff in 2019."



Professor John Halloran makes some parting remarks at his retirement celebration May 25.

This past spring, retired Professor John Halloran was celebrated for 27 years of captivating lectures and impactful ceramics research at U-M.

On May 25, 60 people – including 15 former students – packed into the East Room at Pierpont Commons to celebrate the teaching and research genius of Professor John Halloran.

"John brought an energy to the classroom like no one else," said Professor Emeritus Ron Gibala, who hired Halloran in 1990. "He was like the Energizer Bunny – but with lithium ion batteries, of course."

"John captivated everyone with his gyrations, his voice undulations, his gestures, and his relevant examples," commented Professor Emeritus Wayne Jones, who said he would sometimes sneak into Halloran's lectures just to watch him in action. "John could talk for two hours about how when heated, two marbles become one and you would all listen to every word because he's that good at what he does."

A preeminent ceramics researcher, Halloran's academic career began at the University of Missouri-

Rolla, where he graduated with a B.S. in ceramics engineering in 1973. He went on to earn a Ph.D. in MSE from MIT in 1977. He served on the faculty at both Penn State and Case Western before joining U-M in 1990. As Gibala observed, "John spent twice as much time at U-M than all of the other schools put together, so something must have gone right. John was good for Michigan and Michigan was good for John. It was a win-win situation."

Halloran's former students couldn't agree more.

"Being in the room with John Halloran was a 'hair-blown-back' event," commented Aaron Crumm, a member of Halloran's research group from 1996-2000, who, after earning his Ph.D., embarked on a start-up venture with Halloran. "The single most important thing I learned from John wasn't the ceramics, it was how to keep moving forward, how to be positive and how to look for that bright side."













1. Michelle Griffith flew in from New Mexico to surprise her former graduate advisor. 2. Brother-in-law Bob Hagen and son Peter check out a placemat with an array of old family photos. 3. Former student Grace Hsia poses for a photo. 4. John's sister, Peggy Hagen, enjoys Wayne Jones' anecdotal remarks. 5. Halloran passes out "gifts" from his office to former students. 6. Colby Halloran chats with John Allison post-party.

As many remarked, his personal and professional lessons have had an impact far beyond the classroom and lab.

"I touch roughly 200 lives on a daily and/ or weekly basis," said Michelle Griffith, now at Sandia National Laboratories, "and I use John's model of guidance, knowledge, and means of resources to help people be successful for themselves. John's words, wisdom and behavior run through my daily life and my work life, and for that I am so thankful."

"I've learned so much from John that it continues to influence what I do as a faculty member today," said former student Rod Trice, now a professor at Purdue University. "John's always been an advocate for students and that's something I still try to practice."

"We professor types have the best job in the world," Halloran commented in his closing remarks. "First of all, we love to do research and would do it for free but they pay us here! And then we get to work with all these clever people who walk through the door and bring in all these talents. It's so much fun to teach because at a school like Michigan the students are actually enthusiastic about learning. I'm going to miss that quite a bit."

Speaker Highlights



"Being in the room with John Halloran was a 'hair-blown-back' event."

—**Aaron Crumm**, co-founder of Adaptive Materials (AMI)



"He was like the Energizer Bunny – but with lithium ion batteries, of course."

-Professor Emeritus Ron Gibala



"He created an environment where I could grow and flourish as a scientist and engineer. That for me was life-changing."

—Rod Trice, professor at Purdue University



"John's words, wisdom and behavior run through my daily life and my work life, and for that I am so thankful."

—**Michelle Griffith**, Sandia National Laboratories





Professor **John Allison** was the first recipient of the College of Engineering's Staff-Faculty Partnership Award.



Faculty Emeritus **Wil Bigelow** was one of 28 elected Fellow of the Microanalysis Society (MAS). This was the first year MAS named Fellows.



Stephen Forrest has been named to the American Academy of Arts and Sciences. The 2018 class also includes President Barack Obama, U.S. Supreme Court Justice Sonia Sotomayor, and actor Tom Hanks.



Amit Misra was elected Fellow of the American Association for the Advancement of Science.



Ashwin Shahani's proposal "Abnormal Grain Growth in Four Dimensions" was selected by Army Research Office (ARO) to receive a Young Investigator Program award, his second YIP this academic year.



Max Shtein earned MSE's Outstanding Accomplishment Award, presented annually to a faculty member for their stellar performance in materials research and teaching and service to the department.



Alan Taub was named a Fellow by the Minerals, Metals and Materials Society (TMS), placing him in an elite group of materials professionals.



American Society for Metals International (ASM) named **Katsuyo Thornton** a Fellow of ASM, one of the highest honors in the materials field.

Faculty Professional Service

John Allison

- · TMS Materials Genome Initiative Ambassador
- · TMS Materials Innovation Committee, Chair
- · TMS Nominations Committee
- · TMS ICME 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

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
- · TMS Chemistry and Physics of Materials Committee
- · 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 Flexible Electronics Committee (2010-present)
- · ChemSusChem, Editorial Board (2007-present)
- · ACS Nano, Editorial Board (2007-present)
- The Technion, Israel Institute of Technology Board of Governors (2012-present)
- · Physical Review Applied, Editorial Board (2014-present)

Vikram Gavini

- · Chair, USACM Technical Thrust Area on Nanotechnology and Lower Scale Phenomena (2015-present)
- · Management Committee, Michigan Institute for Computational Discovery in Engineering (2016-present)
- · Steering Committee, Center for Data-driven Computational Physics (2016-present)

M5

Sharon Glotzer

- · ACS Nano, Associate Editor
- · APS Division of Condensed Matter Physics, Chair
- National Academy of Sciences Board on Chemical Sciences and Technology (2015-2018)
- · DOE Advanced Scientific Computing Advisory Committee
- · DOE Basic Energy Sciences Grand Challenges Committee
- · Unifying Concepts in Glass Physics, January 2015, Co-chair

Rachel Goldman

- · Chair, Scientific Advisory Committee, Center for Integrated Nanotechnologies, Department of Energy
- · Vice Chair, Division of Materials Physics, American Physical Society
- · Associate Editor, Journal of Applied Physics
- · Editorial Board, MRS News
- · Executive Committee, Electronic Materials Conference

Peter Green

- Member, the Massachusetts Institute of Technology Corporation Visiting Committee for the Department of Chemical Engineering
- · MRS Communications, Editor-in-chief
- External Review Board for Materials Research, Sandia National Laboratories
- · Advisory Board, ACS Petroleum Research Fund

John Heron

- · Guest Editor of MDPI Materials special issue "Advances in Multiferroics" (www.mdpi.com/journal/materials/special_issues/ Multiferroics), 2018-2019
- Lead organizer of ACerS EMA Meeting "Frontiers in Ferroic Oxides: Synthesis, Structure, Properties, and Applications,"
 Jan. 2019
- · Co-organizer of APS March Meeting "Dielectric and Ferroic Oxides" Focus Session, 2019
- Member, American Ceramics Society, Materials Research Society, and American Physical Society

Jinsang Kim

- · Associate Editor, Macromolecular Research (Springer)
- · Advisory Board, Hanwha Advanced Materials Faculty Award

Emmanouil Kioupakis

· Program Committee member, 13th International Conference on Nitride Semiconductors (ICNS-13)

IN MEMORIUM

Professor Emeritus William F. Hosford

1928-2018



We were saddened to learn of the passing of Professor Emeritus William F. Hosford, 90, on December 28.

"We have lost a truly unique individual," said Professor Emeritus Wayne Jones. "His devotion to educating generations of students through his excellent teaching and his textbooks and monographs will be long

remembered by his colleagues and students."

A native of Maplewood, N.J., Professor Hosford received his B.S. from Lehigh University in 1950, his M.E. from Yale in 1951, and his Sc.D. from MIT in 1959. He was a trainee at GE from 1951-53, and he served as a lieutenant in the U.S. Army Signal Corps from 1953-55. Prof. Hosford joined the faculty at MIT in 1957. He came to U-M in 1963 and retired in 2004.

An inspiring teacher and researcher, Professor Hosford was recognized as an expert in the areas of mechanical properties and metal forming. During his career he published over 75 technical articles and two textbooks. He was a fellow of ASM International and a senior member of the Minerals, Metals, and Materials Society. In 1998, Hosford received the Albert Easton White Distinguished Teacher Award.

er, an "His talents, his sense of humor, and his energy and enthusiasm for life will be sorely missed by us all."

—Professor Emeritus Wayne Jones

"I'll always remember comments students offered about Bill," said Ron Gibala, Van Vlack Professor Emeritus and former MSE chair, "such as, 'He's a perfect picture of the stereotypical professor I had hoped to experience in college.' Many student evaluations described his courses as 'tough, but fair and fun.' Others said they couldn't imagine better student-faculty interactions than those at MMS picnics (over several decades!) at the Hosford farm home. I'll also remember that many MSE students have been scholarship recipients from the endowment fund that Bill and Peg initiated."

In his personal time, Hosford enjoyed canoeing in the Canadian wilderness where travel by water was the only means of transportation. He was recognized as a wonderful watercolorist who documented his life, family and travels with many paintings.

"We are all better for having known Bill," remarked Jones. "His talents, his sense of humor, and his energy and enthusiasm for life will be sorely missed by us all."

A memorial service is planned for March 17. For more information, contact Kristen Freshley at krisfres@umich.edu.

Kathy Sevener appointed DEI instructor in MSE



As part of the DEI (Diversity, Equity and Inclusion) strategic vision laid out in 2015 by U-M President Mark Schissel, the College of Engineering recently hired two DEI instructors, one of which is our own MSE lecturer Kathy Sevener, whose official DEI position began in the fall.

"I look forward to helping create a culture that values and welcomes the experiences, talents, and contributions of all students, staff and faculty," Sevener said.

As a DEI lecturer, Sevener's time will be split into a ratio of 80% teaching and 20% service, which, she says, will include collecting data from faculty about successes they've had in creating welcoming, inclusive classroom environments.

"The goal is to identify and collect effective teaching practices within the College and help disseminate that curricula to faculty," Sevener said, "to create a sort of scaffolding, if you will, for others to employ."

Professional Service (cont'd)

Richard Laine

- · Polymer Division of the American Chemical Society, board member, and chief organizer of new ACS-approved test in Polymer Science and Engineering
- · Director, Macromolecular Science and Engineering Program, University of Michigan (2006-2015)
- · Editorial Board, Polymer International
- · Organizer, Symposium on Hybrid Materials, Pacific Polymer Conference, 2015
- · Organizer, Polymers and Nanotechnology Workshop, 2017

Brian Love

- · Sandia National Laboratories Center for Integrated Nanotechnologies (CINT) External Proposal Advisory Board
- · Chair of the Advisory Committee for Financial Affairs for the University of Michigan, last four years

Peter Ma

- Tissue Engineering and Regenerative Medicine International Society-Americas
- · Council Member, Meetings Committee Member, Dental and Craniofacial TWIG Chair
- · International Association for Dental Research Distinguished Scientist Award Committee member
- · International Chinese Musculoskeletal Research Society, board member
- · Chinese Association for Biomaterials, Advisory board member
- · Grant reviewer: NIH, NSF, UK Regenerative Medicine Research Committee, etc.

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, member-at-large

Pierre Ferdinand Poudeu-Poudeu

· Co-chair of the DOE 2015 Synthesis and Processing Science Principal Investigators' Meeting

Jeff Sakamoto

- · DOE-BES, Basic Research Needs Workshop Panel Lead, Electrochemical Energy Storage (March 2017)
- · NASA Space Power Systems Review Board Member
- · Keynote Presentation, Kyoto, Japan, MRS-J, "Transitioning solid electrolytes into manufacturable solid-state batteries for EVs," August, 2017

Jeff Sakamoto (cont'd)

- · Member, Materials Research Society
- · Member, Electrochemical Society

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 & Manufacturing Division), March 2017-present

Donald Siegel

- · Member, Executive Committee, American Physical Society (APS) Group on Energy Research and Applications
- · Review panelist, U.S. Department of Energy Hydrogen Program and Vehicle Technologies Program Annual Merit Review
- · Review Panelist, NSF Division of Chemical, Bioengineering, Environmental, and Transport Systems
- · Affiliate member, U.S. DRIVE Hydrogen Storage Technical Team
- Faculty Advisor, U-M Society of Automotive Engineers, Student Chapter
- · Member of the Directorate, Joint Center for Energy Storage Research

Alan Taub

- · NAE Committee on Membership
- · Member, DOE USDrive Review Committee
- · MIT Corporation Visiting Committee for MSE
- · Dean's Advisory Council, University of California Davis
- · Panel Session for U.S. Senate Competes Act
- · Keynote Panel Michigan Minority Procurement Conference

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 (AR-CAT), 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

Steve Yalisove

- · MRS Bulletin, Member, Editorial Board
- · MRS Academic Affairs
- · Chair, MRS Education Sub-Committee Academic Affairs
- · TMS Accreditation Committee
- · ABET Volunteer
- \cdot Organizer, 9^{th} annual North American Materials Education Symposium, August 2018

Jinsang Kim tapped as new director of MACRO Program

As of July Professor Jinsang Kim is the new director of the Macromolecular Science & Engineering Program (MACRO).

A leader in the field of polymer science and engineering for nearly 45 years, MACRO is an interdisciplinary program that offers only graduate degrees. MACRO's 34 faculty members largely draw from Engineering (aerospace, biomedical, chemical, electrical, materials science, and mechanical), the Dental School, and the Department of Chemistry.

Professor Kim is a professor of Materials Science and Engineering (MSE), Biomedical Engineering, and Chemical Engineering. He is a former Graduate Chair of MSE. He has been a MACRO faculty member since 2003, and has advised numerous MACRO students. Professor Kim has served on the MACRO Faculty Executive Committee since 2006.

"My goals for the MACRO program include improving the visibility of this excellent degree program," Kim said, adding: "I plan to raise more funding such as industrial sponsorships and training grants, for example, for student fellowships and scholarships. I will also focus on more organized mentoring strategies for students for Graduate Research Fellowships and Graduate Research Awards from major professional societies and society meetings."





Katsuyo Thornton,

L.H. and F.E. Van Vlack Professor of Materials Science & Engineering



On May 16, Katsuyo Thornton was inducted as the L.H. and F.E. Van Vlack Professor of Materials Science & Engineering in a special ceremony/lecture in the Beyster Building.

"Endowed professorships are among the highest honors presented by the College of Engineering," said Dean Alec Gallimore in his opening remarks. "They help attract, reward and retain outstanding faculty members. They acknowledge faculty members' research, teaching and service."

Thornton's first Ph.D. student, Hui-Chia Yu, talked about how Thornton's perfectionistic tendencies continues to influence him in his current position as assistant professor at Michigan State. "Her insistence on high quality and her work ethic greatly affected me in my own research and my career," Yu said.

MSE chair Amit Misra highlighted the wide influence Thornton has had as a pioneer in computational materials science: "Katsuyo has championed the use of computational methods which has brought a completely new dimension in the field of materials science and engineering that gives a lot more capability and power in terms of what our field can do and how we can make an impact in future technologies that improve quality of life."

Thornton then presented her lecture, "Predicting the Future: Art and Science of Computational Materials Science at the Microstructural Scale."

At the conclusion of the ceremony, Dean Gallimore presented Thornton with a personally engraved medal (which she is to wear at all official university events, such as graduation), and unveiled her professorship chair before inviting her to take an official first seat. Guests, including Bruce Van Vlack and Laura Van Vlack-Ailes (son and daughter of Larry and Frances Van Vlack), then mingled and congratulated Thornton at a reception immediately following.

John Allison,

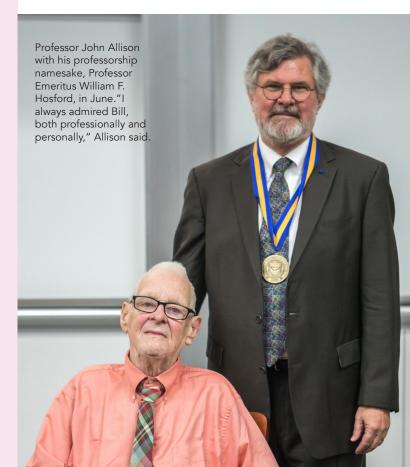
William F. Hosford Collegiate Professor of Materials Science & Engineering

This past spring Professor John Allison was notified that he had earned a collegiate professorship, and, as with all collegiate professorships, he got to choose the person after which to name it. Allison's choice? Professor Emeritus William F. Hosford.

"I always admired Bill, both professionally and personally," Allison said. "As a metallurgist, his contributions to both the science and engineering of metals and alloys are recognized around the world. Whether in the classroom or at the annual MSE picnic at the Hosfords' home on Traver Road, his devotion to the department and, in particular, to our students, made him a great role model for us all. It is a great honor for me to recognize and carry on his legacy through this professorship."

Hosford, 90, was able to attend the professorship ceremony with members of his family in June, but, sadly, passed away six months later.

"I thank John for deciding to name his collegiate professorship in Bill's honor," said Ron Gibala, Van Vlack Professor Emeritus and former MSE chair. "Although Bill received many honors and awards for his teaching and research over the years, that had to have been especially rewarding for him."



Jeanette Johnson retires after 21 years of service

When Jeanette Johnson started as an administrative assistant in 1996, Albert Yee was department chair, the first of four MSE chairs she would assist in her 21-year career.

"The department went through a lot of change and growth during my time here," Johnson commented.

In addition to serving as the liaison between the department chair and a variety of internal and external constituents, Johnson was responsible for coordinating departmental events, from receptions to professorships to the annual Van Vlack Lectureship.

To celebrate her dedicated service, the department threw a special retirement luncheon for her on June 25. "We appreciate all that Jeanette has contributed to the department over the past several years," commented MSE chair Amit Misra. "We wish her a long and happy retirement."



Introducing two new staff members...



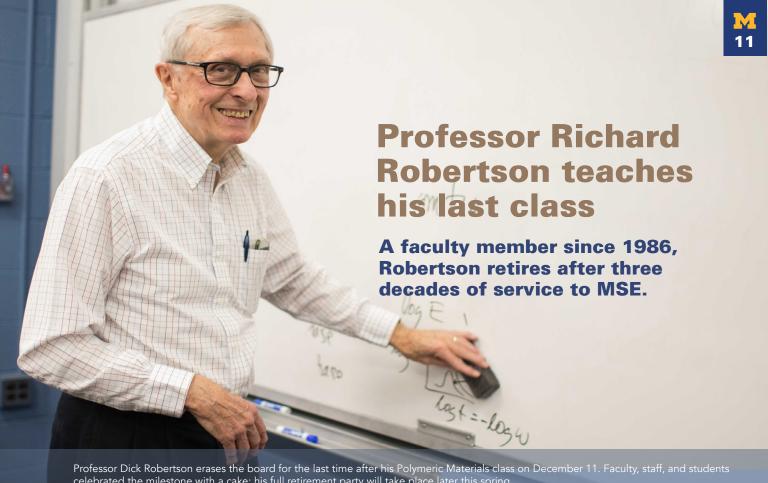
Amy Holihan, Research Process Manager

Amy is responsible for providing expert management and coordination of all aspects of research administration for the department.

Tina Longenbarger, Executive Secretary

Tina's role is to provide administrative assistance for the chair of the department, serve as the primary liaison for the chair's office, and manage the process for faculty promotions, reviews, searches, etc.





celebrated the milestone with a cake; his full retirement party will take place later this spring

With Robertson's retirement, Marquis takes over undergraduate advising reins



Following Professor Dick Robertson's retirement, Associate Professor **Emmanuelle Marquis** assumed the role of MSE undergraduate academic advisor on Jan. 1.

"I have big shoes to fill, no doubt," remarked Marquis. "But I look forward to working with students and making sure their time spent in our program effectively prepares them for their future careers in MSE."

Two MSE staff members earn CoE's first **Creativity, Innovation & Daring (C.I.D.) Award**

In December, engineering technician Tim Chambers and communications and marketing specialist Kristen Freshley were chosen as recipients of the College of Engineering's first Creativity, Innovation & Daring (C.I.D.) Award.

Part of the Michigan Engineering 2020 Strategic Vision, the pilot incentive program for staff was launched to recognize and reward people who embody Michigan Engineering's values of creativity, innovation and daring.





2018 Staff Service Awards

MSE staff members Chris Cristian (Intermediate desktop support specialist), Kristen Freshley (communications and marketing specialist), Todd Richardson (lead unit administrator) and Ying Qi (senior research project engineer) received the 2018 staff service awards presented on Dec. 19 at the annual department holiday luncheon.



Chris Cristian, Kristen Freshley, Ying Qi, and Todd Richardson

Creating new materials for national nuclear security



"Our goal as materials scientists and engineers is to make a difference in the world, and few issues are as important as national security and training the next-generation workforce."

—Professor and MSE Chair Amit Misra Amit Misra, Professor and Chair of Materials Science and Engineering, and Professor (by courtesy) of Mechanical Engineering, and Jyoti Mazumder, Robert H. Lurie Professor of Mechanical Engineering and Professor (by courtesy) of Materials Science and Engineering, are part of a new multi-university team that will contribute to our understanding of additively manufactured advanced metallic alloys for high-strain rate and other structural materials applications in national security.

The Center for Research Excellence on Dynamically Deformed Solids (CREDDS), will receive \$12.5 million over five years from the Department of Energy through the National Nuclear Security Administration (NNSA), the agency behind the Nation's Stockpile Stewardship Mission. CREDDS is multi-university team involving 10 faculty members from Texas A&M University (lead), U-M, University of California-Santa Barbara and University of Connecticut.

"We are excited to be a part of the new DOE/NNSA center," said Misra. "Our goal as materials scientists and engineers is to make a difference in the world, and few issues are as important as national security and training the next-generation workforce."

Materials for National Nuclear Security

The maintenance of the nuclear stockpile entails the introduction of new materials and processes. That's because some of the old manufacturing processes used to produce the original parts of a weapon no longer exist. Plus, some of the materials used in the past can't be used now because of environmental safety and health implications. As a result, scientists and engineers are exploring advanced manufacturing processes like 3D printing as well as new materials.

The advanced materials studied by CREDDS will have hierarchical microstructures that result in properties superior to their predecessors. "Additive manufacturing presents a new opportunity for design of heterogeneous metallic materials," Mazumder said, "but the challenge is to certify-as-you-build." The use of additive manufacturing technology in critical defense applications



requires a high level of quality assurance and Mazumder's group has pioneered *in situ* diagnostic approaches in the certify-asyou-build paradigm of advanced manufacturing.

Of special interest to CREDDS researchers is how the materials deform and spall under very high strain rates, or how quickly the shape of a material changes under extreme conditions such as shock loading. CREDDS researchers aim to observe what happens on the level of individual imperfections in an alloy when it is exposed to high strain rates. They will not only examine the material afterwards—a kind of postmortem analysis—but also understand what's happening during the deformation at short time scales through *in situ* experiments as well as advanced computer simulations. Overall, CREDDS will deliver not only new additively manufactured materials for national security applications but also mechanistic understanding and predictive capability of

quasi-static and high strain rate mechanical behavior through an integration of computational modeling and *in situ* experimental characterization.

Toward the Future

Just as important as the science is training the students. "It is critical to motivate and train the next generation of scientists and engineers to tackle the challenging problems of national security in the future that requires new materials, advanced simulations and manufacturing," Misra commented. To that end, CREDDS will include a variety of outreach activities that include seminars, symposia and summer schools. In addition, students affiliated with CREDDS will have the opportunity to conduct research for extended periods of time at the DOE/NNSA laboratories involved in stockpile stewardship.

A student in Jyoti Mazumder's lab runs a laser deposition system for 3D printing of metallic alloys.

"The new coating could enable equipment to slough off condensed water and chemicals more quickly, increasing efficiency by up to 20 percent. That's a game changer, as those industries are some of the world's most high-volume and energy intensive."



Mathew Boban, Graduate Research Assistant, pours viscous lubricants onto a flexible plastic slide with a superomniphobic coating.

"EVERYTHING-REPELLENT" COATING COULD KID-PROOF PHONES, HOMES

In an advance that could grime-proof phone screens, countertops, camera lenses and countless other everyday items, Associate Professor Anish Tuteja has demonstrated a smooth, durable, clear coating that swiftly sheds water, oils, alcohols, and, yes, peanut butter.

Called "omniphobic" in materials science parlance, the new coating repels just about every known liquid. It's the latest in a series of breakthrough coatings from Tuteja's lab. The team's earlier efforts produced durable coatings that repelled ice and water, and a more fragile omniphobic coating. The new omniphobic coating is the first that's durable and clear. Easily applied to virtually any surface, it's detailed in a paper published in ACS Applied Materials & Interfaces.

Tuteja envisions the new coating as a way to prevent surfaces from getting grimy, both in home and industry. It could work on computer displays, tables, floors, and walls, for example.

"I have a 2-year-old at home, so for me, this particular project was about more than just the science," Tuteja said. "We're excited about what this could do to make homes and daycares cleaner places, and we're looking at a variety of possible applications in industry as well."

He says the new coating is the latest result of the team's systematic approach, which breaks with the traditional materials science "mix-and-see" approach. By mapping out the fundamental properties of a vast library of substances, they're able to mathematically predict how any two will behave when they're combined. This enables them to

concoct a nearly endless variety of combinations with very specifically tailored properties.

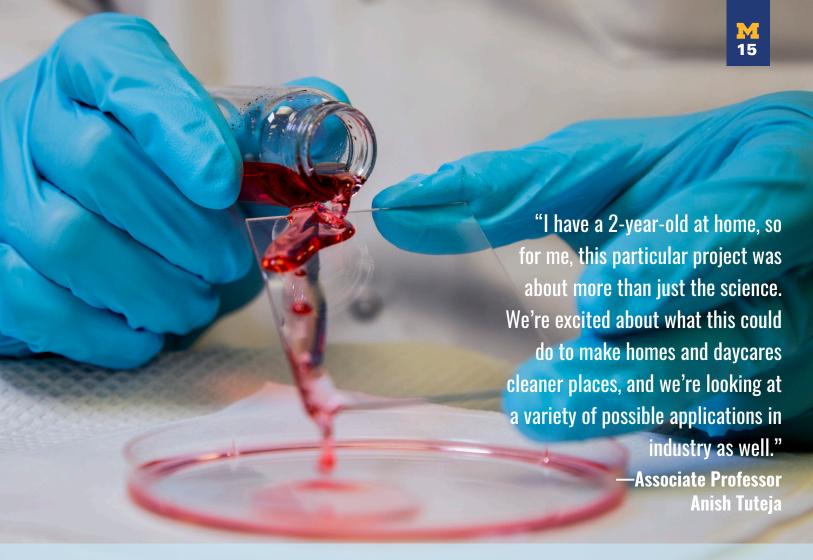
"In the past, researchers might have taken a very durable substance and a very repellent substance and mixed them together," Tuteja said. "But this doesn't necessarily yield a durable, repellent coating."

They discovered that even more important than durability or repellency is a property called "partial miscibility," or the ability of two substances to mix together in exactly the right way. Chemicals that play well together make a much more durable product, even if they're less durable individually.

Tweaking the miscibility of this particular coating posed a special challenge. To make a versatile coating that's optically clear and smooth enough to repel oils and alcohols, the team needed to find a repellent ingredient and a binder with exactly the right amount of miscibility, as well as the ability to stick to a wide variety of substrates. They also needed a coating that would stay smooth during processing and drying.

"You can repel water with a rough surface that creates tiny pockets of air between the water and the surface, but those surfaces don't always repel oils or alcohols because of their lower surface tension," Tuteja said. "We needed a very smooth surface that interacts as little as possible with a variety of liquids, and we also needed ingredients that mix together very well, because too much phase separation between ingredients will scatter light."

Ultimately, the team discovered that a mix of



Mathew Boban pours hexadecane oil onto a glass slide with a superomniphobic coating. The highly viscous lubricant slides easily off the slide, opening up applications like self-cleaning windows and ink jet printers. Photos by Robert Coelius, Michigan Engineering

fluorinated polyurethane and a specialized fluid-repellent molecule called F-POSS would do the job. Their recipe forms a mixture that can be sprayed, brushed, dipped or spin-coated onto a wide variety of surfaces, where it binds tightly. While the surface can be scratched by a sharp object, it's durable in everyday use. And its extremely precise level of phase separation makes it optically clear.

"The repellent and binder mix together well enough to make a clear coating, but there's a very small amount of phase separation between them," explains materials science and engineering graduate researcher Mathew Boban, an author on the paper. "That separation allows the F-POSS to sort of float to the surface and create a nice repellent layer."

Tuteja believes that the coating will be inexpensive by the time it sees the mass market—fluorinated polyurethane is an inexpensive, common ingredient. And while F-POSS is rare and expensive today, manufacturers are in the process of scaling it up to mass production, which should dramatically lower its cost.

The research team is also doing further studies to ensure that

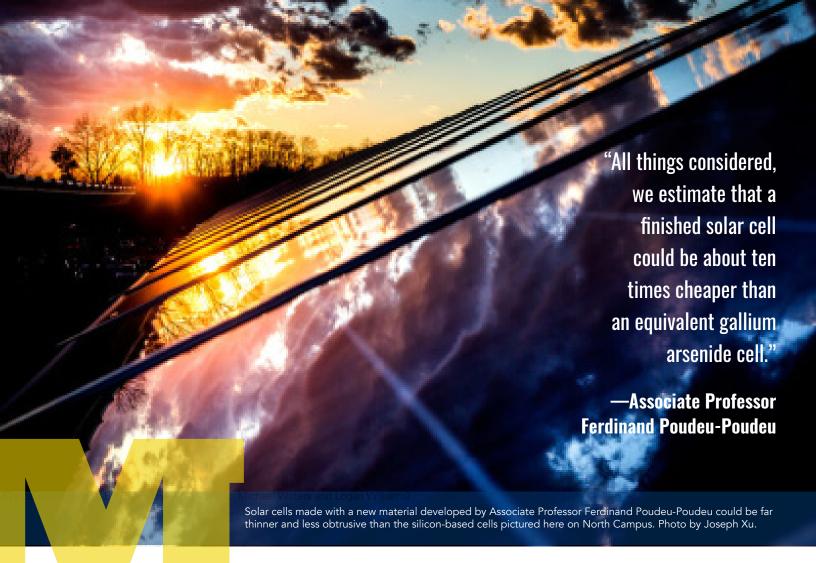
the coating is non-toxic for use in places like daycare centers. Tuteja estimates that the coating could go to market within the next two years, and he believes kid-proof coatings are just the beginning.

The coating could also be used in refrigeration, power generation and oil refining—all industries that depend on the condensation of liquids.

The new coating could enable equipment to slough off condensed water and chemicals more quickly, increasing efficience by up to 20 percent. That's a game changer, as those industries are some of the world's most high-volume and energy intensive.

The paper is titled "Smooth, All-Solid, Low-Hysteresis, Omniphobic Surfaces." Support for the research was provided by the Air Force Office of Scientific Research, the Office of Naval Research and the National Science Foundation. The University of Michigan and the U.S. Air Force have jointly filed patent applications related to the technology.

—Story by Gabe Cherry





Materials science is moving us closer to the era of "solar everywhere," says Pierre Ferdinand Poudeu-Poudeu, associate professor of MSE.

Poudeu led a team of researchers that uncovered a new material that could help usher in the next generation of high-efficiency, low-cost, environmentally friendly solar cells. Their paper, "Sustainable p-type copper selenide solar material with ultra-large absorption coefficient," was recently published in RSC Chemical Science. Poudou answered questions about the work and its implications.

Why is it important to develop new types of solar cells?

For solar energy to reach its potential, we need to embrace "solar everywhere." This is the idea of putting lightweight, unobtrusive solar cells into everyday objects like buildings, cars and clothing. Right now, materials scientists like me are working to find new materials that will make that feasible.

Why can't we use the kinds of solar cells that already exist?

The silicon-based solar cells you see on rooftops are too big and bulky to be unobtrusively built into everyday objects. They also take a lot of energy to manufacture and transport, and they're only about 20 percent efficient.

Gallium arsenide is an alternative to silicon that's in use today—in fact it's used in Novum, the U-M solar car. Gallium arsenide cells can be made thinner than silicon and they're very efficient, approaching 40 percent. The material absorbs light very well and also has electronic properties that make it good for solar cells.

The problem is that gallium is rare—rarer than gold. There isn't enough of it in the Earth's crust to make all the solar cells we're going to need. Arsenic, of course, is toxic, which presents environmental challenges.

Our team has been working to develop a material that has the advantages of gallium

arsenide, without its cost or toxicity.

How are your new findings working toward a solution?

We've created a material that's made of copper, selenium and titanium, processed in a way that combines the atoms of all three elements into a new crystal structure. It absorbs light as well as gallium arsenide in our testing. Copper, selenium and titanium are all readily available, non-toxic materials that cost about a fifth as much as gallium arsenide. Our new material is also much cheaper to process. Making a thin film of gallium arsenide requires an expensive process called molecular beam epitaxy, but our new material can be processed using a less expensive method called powder and pulse laser deposition.

In addition, our material can be made into a thinner film than gallium arsenide, which requires less raw material and makes the finished product lighter and easier to work with. All things considered, we estimate that a finished solar cell could be about ten times cheaper than an equivalent gallium arsenide cell.

How did you arrive at this particular solution?

On a basic level, we take atoms of individual elements and arrange them into a crystal structure called a lattice. This project built on a previous material that used two atoms of copper, two atoms of indium and four atoms of selenium. This gave us the properties we wanted, but indium is somewhat toxic and very expensive. Also, a compound with only eight atoms leaves a lot of vacant spaces in the lattice, and that causes defects.

So, we devised a process that replaced the two atoms of indium with two additional atoms of copper and one atom of titanium. This eliminated the need for indium, and because it uses more atoms, it has fewer defects.

What are the next steps for your research? How long before we see this technology in a solar cell?

We're at least three years from using this in a prototype solar cell. The first step is to change the compound's electronic properties to make it more suitable for solar energy use; we believe we can do this by making small changes to the way we process

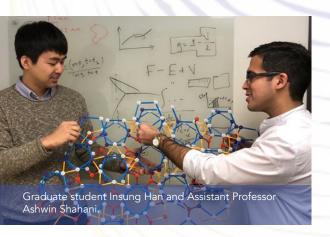
the material. Provided that goes well and we get the efficiency we need, we can then start work on a proof-of-concept solar cell.

Other authors on the paper include U-M materials science and engineering graduate researchers Erica M. Chen, Logan Williams, Alan Olvera, Mingfei Zhang and Guangsha Shi; U-M materials science and engineering assistant professors John T. Heron and Liang Qi; U-M materials science and engineering associate professor Emmanouil Kioupakis; U-M electrical engineering and computer science professor Jay Guo; and U-M electrical engineering and computer science graduate researcher Cheng Zhang. Funding for this project was provided by the Department of Energy and the National Science Foundation.

<mark>—</mark>Story b<mark>y Ga</mark>be Che<mark>rry</mark>

The material that could power tomorrow's solar cells

Showing in 3D: Quasicrystal Growth & Dissolution



Assistant Professor Ashwin Shahani and his team recently captured the real-time growth and dissolution of decagonal (2D) and icosahedral (3D) quasicrystals. Quasicrystals are structures that exhibit long-range order and non-crystallographic symmetry. Hence, quasicrystals do not have repeating unit cells, making this the main difference between quasicrystals and conventional, periodic crystals. The emergence of quasicrystalline structure from a parent liquid phase has been stimulating the curiosity of researchers worldwide since their discovery in the 1980s. Even so, the growth of quasicrystals remains a mystery. This is due to the lack of experimental investigations with which to test the various theories of quasicrystal formation.

To fill in the gaps in our understanding, Professor Shahani and his team conducted real-time X-ray imaging experiments on a stable decagonal quasicrystal (in the Al-Co-Ni system) and an icosahedral quasicrystal (in the Al-Pd-Mn system) at the Advanced Photon Source in Argonne National Laboratory (Lemont, Illinois). In situ and high flux X-ray tomography technique was employed to visualize the morphological evolution in real time at temperature during slow cooling. By virtue of the high spatial and temporal resolutions afforded by the synchrotron experiment, the team was able to observe the growth, equilibration, and dissolution of a single quasicrystal from the parent liquid phase and keep track of the transient morphological evolution.

Interestingly, the ten-fold symmetry of the 2D decagonal quasicrystal was maintained during growth, which indicates nearly the same growth rate of the ten facets belonging to the decagonal quasicrystal (see image at left). In this mobility-limited regime, growth occurs via cluster attachments and rearrangements at the growth front. However, the ten-fold symmetry was broken upon dissolution (right). Therefore, the growth and melting processes of the decagonal quasicrystal do not have time-reversal symmetry, and quasicrystal melting is not locally-

controlled. In addition, Professor Shahani and his team derived the kinetic coefficient of the Al-Co-Ni decagonal quasicrystal, which is proportional to the growth rate of crystals, during the growth experiment. The kinetic coefficient of decagonal quasicrystal was calculated based on analysis of X-ray attenuation through the sample as solidification proceeds. The calculated kinetic coefficient of the Al-Co-Ni decagonal quasicrystal was significantly smaller than kinetic coefficients of periodic crystals (both simple and intermetallic). The smaller kinetic coefficient points to the presence of large attaching clusters or "building blocks" that contribute to a sluggish growth rate, which supports the theory of cluster-based quasicrystal growth.

The morphology of quasicrystals during growth may be a function of the supersaturation. For instance, Professor Shahani and his team also investigated the growth of a 3D icosahedral quasicrystal and concluded that the growth shape of the icosahedral quasicrystal (a pentagonal dodecahedron) differed from its equilibrium shape (a truncated dodecahedron). Near-equilibrium is defined when the interfacial velocity of each facet is nearly zero. This study provided the first experimental evidence that the two shapes are not necessarily the same, consistent with theories of faceting in bond-oriented

"Aperiodic short-range order transcends quasicrystals. For instance, metallic glasses are also built up of icosahedral clusters," said Shahani. "Thus, the key insights gained in these works may also generally advance our understanding of glass formability and complex crystallization. Our next steps are to identify the atomic origins of cluster attachments leading to quasicrystal growth."

The papers regarding the quasicrystal growth were published in *Scientific Reports and Scripta Materialia*.

—Story by Insung Han

Metals that court chaos could be the future of computing

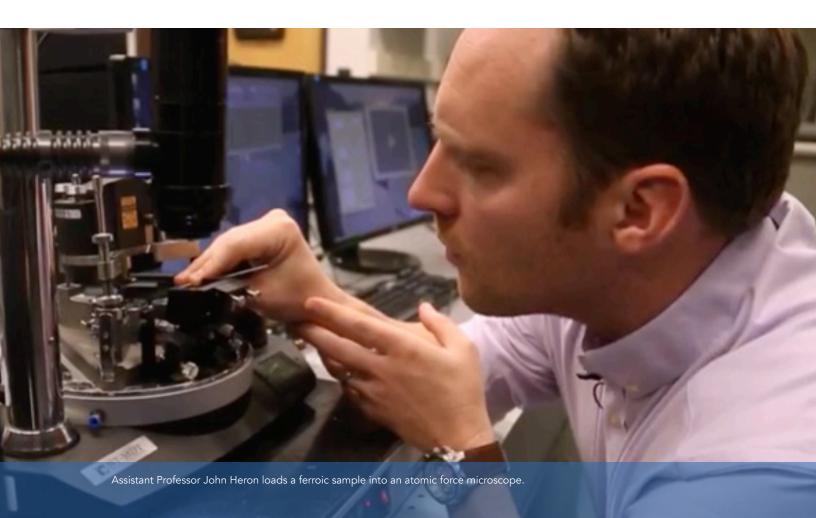
Assistant professor John Heron believes that entropy-stabilized oxides—metal mixtures that contain as many as eight different elements instead of an ordinary alloy's two or three–could one day drive a new generation of post-silicon computing devices. By using both magnetic fields and electricity to store data, they could potentially deliver superior performance while consuming a fraction of the power.

The trick is to develop alloys whose conductive and magnetic properties can be dialed in independently. This could create a metal whose magnetic polarity can be "flipped" with a pulse of electricity. Within the bounds of traditional alloying, it's a very difficult feat.

Heron's approach breaks traditional material boundaries by piling many elements into a ceramic alloy, creating disorder, or entropy. In the stereochemical chaos, the material begins to make its own rules, creating order from disorder and opening the door to a new world of alloys that are far more tunable and versatile.

Heron has taken the first step by showing that entropy-stabilized oxides can show unprecedented improvements in the type of magnetic phenomena used in hard disk drives. His lab is innovating with them right now. To learn more, check out the article, "Electric and magnetic domains inverted by a magnetic field," at nature.com.

In the...chaos, the material begins to make its own rules, creating order from disorder and opening the door to a new world of alloys that are far more tunable and versatile.





ROBERT D. PEHLKE LECTURESHIP

IN MATERIALS PROCESSING

The first Robert D. Pehlke Lectureship in Materials Processing was held Sept. 13-14.

The event featured
Dr. Ron Radzilowski,
a principal research
engineer with AK
Steel Corporation
and former graduate
student of
Professor Pehlke.

The first Robert D. Pehlke Lecture in Materials Processing, generously endowed by Professor Emeritus Robert Pehlke, was held September 13 and 14 and featured Dr. Ron Radzilowski, a principal research engineer with AK Steel Corporation and former graduate student of Professor Pehlke.

The inaugural lectureship festivities kicked off with a dinner in Tishman Hall followed by a presentation where Radzilowski shared anecdotal remarks about Pehlke's life and career, stretching all the way back to his boyhood. Raised in Ferndale, Michigan, Pehlke had two passions: hockey (he played left wing) and sports cars, especially Corvettes.

Radzilowski relayed a time when the two passions (literally) collided:

"One story that I'm happy ended well was when he was going to a hockey play-off game dressed in his hockey gear. Driving on Geddes Road, his Corvette met with another automobile and it was a quite serious accident – the Corvette was totaled, but he came out without a scratch. That was because he had the foresight to wear his protective hockey padding and that's why we still have him today."

Radzilowski went on to share Pelkhe's "mile long" list of academic accomplishments, including earning Fulbright honors as an undergraduate at U-M and



Professor-Emeritus Bob Pehlke and his former student, Dr. Ron Radzilowski, pose for a photo following a presentation Radzilowski gave about Prof. Pehlke's life and career, part of the inaugural Robert D. Pehlke Lectureship in Materials Processing.

UNIVERSITY

"The faculty are outstanding and the department is strong. We have a true gemstone here." —Professor Emeritus Robert Pehlke

advanced degrees at MIT. During his time on the U-M faculty (1960-2002), Pehlke mentored 25 doctoral students, and authored or co-authored 300+ technical publications and 11 books (including his recently published memoirs: "Adventures of a Materials Scientist," which Radzilowski praised as a "good read"). Pehlke also taught 60+ courses, to which Radzilowski could speak directly.

"He was a very good professor," Radzilowski said. "He was very tough, but I weathered it and I continued to work and am still working today so I have to thank him for his academic prowess."

Pehlke's early research focused on hightemperature physical chemistry, a field Radzilowski said he himself excelled in, again, thanks to Pehlke: "High-temperature physical chemistry was the game and thanks to Professor Pehlke and his classes and his toughness, I came out ahead on that score."

Later in his career, when funding dried up for steelmaking projects, Pehlke "reinvented" himself as an expert in computer-aided design in metallurgy, which, Radzilowski says, continues to be a "hot topic" to which Pehlke is still contributing.

Known worldwide for his industrial and forensic expertise, Pehlke has often been called on to conduct autopsies on failed metal systems. He is considered an expert in the processing of steel systems, blast furnaces and continuous caster systems, and has

advised/served as an expert witness for at least 100 legal cases.

One of Radzilowski's proudest moments, he said, involved recommending Professor Pehlke to conduct an autopsy at a Severstal North America plant, when one of its blast furnaces exploded in 2008.

"When they asked who we should call, I suggested Professor Pehlke, and the rest is history," Radzilowski commented, adding that it was a very dicey experience. "They attached a gondola to a 10-story-high crane and lowered him into the vessel, which was still extremely hot, to examine the interior," Radzilowski recalled. "The problem was the 10-mile-an-hour wind that kept the bucket moving back and forth. It was a white-knuckle experience."

At the conclusion of Radzilowski's remarks, MSE department chair Amit Misra presented Radzilowski with the inaugural lectureship award. The following morning, then, Radzilowski presented the first official Robert D. Pehlke Lecture in G.G. Brown: "Emerging Technologies and Process Innovations in the Steel Industry."

In his remarks the evening of the 13th, Pehlke told the audience: "You've heard a lot about me tonight but really it's about all of us. The [MSE] faculty are outstanding and the department is strong. We have a true gemstone here."

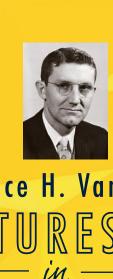




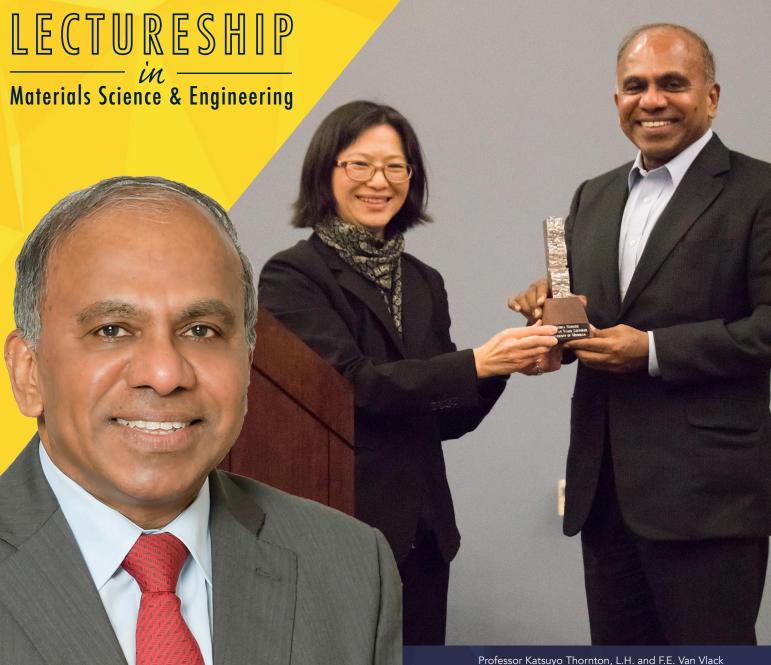




1. Professor Emeritus Bob Pehlke enjoys dinner with his family, who flew in from all corners of the country to attend. 2. Speaker Ron Radzilowski begins his presentation about the life and career of Prof. Pehlke. 3. Prof. Pehlke addresses guests after the presentation. 4. Prof. Pehlke and his daughter, Lisa, wait for Dr. Radzilowski's lecture to begin in 1571 G.G. Brown.



Lawrence H. Van Vlack



Professor Katsuyo Thornton, L.H. and F.E. Van Vlack Professor of Materials Science & Engineering, presents Subra Suresh with the 2018 Lawrence H. Van Vlack Lectureship Award.

2018 Van Vlack Lectureship features international materials icon Subra Suresh

This year's Van Vlack Lecture went international with a visit from Subra Suresh, current president of Nanyang Technological University in Singapore and former NSF director and president of Carnegie Mellon University.

"It was such an immense honor to have Professor Suresh make the effort to join us all the way from Singapore," said Katsuyo Thornton, the Lawrence H. and Francis E. Van Vlack Professor of Materials Science and Engineering, adding, "It just goes to show what enduring prominence the Van Vlack name has in the materials community."

The festivities began with dinner on the evening of September 26, which nearly 60 people attended, including Bruce Van Vlack of Goodrich, Mich., son of Larry and Frances Van Vlack. In a brief presentation following dinner, Thornton presented Suresh with his award.

"It is so wonderful to be back at the University of Michigan," Suresh commented, noting how he used Professor Van Vlack's iconic textbook Elements of Materials Science and Engineering in his early teaching days at MIT.

The next day Suresh participated in a series of group discussions with 18 different faculty members, taking time out in late morning to present a talk in Stamps Auditorium: "Materials Science and the Study of Human Diseases," in which he presented an overview of his research on biotechnology's intersection with material science and engineering.

"It's just so amazing how he can talk knowledgeably about materials fatigue one minute and blood disorders the next," commented Assistant Professor Ashwin Shahani. "I am in awe of the depth and breadth of his intellect."

Born in Bombay, India, Suresh is an eminent American scientist, engineer and entrepreneur with decades of distinguished and impactful leadership in academia, industry and government. From 2007-2010 he served as dean of the School of Engineering at MIT. In 2010 he was appointed by Barack Obama to head the National Science Foundation, which he led until 2013, when he left to become president of Carnegie Mellon University. He joined Nanyang Technology University as president on January 1, 2018.

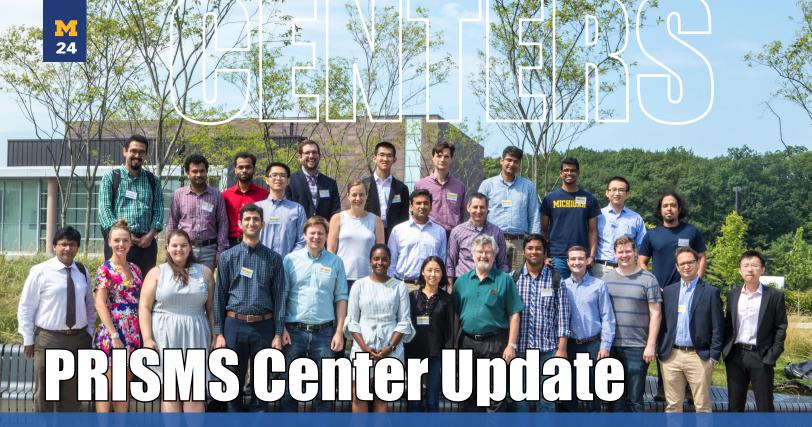
The annual Van Vlack Lectureship started in 2001 in honor of Professor Lawrence H. Van Vlack, who was instrumental in establishing what would eventually become the current Department of Materials Science and Engineering. Van Vlack authored 12 books, including *Elements of Materials Science and Engineering*,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







Top: Bruce Van Vlack (left), son of Larry and Frances Van Vlack, catches up with Professor Emeritus Ron Gibala, who was the first MSE faculty member to be installed as the L.H. and F.E. Van Vlack Professor of Materials Science & Engineering. Center: Professor John Allison listens to Subra Suresh at the dinner reception. Bottom: Subra Suresh addresses the audience after accepting the 2018 Lawrence H. Van Vlack Lectureship Award.



1100 researchers+ use PRISMS software tools/One million+ data files uploaded by 225+ users

PRISMS Center members include (front row) Amit Misra, Ellen Kampf, Anna Buzuolits, Mohammadreza Yaghoobi, Brian Puchala, Aeriel Murphy, Qianying Shi, John Allison, Aaditya Lakshmanan, Duncan Greeley, Ransom Stamps, David Montiel-Taboada, Chaoming Yang, (middle row) Zhihua Huang, Samantha Daly, Anirudh Natarajan, Glenn Tarcea, (back row) Mohsen Taheri, Phani Motamarri, Sambit Das, Stephen DeWitt, Zhe Chen, Anton Van Der Ven, Vikram Gavini, Srihari Sundar, Liang Qi, and Arunabha Roy.



PRISMS Center director John Allison teaches a session at the August technical symposium, which was attended by 60 researchers.

The Center for PRedictive Integrated Structural Materials Science (PRISMS Center) held its fourth annual workshop in August 2018 – 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, we have graduated seven Ph.D.s, and with our renewal last year, have added new students, post-docs and research staff for a total current PRISMS Center membership of 28 faculty, staff, students and post-docs. Our four primary high performance open-source PRISMS software tools have been downloaded by over 1100 researchers worldwide and our information repository and collaboration platform, the Materials Commons, has over 225 users who have uploaded over one 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.

We hope that you can attend our 2019 workshop which will be Aug 5-9. To join our mailing list and/or find additional information, please visit the PRISMS Center website at www. prisms-center.org.

M 25

(MC)² offers state-of-the-art materials analyses

(MC)² has upped its game. In early 2018, (MC)² unveiled its new Zeiss Xradia Versa 520 instrument. X-ray micro computed tomography (micro CT) is X-ray imaging in 3D, using a similar method to that of hospital CT (or "CAT") scan systems, but on a fine scale with significantly increased resolution. As a 3D microscopy technique, it allows the very fine-scale internal structure of objects to be imaged non-destructively.



Director Emmanuelle Marquis, Associate Professor of Materials Science and Engineering, together with a number of colleagues from across campus, received a grant from the National Science Foundation – Major Instrumentation (NSF-MRI) Program, which allowed (MC)² to acquire a new, one-of-a-kind scanning electron microscope for

real-time studies of materials behaviors. This TESCAN RISE system, a variable pressure SEM, with *in situ* Raman spectroscopy and imaging capability, a full cathodoluminescence system, an electron back-scattered diffraction system, an X-ray energy dispersive spectrometry system, and a high temperature heating stage, has been installed and is now available to users.

(MC)² is also in the process of upgrading the current fleet of SEM/FIB and TEM instruments, starting with the installation of a Gatan K2 camera on the JEOL 3100R05 microscope to facilitate *in situ* imaging, fast acquisition video recording, and low-dose electron energy loss spectroscopy.

In staffing news, after 20 years of dedicated service, Dr.

John Mansfield, (MC)²'s Senior Director of Education and

Engagement, retired from U-M. He is currently serving as the editor-in-chief of *Microscopy & Microanalysis*, a major microscopy journal. New hires include Dr. Nancy Senabulya as an instrument specialist and Deanna Wendel is (MC)²'s new administrator.

"This past year saw important gains as far as both equipment and organization," commented Marquis. "We are now even more equipped to provide state-of-the-art materials analyses, professional training and in-depth education for our diverse users."



John Mansfield



Nancy Senabulya



Deanna Wendel

(MC)² Hosts Microanalysis Society's Conference on EBSD

(MC)¹² was excited to co-organize and host a Microanalysis Society topical conference on Electron Backscatter Diffraction (EBSD) May 23–25, bringing together over 170 international participants, including students, researchers, and vendors. The conference featured three days of lectures and animated conversation on EBSD applications and developments within materials science, geoscience, planetary science, engineering, and industry. The dynamic conference format combined interactive live demonstrations from

vendors using (MC)² equipment to showcase the latest EBSD hardware and software with poster and plenary sessions.

 $(MC)^2$

multi-

currently

supports

a diverse

disciplinary

user base

of more

than 450

the U-M

campus,

more than

research

20+ non-

academic

100 internal

groups, and

users across

Represented vendors at the conference included Bruker, EDAX, Oxford Instruments, TESCAN, Thermo Scientific, ZEISS Microscopy, JEOL, Hitachi,

Gatan, E.A. Fischione, EXpressLO LLC, Leica Microsystems, Mager Scientific, Cambridge Press, Buelher, BLG Vantage, NanoMEGAS, and Bluequartz.

Through the support of the NSF and represented vendors, over 50 students received financial support for travel costs and registration fees. Graduate students Penny Weiser (Univ. of Cambridge) and Tian Liu (Univ. of Alabama) received best poster awards for Geological and Materials Sciences, respectively.



Dr. Maurine Montagnnat of French National Centre for Scientific Research delivers a keynote address titled, "New insights about deformationa dn recrystallization mechanisms in ice from cyo-EBSD" on May 24.

U-M hosts 9th Annual North American Conference for Materials Education

On August 16-18, Ann Arbor hosted the 9th annual North American Conference for Materials Education (NAMES).

Featured speakers included professors from around the U.S., Canada, and U.K. Presenters representing U-M MSE included John Allison, Tim Chambers, Rachel Goldman, Alan Taub, Katsuyo Thornton, and Steve Yalisove.

Presentations centered around the theme "Personalized learning: delivering a diverse curriculum in a student-centric environment."

"The NAMES Conference offers a unique opportunity for materials educators to get together and share their ideas and insights about teaching methodologies and projects," said MSE Professor Steve Yalisove, who co-organized the event. "I am sure that the debates and discussions that the presentations sparked have already lead to true innovation."



Professor Mike Ashby of Cambridge University presents "Micro-Projects to Engage, Educate and Entertain."



"The NAMES Conference offers a unique opportunity for materials educators to get together and share their ideas and insights about teaching methodologies and projects. I am sure that the debates and discussions that the presentations sparked have already lead to true innovation."

—Professor Steve Yalisove,
NAMES Conference co-organizer



Materials education a hot summer topic

Xplore Engineering

On June 28 and 29, the Van Vlack Lab was bustling with kids aged 8-13 participating in hands-on materials science activities during the college's annual Xplore Engineering event, which this year drew hundreds of alumni families to campus. Xplore Engineering is designed for alumni and the children in their life entering the 4th-7th grade.

The MSE workshop, called eXtraordinary Materials and led by Dr. Tim Chambers with help from MSE graduate students Ben Derby and Peter Meisenheimer, included three interactive activities alongside several demonstrations. Participants enjoyed using microscopes to study and identify "Mysterious Everyday Materials,"learned about phase transformations using "The Iron Wire," and synthesized (and characterized!) their own delicious specimens of "Cryogenic Ice Cream."

"This year we acted on feedback from previous Xplore events to build a real greatest-hits showcase of MSE activities that engage students in understanding how broad and interesting the world of materials is," said Chambers.

Summer School for ICMEd

For two weeks, June 4-15, 24 university educators became students again — taking notes and absorbing concepts like finite difference methods — at the eighth annual Summer School for Integrated Computational Materials Education (ICMEd) held in U-M's West Hall.

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.

This year's ICMEd participants hailed from universities across the U.S., as well as Europe, South Korea, and India.

"The feedback we get from these events from participants is always extremely positive," commented Thornton. "After hosting the summer school for eight summers now, we estimate that we have impacted nearly 2,000 students worldwide, which is extremely exciting."

ASM Teachers' Camp

This past July, MSE hosted the annual ASM Teachers' Camp. 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.

Attendees spent five days performing experiments, attending presentations, and holding discussions in MSE classrooms and the Van Vlack Lab. Some highlights included hands-on time with an electron microscope, drawing fiber optic cables and pouring tempered glass, and employing redox reactions for purposes as varied as glazing pottery and purifying metal.

"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 Chambers.



1. A student reacts to "The Iron Wire" demonstration at Xplore Engineering. 2. Katsuyo Thornton leads a session at the Summer School for ICMEd. 3. Students take in a lecture during the Summer School for ICMEd in West Hall. 4. Master Teacher Debra Goodwin gives a presentation at the ASM Teachers' Camp. 5. ASM Teachers' Camp participants react during a presentation.

Undergrad program leaps to #2 ranking

The MSE undergraduate program jumped two spots to #2 in the nation, according to the 2019 U.S. News & World Report.



Michigan Materials Society (MMS) Update

MMS has recently been focused on new ways to help students have a rewarding undergraduate experience. With the support of alumni donors, MSE, and CoE, we will be sending students to attend the TMS Annual Meeting in San Antonio in March and the SPE ANTEC conference in Detroit. We have been volunteering at outreach events, helping younger students find the wondrous excitement of MSE. This year in our weekly Friday luncheon series, we've hosted speakers from Arconic, 3M, Daimler, and more. Recent social events include the department picnic, pumpkin painting, and pre-finals breakfast. If your company is interested in speaking at a weekly luncheon, please contact mmsboard18-19@umich.edu. You can also find us online at mms.engin.umich.edu.

—Sahil Dagli, president of MMS

Undergraduate student awards

Nathaniel L. Field Scholarship Evan Raeke

Richard A. Flinn Scholarship Tristan Blanzy, Chandler Humphrey

Fontana-Leslie Scholarship Fund Wesley Fermanich

James W. Freeman Memorial Scholarship Sahil Dagli, Asia Dillard, Tanvi Gupta Morgan Meade
William F. Hosford Scholarship

Jack J. Heller Memorial Engineering

Hamza Haque, Leah Hummel, Malhar Kute, Allison Podnar, Luis Rangel DaCosta

Schwartzwalder Memorial Scholarship Anna Chambers, Bethany DeMarco, Jacob Pietryga

Clarence A. Siebert Memorial Scholarship Aaron Adiwidjaja, Jed Forster, Brendan Warren

Alfred H. White Memorial Scholarship David Frank, Declan Shannon, Reed Yalisove

Brian D. Worth Prize Sahil Dagli

MMS Anvil Award Sahil Dagli

Alpha Sigma Mu Distinguished Member Matthew Sweers

James P. Lettieri Undergraduate Award Carolina Frey, Shengtin Shao, Matthew Sweers

CoE Distinguished Achievement Award Catherine Haslam

A.D. Moore Award (CoE) Luis Rangel DaCosta



While on an MSE 360 field trip, Dilara Meli pours molten aluminum into a permanent mold, supervised by Joyworks foundry staff. All students in MSE 360 have regular opportunities to engage in hands-on project work during their lab experience.

Two students attend FEF Conference

Two undergraduates attended the Foundry Educational Foundation College Industry Conference in Chicago on Nov 15-16.

Attended annually by over 100 students and 200 industry professionals and faculty, the conference's primary purpose is to attract and retain students in the metalcasting and foundry industries. The conference is focused on giving students opportunities to network with industry professionals and pursue

internships and careers.

"The conference really opened my eyes to all the opportunities that exist for materials engineers in the metal-working industry," said senior Noel Boland. "It was an amazing experience to meet students from different schools with similar passions and network with people directly from the metal-working industry."



Renewal energy lessons in Iceland

Senior Andra Chen spent 11 days in Iceland this past May as part of a renewable energy study abroad program.

Highlights of the trip included instruction on renewable energy taught by faculty and industry experts from Reykjavik University, facility tours to various power plants (including hydro, geothermal and a biofuel location), and work on a capstone project on a specific renewable energy project.

The program also included an adventure and cultural component, including camping and snorkeling, which, according to Chen, "empowered us to grasp creative leadership, teamwork, and personal growth."

For Chen, the trip was especially eye-opening in terms of experiencing the urgency of climate change first-hand.

"At some point during our school years, we are shown data and charts that explain the effects of climate change," Chen began. "We understand the message, but we probably don't physically register the impact.

"I saw it in real time while on a glacier walk with a glaciologist, who showed us how climate change has drastically changed the Icelandic landscape over the past ten years."

Inspired by her trip, Chen says she intends to "become an ambassador to spread sustainability to others" through lectures and presentations.

"Most important," she added, "I am currently collaborating with several previous program alumni to encourage individuals to think about our future environment."

Employer List

Our 2013-18 graduates matriculated to the following employers:

Electronics/Computing

Apple, Amazon, Google, Intel Corporation, Microsoft, Samsung, Texas Instruments, Hitachi America, Gartner, McKinsey & Company, TE Connectivity, Applied Materials, Inc

Aerospace

Boeing, GE Aviation, Lear Corp., Lockheed Martin Corp., Moeller Aerospace, United Technologies Corp.

Automotive

Chrysler Fiat, Ford Motor Co., GM, Nissan, Rolls-Royce, Toyota

Oil & Gas

Aramco Services Company, Baker Hughs Inc., Daewon Holdings Co., Enterprise Products, Exxon Mobil Corporation, Pacific Gas & Electric, Philips, Shell Oil Co.

Manufacturing

AK Steel, Caterpillar, Cummins, General Mills, Kraft, Proctor & Gamble, Atotech, Inc., Advanced Ceramics Manufacturing, Bechtel Corp., Eaton, Louis Berger, Warmilu LLC, Whirlpool, Worthington Steel

Polymer/Biomedical/ Healthcare

Corning, Dow Chemical, GN ReSound, St. Vincent Neuroscience Inst., Thermo Fisher Scientific, TissueRegeneration Systems, Wright & Filipis

Energy

LG Electronics, Battery Nano Tech ENOVIX Corp., Stealth Battery Company, Bluestone Global Technology, Ceramtec, Covaron Advanced Materials, Bureau of Reclamation, Solar City, First-O-Lite, Nanolab Technologies, Vision Farthcare

Consulting

Axiom Consulting, Bain & Co., The Boston Consulting Group, Capital One, Exponent, Ropes & Gray, LLC, TransUnion, Wells Fargo



MSE students who volunteered at Ann Arbor food bank Food Gatherers in November include Ron Keinan, Jon Schwartz, Kyle Bushick, Logan Williams, Max Powers, Geordie Lindemann, Jacob Pietryga, Kayla Byrd, and Aaron Gladstein.

From volunteering activities in Detroit to outreach events in middle schools to fun social events like bar crawls and bakeoffs, the Graduate Student Council has maintained a full calendar of extracurricular options for graduate students.

"This is one of the most active Graduate Student Councils we've ever had," remarked Renee Hilgendorf, MSE graduate program advisor since 1999.

One of the most recent events was a friendly "food fight" between undergrads, graduate students and faculty/staff to see who could donate the most to Food Gatherers. The drive lasted through the month of November and ultimately netted \$950, 192 food items, and 89 hygiene/personal items for the local food bank.

"Our food drive competition was

created to increase comradery within the department and as a reminder that we can all give back to the community and help those in need," said GSC Social Committee co-chair Aaron Gladstein. "We chose to work with Food Gatherers due to their deep and widespread connections within Washtenaw County, and we hope to have more events volunteering with them again in the future."

"This is one of the most active Graduate Student Councils we've ever had."
—Renee Hilgendorf, MSE graduate program advisor

MSE graduate students gather before an outreach event at the Detroit Science Center in July: (front) Kathleen Chou, Hongling Lu, Jon Schwartz, Aaron Gladstein (standing), Tianjiao Lei, Jordan Occena, Brian Iezzi, Rebecca Perreault, Sid Borsadia, Duncan Greeley, Ben Swerdlow, Ben Derby and Tim Chambers.



Graduate student awards

MSE Graduate Student Council

Sid Borsadia, Avi Bregman, Benjamin Derby, Duncan Greeley, Ashley Hilmas, Celia Keany, Keara Saud, Jill Wenderott

MSE Graduate Service Award for Recruiting

Veronica Caro, Duncan Greeley, Alex Halvey, Brian Iezzi, Joseph Valle

CoE Distinguished Leadership Award

Ben Derby

Rackham Predoctoral Award

Logan Williams

MSE 1st Publication Award

Class of 2016 - Kathleen Chou

Materials Research Symposium

Award winners from the 3rd annual Materials Research Symposium, held Friday, November 16 are listed below. The symposium was open to graduate and undergraduate students across campus at U-M who are engaged in materials research.

Oral Presentations

Gold: Logan Williams (MSE)

Silver: Kathleen Chou (MSE), Caymen Novak (BME), Kwangnam Kim (ME), Yichen Wang (MSE), Ji Young Kim (MSE),

Poster Presentations (Ph.D. students)

Gold: Bryan Van Saders (MSE)

Silver: Allison Roessler (Chem), Tianyu Liu (MACRO)

Honorable Mention: Zhihua Huang (MSE), Chaoming Yang (MSE)

Poster Presentations (Undergraduate students)

Best poster: Andra Chen (MSE)

Honorable Mention: Gregory Cunningham (MSE)



Caymen Novak (BME), Ji Young Kim (MSE), Logan Williams (MSE), and Kwangnam Kim (ME).

Grad Students Honored with Prestigious Awards, Grants



Kevin Golovin (PhD '17) was one of only 10 recent U-M graduates selected to receive a ProQuest Distinguished Dissertation Award for 2017. This award

is given in recognition of the most exceptional scholarly work produced by doctoral students at the University of Michigan who completed their dissertations in 2017. Golovin's research advisor, Associate Professor Anish Tuteja, commented: "Kevin is an exceptionally gifted scientist and researcher, and one of the best graduate students that I have ever interacted with. He combines an excellent grasp of engineering fundamentals, with extensive research expertise and abilities in a variety of subjects, and is extremely deserving of this honor."



Ph.D. candidate Keara Saud (2nd year, Solomon group) won a National Science Foundation (NSF) Graduate Research Fellowship. More than 12,000 graduate students

from across the country applied and only 2,000 were chosen to receive the prestigious honor, which includes a three-year annual stipend of \$34,000, plus a \$12,000 cost-ofeducation allowance to U-M.



Aeriel Murphy, who completed all her Ph.D. requirements in December, received the Susan Lipschutz Award (\$8,000) for spring and summer support and research.



Homecoming 2018 on October 5 was a packed day of activities, starting with an External Advisory Board (EAB) meeting where members discussed the state of our undergraduate and graduate programs, plus explored ways to get alumni more engaged with career advising.

Next on the agenda was a luncheon and presentation from Max (Jerry) Madden, this year's Alumni Merit Award winner. Madden gave an overview of his career (see pg. 33) and ended with the audience clapping along to "Hail to the Victors."

Immediately following the luncheon, alumni gathered to participate in a career advising panel,

where they fielded questions from both MSE undergraduates and graduates.

The day finished with a career fair, where students had the opportunity to meet one-on-one with company reps.

"All of the Homecoming activities this year were a great opportunity to hear from distinguished alumni who have real-world experience and advice," said Ph.D. candidate Ashley Hilmas, who organized and moderated the alumni career panel. "Having such a diverse group of alumni from a variety of different career paths really helps show graduate students what options are available to them and allows them to start expanding their networks."

Career Fair Participants

AK Plastics
AK Steel
Exponent
Hanon Systems
Joyworks
Novelis
Sandia National Laboratories



MSE alumni who were onhand for this year's Homecoming festivities include: Andrew Cronin, Aditya Pittie, Max Madden, Jerry Hoffman, Amit Misra, Liz Holms, Grace Hsia, Jody Hall, Sue Hartfield-Wunsch, Keith Bowman, Chris Adams, Wally Rhimes, Chip Keough, Jason Hertzberg, Dan Gamota, Rachel Goldman, and Ray Decker.













1. The EAB listens to Professor Steve Yalisove talk about goals for the undergraduate program. 2. Grace Hsia introduces herself during the Alumni Merit Luncheon. 3. Dr. Jody Hall (right) gives advice to students during the career panel as Dr. Susan Hartfield-Wunsch looks on. 4. Dr. Jason Hertzberg, EAB chair, and Dr. Keith Bowman joke with each other during the alumni career panel. 5. A packed house listens to the presentation by Alumni Merit Award winner Max Madden.

Alumni Merit Award: Dr. Max Madden



Homecoming this year was extra special for Max (Jerry) Madden (BSE '62, MSE '63, PHD '65), who was selected by the College of Engineering as the 2018 Alumni Merit Award winner for MSE.

As part of the honor, Madden gave a special luncheon presentation to MSE faculty and students on Friday before accepting the award at an official CoE ceremony that evening in Tishman Hall.

A self-described "product person," Madden worked the bulk of his career (1968-1993) in research and development with DuPont in Wilmington, Del., where he helped advance the development of Kevlar coating and oversaw the transition from dry-spinning to wet-spinning, an important step in fiber processing. From Dupont, Madden went on to become president and CEO of Nye Lubricants in New

Bedford, Mass. When Madden came on board in 1994, Nye was a 150-year-old company whose original products were based on refining special fluids found in the heads of toothed whales. Under Madden's leadership, the company transitioned to becoming the world leader in the supply of synthetic lubricants and developed a strong growth period which included a significant export business network.

"I enjoyed every minute," said Madden of both his industry and academic accomplishments, especially his time in Ann Arbor as a graduate student studying under Professor Van Vlack. "There is no way to measure the value of the time you're spending at this university and the good it's doing all of you," Madden told students, "You will wear it well, believe me."

Distinguished Alumni Lectureship Award 2018

This year two alums earned MSE's Distinguished Alumni Lectureship Award, which 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.

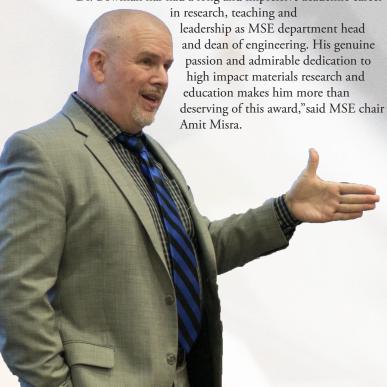
Keith Bowman (PHD '87)

Keith J. Bowman is dean of the College of Engineering and Information Technology and Constellation Professor of Information Technology and Engineering at UMBC, the University of Maryland, Baltimore County. Prior to his role at UMBC, he was dean of the College of Science and Engineering at San Francisco State University. Earlier in his career he held various positions at the Illinois Institute of Technology and Purdue University. At the Illinois Institute of Technology, he was the Duchossois Leadership Professor and chair of mechanical, materials, and aerospace engineering. In Purdue University's School of Materials Engineering, he served as a professor and head of the school. He also held visiting professorships at the Technical University of Darmstadt in Germany and at the University of New South Wales in Australia.

Over the span of his career, Bowman has received nearly \$20 million in research funding and awards. He is a fellow of the American Ceramic Society.

As an education leader, Bowman is particularly interested in advancing diversity and inclusion across engineering disciplines. While at Purdue University, he was recognized for his commitment to teaching and mentoring, receiving the Charles B. Murphy Undergraduate Teaching Award and College of Engineering's Mentoring Award.

"Dr. Bowman has had a long and impressive academic career



Nikhilesh Chawla (PHD '97)

Nikhilesh (Nik) Chawla currently serves as the acting chair of the MSE program at Arizona State University and director for the Center for 4D Materials Science.

Professor Chawla's award lecture was titled, "In Situ Materials Science: Probing Microstructural Evolution of Metallic Materials in Real-Time."

"Professor Chawla is a shining example of an MSE alum with a distinguished career as a materials researcher," said MSE chair Amit Misra.

Prior to joining Arizona State University in 2000, Chawla was a postdoctoral fellow jointly at Ford Motor Company and U-M, working with Wayne Jones and John Allison, and a senior development engineer at Hoeganaes Corporation. Chawla is a fellow of ASM International and past member of TMS Board of Directors. His most recent awards include the Acta Materialia Silver Medal for 2017, and New Mexico Tech Distinguished Alumnus Award for 2016. He received the 2016 Structural Materials Division Distinguished Scientist/Engineering Award, as well as the 2016 Functional Materials Division Distinguished Scientist/Engineering Award from TMS.

His work has been featured on the show "Modern Marvels" on the History Channel, R&D News, Fox News, and the Arizona Republic.





Following is a list of our generous donors from 2014-2018, organized by giving category.

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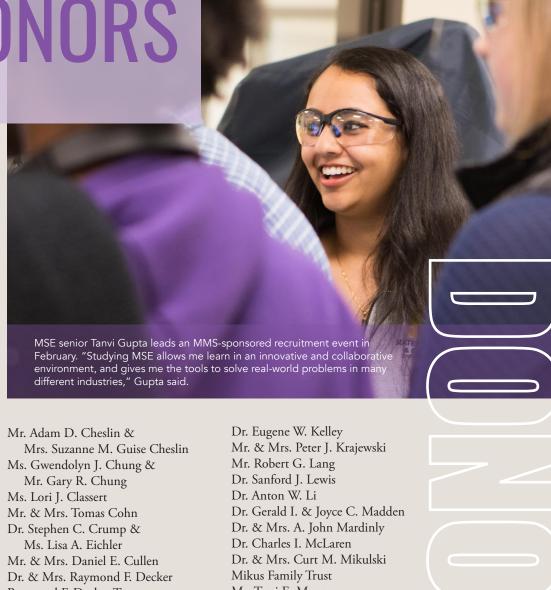
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The following funds were generously established by alumni since the publication of our last newsletter.

Arden L. Bement, Jr. Endowed Scholarship Fund



This gift from Arden L. Bement, Jr. (PHD '63) provides need-

based scholarship support to undergraduates.

Nathaniel L. Field MSE Scholarship Fund for Metals Research

Established by Nathaniel L. Field (BSE ME '59, MSE '59), this fund provides needbased scholarship support to undergraduates whose academic focus surrounds metals research.

Gerald I. & Joyce M. Madden Graduate Fellowship Fund

This fund, a gift from Gerald (BSE '62, MSE '63, PHD '65) and Joyce Madden, will provide need-based support to graduate students.

Neil A. Weissman Fund for Materials Science & Engineering



Neil A. Weissman (BSE MSE '95) established this fund which will be

used by the MSE chair to support programs or purchase equipment for undergraduate student laboratory research.

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Thank you!

ATTENTION ALUMS! The MSE Undergaduate Curriculum Committee has created a special survey just for you to collect your thoughts on how well MSE prepared you for your career and any suggestions you have to make our program even stronger. To participate in the survey, please go to: bit.ly/2H1XB6C

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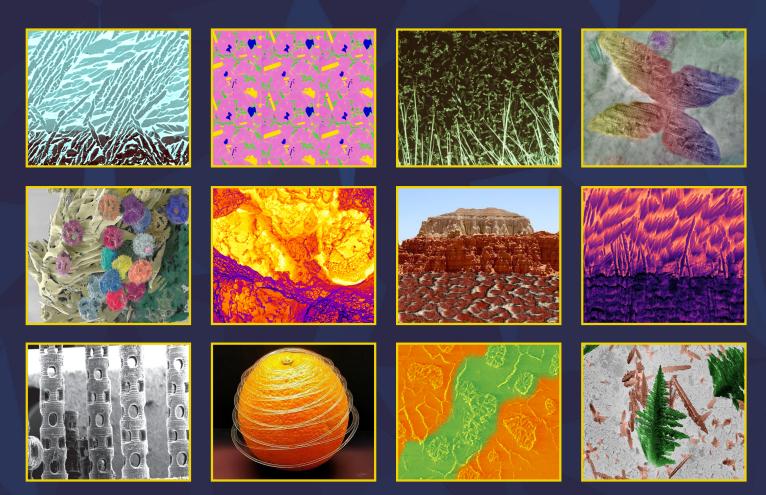








Materials Science as Art



Top row: "Frozen Lake." A scanning electron microscope image of the oxide/metal interface in a Ti-Nb alloy showing alpha laths in the matrix (top) and a layered oxide scale (bottom), colored to resemble the snow and ice of Michigan winters (Kathleen Chou/Marquis). "Retrograde." SEM image of an Al Ti-C metal matrix composite colorized and tiled to look like a 1990's theme (Aaron Gladstein/Taub). "Falling Leaves on Green Grass." Photoluminescence image of coordination polymer crystals containing zinc and purely organic phosphor ligand (Seong-Jun Yoon/Kim). "Inorganic Butterfly." TEM image of planar defects in Al-Si alloy (Huai-Hsun Lien/Misra). Middle row: "Dandelion Dandy." SEM image of a petal of dandelion (Wonjin Choi/Kotov). "The Metallic Radiance." SEM image of dimples in a ductile fractured tensile bar of austempered ductile iron (Andra Chen & Ron Keinan/480 Design Project). "Goblin Valley." The strange shapes and formations (bottom half) are actually silver grains poking out from a thin film surface. It is not unlike the colorful and unique sandstone formations found in Goblin Valley, Utah (Ben Derby/Misra). "Forest Fire." Interface between oxide layers (bottom) and metal (top) of an oxidized Ti-Nb alloy. (Thomas Maulbeck (assisted by Kathleen Chou)/ Marquis "Cheese Flutes." SEM micrograph of 3D printed cochlear implant scaffolds that look like cheese flutes (Angelica Galvan/Sakamoto). "Ode to Spring." Rotationally symmetric kirigami spring adopts the shape of an orange (Erin Evke/Shtein). "The Floor is Lava." A re-colored SEM image shows new aluminum oxide "ridges" which have grown above previous grain boundaries in a high-temperature protective oxide scale. (Talia Barth/Marquis). "Merry Crystmas." Crystals of succinic acid deposited via organic vapor jet printing (OVJP) (Sid Borsadia/Shtein).