Department of Materials Science and Engineering

The Department of Materials Science and Engineering (DMSE) is vibrant and poised for growth. In September 2018, we hosted our visiting committee and reported on recent educational initiatives, faculty hiring, administrative restructuring, and student affairs. The consensus is that DMSE is healthy and has done well in responding to needs and meeting goals. Hiring Frances Ross and James LeBeau has fulfilled a long-time goal of reestablishing DMSE's characterization faculty, and the entire department is excited for the future.

DMSE has maintained its top position in *U.S. News and World Report*'s graduate and undergraduate lists, in the QS World University Rankings by Subject, and in the Shanghai Ranking.

Educational Initiatives

Over the past several years, DMSE faculty have worked with lecturer Jessica Sandland to create online versions of Course 3 subjects, available through MITx and in some cases used in conjunction with the residential degree program. In 2018–2019, DMSE initiated the development of an online "micro-minor" in materials science and engineering in which our subjects would be used by institutions that do not offer programs in materials science and engineering. The goal is to share the hard work that our faculty have already done and to increase awareness of our field, thus feeding the pipeline, particularly for women and underrepresented minorities. We hope to work with schools that have large minority populations and a high percentage of first-generation college goers. This past year, a group of students in the Department of Physics at Gordon College were the first to participate in this program. They used the online materials as lectures but had recitation and lab sessions with their own faculty. In the future, we plan to start similar projects with other institutions.

Undergraduate Education

With an incoming sophomore class of 31 students, DMSE's undergraduate enrollment will be 99 students, with approximately 65% women, 28% underrepresented minorities, and 3% international students. Twenty students are designated Course 3-A (a flexible degree program often taken by students intending to continue their education in the fields of medicine, business, or law). This past academic year, three students graduated with a double major, and two current students are declared double majors.

DMSE successfully completed its first year of participation in the New Engineering Education Transformation (NEET) program. The Advanced Materials Machines (AMM) thread combines aspects of 3-A and 2-A (mechanical engineering), teaching students about additive manufacturing, powder and casting processes, and soft materials processing, among other practices. Atlantic Richfield Associate Professor of Energy Studies Elsa Olivetti and Associate Professor of Mechanical Engineering John Hart led the inaugural year of the AMM thread and taught its first associated subject, 3.007 Introduction to Materials and Mechanical Design. Nine 3-A students are currently pursuing the NEET AMM certificate. Professor of Materials Science and Engineering Geoffrey S.D. Beach served on the core NEET committee.

Graduate Education

The department's graduate enrollment remains strong, numbering 169 in fall 2018. Approximately 29% of graduate students are women and 5% are underrepresented minorities. Twenty DMSE students participate in the Program in Polymers and Soft Matter. For AY2020, we anticipate an incoming class of 39, 33% of whom are women.

This year, DMSE again received a record number of applications (571) for graduate admission.

The Departmental Committee on Graduate Students continues to examine the curriculum and the process for doctoral candidates to pass the written and oral exams.

Student Organizations

DMSE's student organizations are great ambassadors for the department, organizing events and developing activities for their fellow students and the community. For example, they participate in the First-Year Pre-Orientation Program, recruiting efforts, the Cambridge Science Festival, Science on Saturday offerings, and lunch and dinner events with faculty and alumni.

The 2019–2020 Society of Undergraduate Materials Scientists officers are president Kevin Santillan, vice president Alby Joseph, career development chairs Lauren Cooper and Claire Halloran, social chairs Carolyn Jons and Maya Berlinger, publicity chair Jeremy Dudo, commons chairs Richard Colwell and Jacqueline Ahrens, outreach chair Ella Richards, sophomore representative Sophia Mittman, junior representative Jeremy Dudo, and senior representative Omar Laris.

The Graduate Materials Council (GMC) officers for 2019–2020 are president Margaret Lee; vice president Ty Christoff-Tempesta; secretary Shayna Hilburg; treasurer Elad Deiss-Yehiely; Departmental Committee on Graduate Students representatives Max L'Etoile and George Varnavides; academic chairs Kate Reidy, Jatin Patil, and Jackson Bauer; social chairs Tunahan Aytas, Kevin Ye, Sarah Antilla, and Yukio Cho; athletics chair Brian Traynor; outreach committee members Haihao Liu and Ethan Rosenburg; alumni chairs Kat Mizrahi and Jackie Lunger; Graduate Student Council representatives Eesha Khare and Philipp Simons; public service chair John Ryter; well-being chair Sara Sand; coffee hour chairs Josh Kubiak and Leo Zornberg; sustainability chair Evi Postelnicu; and Materials Research Society Student Chapter president Jasper Lienhard.

Last year, the Graduate Materials Council created new chair positions for public service and wellbeing. As part of their activities, these GMC chairs reintroduced Materials Lectures: The Basics, new volunteer opportunities, enhanced departmental mentoring, and de-stressing events. The group also plans to follow up its annual Graduate Student Town Hall with a survey to better measure the success of GMC events and activities.

In January 2019, DMSE graduate student Cécile Chazot received training and funding from the Graduate Student Life Grants program to establish the DMSE Resources for Easing Friction and Stress (REFS) program. She created a departmental REFS (dREFS) website, actively recruited new dREFS students, and met with graduate students who needed support.

Facilities

Facilities efforts over the last year focused on meeting the needs of new departmental faculty and current staff as well as planning for the future needs of existing faculty and research groups. To meet the needs of new faculty hires, space was allocated for offices in Building 13, labs in the Building 13 Materials Research Lab imaging suite, and lab space in the new MIT.nano building. In addition, DMSE reacquired office suites 8-328 and 8-331 after the disbanding of the Administrative Services Organization. The two suites, with the capacity to accommodate 13 staff members, provided an efficient office and central service area for the teaching staff within DMSE.

Considering potential future space needs, the DMSE Space Committee gathered information from junior faculty about their anticipated space requirements. In correlation with that information, the Space Committee investigated existing DMSE lab and office space infrastructure with MIT Engineering and the MIT Capital Renewal team. The information gained during this process provided the department with a vision of how it might best be able to provide appropriate research and office space for DMSE faculty and research groups in the upcoming months and years.

Fundraising

This past year, DMSE received a generous gift from Inditex to support a graduate student fellowship, with the aim of furthering research into sustainable practices in the product life cycle. Also, the Saks Kavanaugh Foundation continued the Kavanaugh Translational Innovation Fellows Program. The funds received were sufficient to award two fellowships to graduate students working to commercialize technologies, fully supporting them as they continue to pursue technical and business development.

Personnel

Frances M. Ross joined the DMSE faculty in December 2018 as one of two new hires with expertise in characterization. Ross performs research on nanostructures, using transmission electron microscopes (TEMs) to see, in real time, how nanostructures form and then to observe how the growth process is affected by changes in temperature, environment, and other variables. She was educated at Cambridge University, where she received both her BA and her PhD. Most recently, she was employed as a research scientist at the Nanoscale Materials Analysis Department within IBM's Thomas J. Watson Research Center in Yorktown Heights, NY. She holds the Ellen Swallow Richards Professorship.

James M. LeBeau will join the department as an associate professor effective July 1, 2019. He previously held the position of associate professor of materials science and engineering at North Carolina State University, where his research focused on developing new TEM and scanning transmission electron microscope techniques to determine the atomic structures of materials. LeBeau has a BS from Rensselaer Polytechnic University and a PhD from the University of California, Santa Barbara, both in materials science and engineering. His reputation as a rising star in this field has been recognized with a Presidential Early Career Award for Scientists and Engineers, the Microanalysis Society's Kurt F.J. Heinrich Award for a Leading Microscopist Under 40, a National Science Foundation CAREER Award, and acceptance into the Air Force Office of Scientific Research Young Investigator Program. He will hold the John Chipman Career Development Chair.

Associate professor of metallurgy Antoine Allanore will be awarded tenure as of July 1. He has built a research program around fully scalable green materials processing technologies. Associate professor of materials science and engineering Juejun (JJ) Hu will also be awarded tenure as of July 1. His work on photonic and optical materials has resulted in new devices and applications such as the "spectrometer on a chip," as accurate and powerful as a bench-top instrument.

Jennifer Rupp will be promoted to associate professor effective July 1. Professor Rupp, who holds a joint appointment in the Department of Electrical Engineering and Computer Science, has built a strong international presence as a leader in the area of functional ceramic materials and devices with an emphasis on ionic conductors. Her work ranges from the fundamental science of ionic conductivity to device construction and demonstration. C. Cem Taşan will also be promoted to associate professor effective July 1. His research on deformation and damage in metals has wide applications and has led to collaborations and outside interest. Professor Taşan has quickly become an integral part of our community, serving on the DMSE Recruiting, Admissions, and Placement Committee and the DMSE Faculty Search Committee.

Assistant professor Robert Macfarlane has been awarded the Paul M. Cook Career Development Professorship, which recognizes a junior faculty member with strong interest in materials and chemical sciences. Professor Macfarlane, who joined our faculty in 2015, holds a BA in biochemistry from Willamette University and a PhD in chemistry from Northwestern University. He has received a National Science Foundation CAREER Award, the American Chemical Society Unilever Award for Outstanding Young Investigator in Colloid and Surfactant Science, and the Air Force Office of Scientific Research Young Investigator Program Award.

David Paul, senior lecturer and research scientist, retired at the end of the 2019 spring semester. He first came to MIT in 1992 to continue his research on magnetic materials. As a member of the teaching staff, he taught many subjects in the academic core and was an important part of students' introduction to MIT in his role as an instructor and first-year advisor for 3.091 Introduction to Solid-State Chemistry.

Angela Belcher, James Mason Crafts Professor of Biological Engineering and Materials Science and Engineering, will be the head of the Department of Biological Engineering effective July 1.

Merton C. Flemings-SMA Professor of Materials Science and Engineering Eugene Fitzgerald has been appointed chief executive officer and director of the Singapore-MIT Alliance for Research and Technology.

Associate professor in materials science and engineering Polina Anikeeva now holds a joint appointment in the Department of Brain and Cognitive Sciences.

Tara Fadenrecht has been promoted to lecturer. Fadenrecht teaches metalworking and is a valuable member of our teaching staff, helping students truly understand the hands-on aspects of materials science.

Tashi Hamilton has joined the DMSE staff as financial coordinator.

Casey Johnson has been promoted to human resources coordinator in recognition of the critical role she plays in hiring, making academic and research appointments, and training and retention.

Two members of the DMSE community joined the Quarter Century Club: senior lecturer Geetha Berera and administrative assistant Laura von Bosau.

Research Highlights

Over the past year, DMSE faculty, staff, and students continued research in areas of critical societal importance, and there was considerable work with colleagues from varied departments and centers at MIT and outside representing many different disciplines. The opening of MIT.nano has focused attention on needs and opportunities in that space: preparing funding proposals, negotiating use of space, working with architects and engineers, and building collaborations across the Institute. After so many years of planning and effort, it is clear that the building will be a valuable resource for all of MIT, leading to many research collaborations across the Institute.

Research activities in DMSE range from the nano scale to the macro scale, with breakthroughs in developing new ways to extract copper from sulfur-based minerals from Professor Allanore's group, publication of research on cold fusion from Kyocera Professor Yet-Ming Chiang's group, and a new understanding of the mechanics of hydrogen embrittlement from Professor Taşan's group. Medical research breakthroughs this year included new technologies for sensing dopamine levels in the brain from David H. Koch Professor of Engineering Michael Cima's group, new technologies for cancer imaging from Professor Belcher's group, and new ways to help regenerate blood cells after radiation treatment from Michael (1949) and Sonja Koerner Professor of Materials Science and Engineering Krystyn Van Vliet's group.

Finmeccanica Career Development Professor of Engineering Julia Ortony received a Professor Amar G. Bose Research Grant. This grant program provides funding over a three-year period to MIT faculty who explore areas that other researchers may ignore.

Among those receiving funding from the MIT Energy Initiative this year were W.M. Keck Professor of Energy Yang Shao-Horn, for research on efficient conversion of methane to methanol, and Toyota Assistant Professor in Materials Processing Rafael Gomez-Bombarelli, for research on using machine learning to solve the "zeolite conundrum."

Awards and Honors

Associate Professor of Materials Science and Engineering Alfredo Alexander-Katz received MIT's Frank E. Perkins Award for Excellence in Graduate Advising in recognition of his service as an advisor and mentor for graduate students.

Professor Antoine Allanore was awarded the Elsevier Atlas for his co-authored article "Local Fertilizers to Achieve Food Self-Sufficiency in Africa." Atlas articles showcase research that has the potential for significant impact on people's lives around the world.

Also, Professor Allanore and members of his group were awarded the third-place prize in the Minerals, Metals and Materials Society's Best Conference Proceedings Manuscript competition for their presentation "Surface Tension of High Temperature Liquids Evaluation with a Thermal Imaging Furnace."

Professor Polina Anikeeva and Jessica Sandland received the MITx Prize for Teaching and Learning in MOOCs (massive open online courses) for their significant digital learning contributions.

Professor Angela Belcher won the Innovation at the Intersection Xconomy Award. Also, she was invited to be the 43rd Speaker for the West Texas Medical Associates Distinguished Lectureship in Science at Angelo State University.

Professor Yet-Ming Chiang was invited to speak at the Trailblazer Lecture Series, hosted by Georgia Tech's George W. Woodruff School of Mechanical Engineering.

Matoula S. Salapatas Professor of Materials Science and Engineering Lorna Gibson was selected to receive MIT's Alan J. Lazarus (1953) Excellence in Advising Award for her outstanding contributions.

Professor Hu received the Society of Photo-Optical Instrumentation Engineers Early Career Achievement Award, which is presented in recognition of significant and innovative technical contributions in optics and photonics.

Professor of Materials Science and Engineering Klavs Jensen was named the American Institute of Chemical Engineers John M. Prausnitz Institute Lecturer for 2018.

GMC presented the Best Advisor award to Professor Elsa Olivetti and the Best Teacher award to Professor Michael Cima.

Professor Frances Ross won the International Federation of Societies for Microscopy Hatsujiro Hashimoto Medal for Applications in Physical Sciences.

Danae and Vasilis Salapatas Professor of Metallurgy Chris Schuh was elected to the National Academy of Engineering for his contributions to design science and application of nanocrystalline metals.

For his pioneering research on electro-ceramics, R.P. Simmons Professor of Ceramics and Electronic Materials Harry Tuller was awarded the Thomas Egleston Medal, a recognition of distinguished achievement by a Columbia University engineering alumnus in engineering or applied science.

Undergraduate Awards

Felipe de Quesada '19 received the Outstanding Senior Thesis Award for "Hierarchical Control of Hydrogel Dynamics via Variations in Ligand Chemistry."

Ximena Hasbach '19 received the Outstanding Senior Award for her research work in the Undergraduate Research Opportunities Program and her educational development work for 3.091 Introduction to Solid-State Chemistry.

Alby Joseph ’21 won the Outstanding Sophomore Award for his academic success and strong involvement in the DMSE community.

Ava LaRocca ’19 was presented the Joseph M. Dhosi Outstanding Internship Award for completing a summer 2018 internship at the University of Fribourg’s Adolphe Merkle Institute.

Pooja Reddy ’20 won the Julian Szekely Award for Outstanding Junior for her work in DMSE labs and research groups, for her contributions as a teaching assistant for 3.016 Mathematics for Materials Science and Engineers, and for being an active and enthusiastic member of the community.

Madison Sutula was presented the Undergraduate Teaching Award for her work as a teaching assistant for 3.091 and 3.024 Electronic, Optical and Magnetic Properties of Materials. She was commended for her devotion to students’ understanding and the time and care she put into the community.

Caitlin McCandler ’19 won the Association of MIT Alumnae Senior Academic Award, which recognizes an outstanding senior woman who has demonstrated the highest level of academic excellence. Caitlin also received the School of Engineering Henry Ford II Scholar Award for her enthusiasm, strong contributions to teaching and mentoring, leadership, and service to the MIT community.

Ava LaRocca, Valerie (Chris) Sacha ’19 and Olivia Saouaf ’19 were invited to join the Xi chapter of Phi Beta Kappa.

Amnahir Peña-Alcántara ’19 was selected as one of this year’s Knight-Hennessy Scholars based on her academic excellence, independence of thought, purposeful leadership, and civic mindset.

Amalia Lee ’19 and Garrett Souza ’19 received Laya and Jerome B. Wiesner Student Art Awards, which honor students for their outstanding achievements in the arts at MIT.

Talia Khan ’20 and Ciara Mulcahy ’20 were selected as Burchard Scholars for demonstrating excellence in different aspects of the humanities, arts, or social sciences.

Graduate Awards

Li-Chen Cheng received the Best PhD Thesis Award for “Templated Self-assembly of Novel Block Copolymers.”

Eric Fadel and Rachel Kurchin each received the Graduate Student Teaching Award in Teaching a Graduate Subject for their respective teaching assistant positions in 3.23 Electrical, Optical, and Magnetic Properties of Materials.

Kate Reidy and Daniel Schwalbe Koda both won Exceptional First-Year Performance Awards for overall excellent academic performance and involvement in research.

Edward Pang won the John Wulff Award for Excellence in Teaching an Undergraduate Subject for his work as a teaching assistant in 3.032 Mechanical Behavior of Materials. He was recognized for his exceptional commitment and careful planning and organization.

George Varnavides received the Best Paper Award for a First- or Second-Year Student for "Non-Equilibrium Phonon Transport Across Nanoscale Interfaces."

Shayna Hilburg and Emiko Zumbro were selected as MIT Graduate Women of Excellence for their leadership and service contributions, dedication to mentoring, and drive to make changes to improve the student experience.

Rachel Kurchin, Philipp Simons, and Mikhail Y. Shalaginov were winners at the MIT Materials Day Poster Session during the Materials Day Symposium.

Philipp Simons was the recipient of a Hugh Hampton Young Memorial Fund Fellowship, a prestigious award that recognizes academic achievement and exceptional personal strengths.

Brendan Smith and his startup SiPure were the winners of the MIT Water Innovation Prize for creating a membrane that could purify textile wastewater.

At the fall Materials Research Society meeting in Boston, Lucas Caretta and Jing Yang were presented the Graduate Student Gold Award, and Ivan Lemech won the Silver Award. These awards honor graduate students whose academic achievements and current materials research display a high level of excellence and distinction.

Ty Christoff-Tempesta was a member of the MIT team that won first place in the Patagonia Case Competition, which presents graduate students with challenges involving environmental sustainability.

Alexander Laiman was a member of the Command, Sensing, and Mapping Information Center team that won first place at the United States Air Force Visionary Q-Prize competition.

MADMEC (Making and Designing Materials Engineering Contest) continues to expose students to new technologies in prototyping while allowing them to develop innovation and entrepreneurial skills. In 2018, Fiat Flux won the $10,000 first-place prize for its system that uses light to clean water filtration systems; Gryffindor was awarded the second-place prize of $6,000 for an inexpensive system that efficiently applies graphene to the surface of metal substrates to improve fatigue resistance; and the Boston Boron Company was awarded third place ($4,000) for its novel design of a system that leverages molten oxide electrolysis to produce boron inexpensively.

Staff Awards

MIT's Environment, Health, and Safety Office (EHS) recognized DMSE with an Excellence Award in 2018, acknowledging the care and dedication to safety of departmental EHS representatives, especially EHS officer Mary Lindstrom.

Several members of the DMSE staff were recognized at the School of Engineering awards ceremony this spring. Academic administrator Angelita Mireles received the 2019 Ellen J. Mandigo Award for Outstanding Service, and both administrative assistant Priyanka Chaudhuri and administrative officer Magdalena Rieb won Infinite Mile Awards for Excellence in recognition of their exceptional support and service.

Future Plans

In the coming year, DMSE will consider future interactions with the Stephen A. Schwarzman College of Computing. We expect that our next faculty searches will be for computational materials scientists, and we hope to explore other areas of collaboration with the college, whether academic or research. The committees assigned to revise the undergraduate and graduate curricula have completed the first phases of work, and we expect to launch the new programs in 2020.

Christopher A. Schuh
Department Head
Danae and Vasilis Salapatas Professor of Materials Science and Engineering