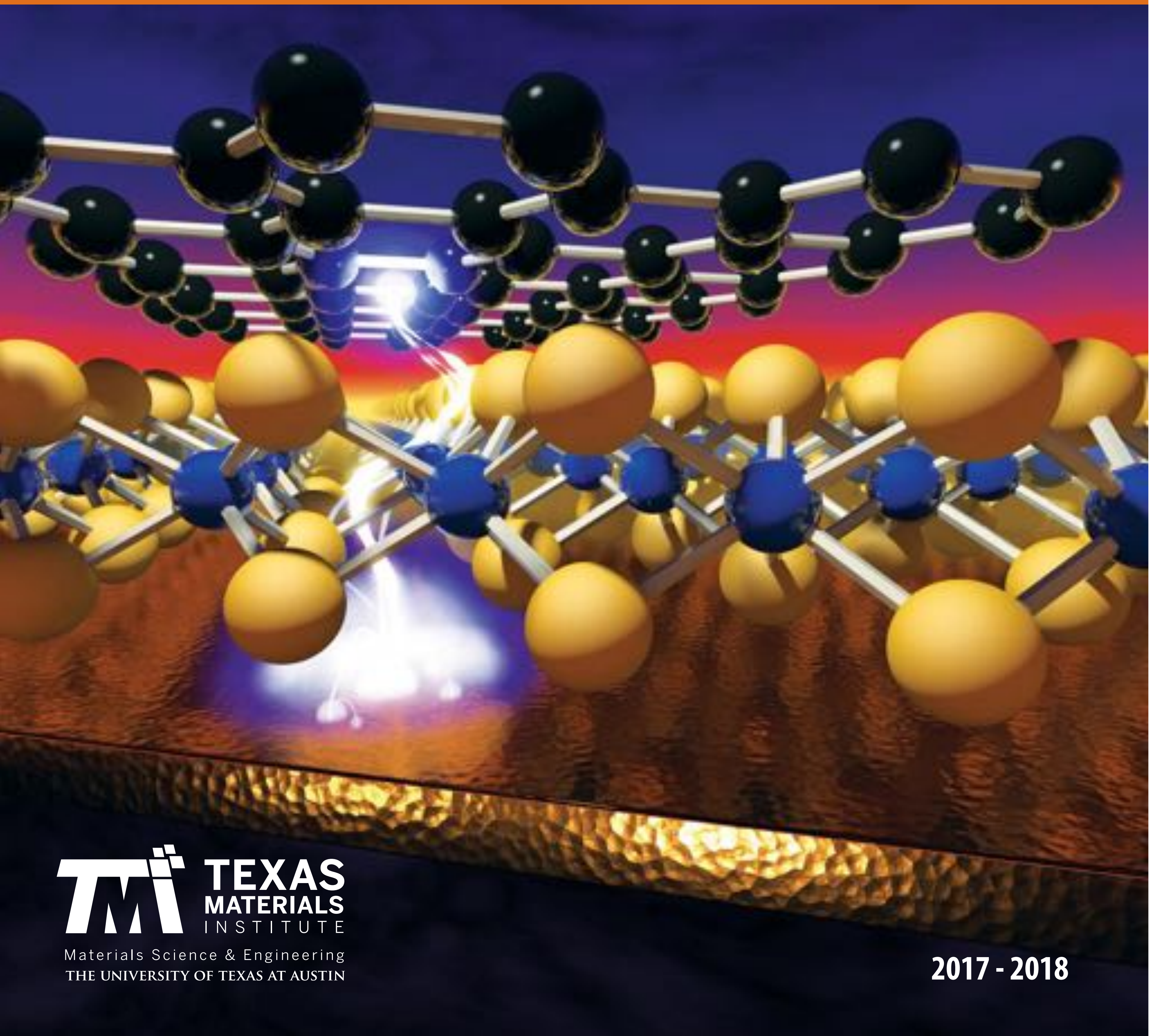
NEWS BULLETIN

Texas Materials Institute

Materials Science and Engineering Program



TEXAS MATERIALS INSTITUTE

Materials Science & Engineering

THE UNIVERSITY OF TEXAS AT AUSTIN

2017 - 2018

Greetings from the Director

Greetings!

I am pleased to present to you the Texas Materials Institute (TMI) Newsletter for the 2017-2018 academic year. As I reflect on the past year, I am happy to take the opportunity to look back on all the wonderful advances we have made during this time.

This year we see the first ever minor program being offered in an engineering discipline at UT Austin. Undergraduates now have the opportunity to pursue a minor in Materials Science and Engineering; we couldn't be happier to expand our materials education to more students across campus.

We have just marked the one-year anniversary of our Materials Research Science and Engineering Center (MRSEC): The Center for Dynamics and Control of Materials (CDCM). In addition to cutting-edge materials research, the center has initiated many educational and outreach developments including a K-12 program, Research Experiences for Undergraduates (REU) program, and Research Experiences for Teachers (RET) program which brings in local K-5 teachers to guide them in best practices for teaching STEM topics and engaging their students. The research and programs this center has brought to TMI will continue to foster our core mission of cutting-edge materials research and education.

We are making major strides with expanding our equipment and facilities. Soon we will have installed this Fall a new state-of-the-art scanning/transmission electron microscope (S/TEM), the JEOL NEOARM. This aberration-corrected TEM is one of the first of its class with the ability to achieve < 1.9 Å resolution at 30 kV along with energy dispersive x-ray spectroscopy (EDS), electron energy loss spectroscopy (EELS), and annular bright field (ABF) detector for imaging light elements such as O and Li.

Our faculty and students had a great year with many awards and recognitions. Our Materials Science and Engineering graduate program had one of the largest incoming Ph.D. classes in years with 22 incoming students. In addition, we graduated 17 Ph.D. students who have gone off to work in various roles in industry and academia. We will continue to bring in and produce top students as we move forward. They are a driving force for what we do and keeping the program thriving.

We are dedicated to being a top-tier research unit and graduate program, and as we embark on another year, I want to thank everyone at TMI for the continued support in making our research unit and graduate program a great success.

Sincerely,

Arumugam Manthiram
TMI Director

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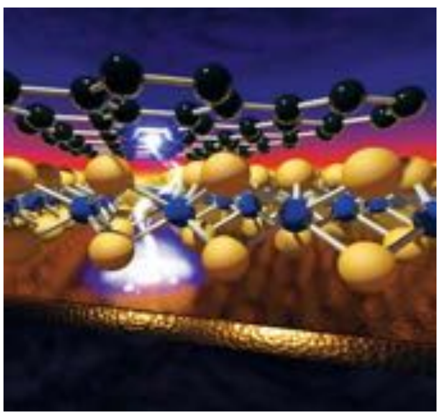


TMI and MS&E faculty member, Deji Akinwande along with a team of electrical engineers at The University of Texas at Austin, in collaboration with Peking University scientists, have developed what Akinwande has coined the "atomristor." Made from 2-D nanomaterials, it is the thinnest memory storage device with dense memory capacity, paving the way for faster, smaller and smarter computer chips for everything from consumer electronics to big data to brain-inspired computing.

"For a long time, the consensus was that it wasn't possible to make memory devices from materials that were only one atomic layer thick," said Deji Akinwande, associate professor in the Cockrell School of Engineering's Department of Electrical and Computer Engineering. "With our new 'atomristors,' we have shown it is indeed possible."

The atomristors improve upon memristors, an emerging memory storage technology with lower memory scalability. He and his team published their findings in the January issue of Nano Letters.

"Atomristors will allow for the advancement of Moore's Law at the system level by enabling the 3-D integration of nanoscale memory with nanoscale transistors on the same chip for advanced computing systems," Akinwande said.

Memory storage and transistors have, to date, always been separate components on a microchip, but atomristors combine both functions on a single, more efficient computer system. By using metallic atomic sheets (graphene) as electrodes and semiconducting atomic sheets (molybdenum sulfide) as the active layer, the entire memory cell is a sandwich of about 1.5 nanometers thick, which makes it possible to densely pack atomristors layer by layer in a plane. This is a substantial advantage over conventional flash memory, which occupies far larger space. In addition, the thinness allows for faster and more efficient electric current flow.

Given their size, capacity and integration flexibility, atomristors can be packed together to make advanced 3-D chips that are crucial to the successful development of brain-inspired computing. One of the greatest challenges in this burgeoning field of engineering is how to make a memory architecture with 3-D connections akin to those found in the human brain.

"The sheer density of memory storage that can be made possible by layering these synthetic atomic sheets onto each other, coupled with integrated transistor design, means we can potentially make computers that learn and remember the same way our brains do," Akinwande said.

The research team also discovered another unique application for the technology. In existing ubiquitous devices such as smartphones and tablets, radio frequency switches are used to connect incoming signals from the antenna to one of the many wireless communication bands in order for different parts of a device to communicate and cooperate with one another. This activity can significantly affect a smartphone's battery life.

The atomristors are the smallest radio frequency memory switches to be demonstrated with no DC battery consumption, which can ultimately lead to longer battery life.

"Overall, we feel that this discovery has real commercialization value as it won't disrupt existing technologies," Akinwande said. "Rather, it has been designed to complement and integrate with the silicon chips already in use in modern tech devices."

Funding for the UT Austin team's work was provided by the National Science Foundation and the Presidential Early Career Award for Scientists and Engineers, which Akinwande was awarded in 2015.

Original article from Cockrell School of Engineering Communications

New Minor Program in MS&E

"THE MINOR IS A GREAT JUMPING OFF POINT FOR STUDENTS INTERESTED IN EITHER STUDYING MATERIALS SCIENCE AND ENGINEERING IN GRADUATE SCHOOL OR WHO WANT TO COMBINE THEIR MAJOR WITH A KNOWLEDGE OF MATERIALS TO FURTHER THEIR MARKETABILITY"
- Dr. Desiderio Kovar

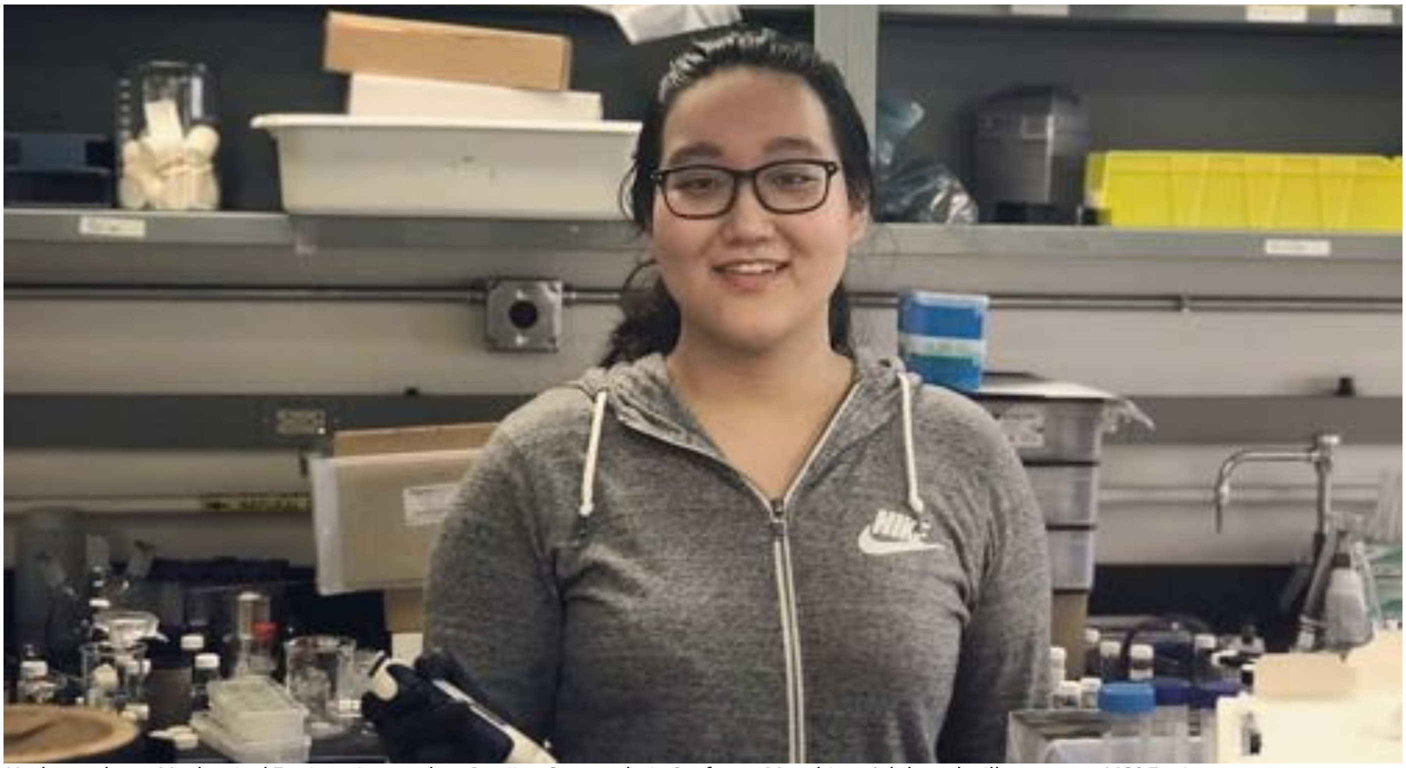
Dr. Desiderio Kovar was a driving force in the materials minor approval process.

Texas Materials Institute has pioneered the first minor for undergraduate students offered through the Cockrell School of Engineering or the College of Natural Sciences. Beginning Fall 2018, students can pursue a minor in Materials Science and Engineering. We are excited to bring a world-class materials education to even more students at UT Austin.

The minor is initially open to students who are majoring in Chemistry, Physics, Electrical and Computer Engineering, or Mechanical Engineering. Professor Desiderio Kovar, who shepherded the minor through the approval process said, "the minor is a great jumping off point for students interested in either studying materials science and engineering in graduate school or who want to combine their major with a knowledge of materials to further enhance their marketability." The minor is unique in that it is designed to work with a student's major requirements to ensure that students can obtain the minor while still graduating in four years. As such, each track is tailored with courses that are unique to each major.

This university-recognized minor has the advantage that it will appear on a student's transcript. It must be completed in conjunction with an undergraduate degree and will consist of fifteen credit hours. Students begin the program with a three-credit hour, laboratory-based bridge course, ES 360M Hands-on Materials Science and Engineering. This course is meant to teach practical techniques in the synthesis and characterization of materials and their properties and also to teach students to use experiments to explore fundamental and sometimes abstract materials concepts and theories. The remainder of the required coursework will consist of a sequence of classes dependent on the students major. TMI is thrilled with this new development and addition to our program offerings.

"DESIGNING A MATERIAL THAT CAN FUNDAMENTALLY SOLVE THE PROBLEM IS LIKE FINDING A CURE FOR A DISEASE: ITS INFLUENCE CAN BE AT THE LARGEST SCALE" - Ruojiao Sun, MS&E Minor Student



Undergraduate Mechanical Engineering student Ruojiao Sun works in Professor Manthiram's lab and will pursue an MS&E minor.

Current Mechanical Engineering student, Ruojiao Sun, will begin the minor in Fall 2018. she currently works as an undergraduate researcher in Dr. Arumugam Manthiram's lab. We sat down with Ruojiao to ask what she's most excited about for the minor program.

Tell us about your background and why you decided to pursue the materials minor.

The realm of material has intrigued me since I was little. My grandparents and my father all worked in the stainless-steel industry so I have been significantly exposed to the idea that by simply changing the metal compositions or the manufacturing methods, materials will be given various characteristics and functions. The magic recipe for a material is fascinating to me. Furthermore, I have always been empathetic to the nature. Learning about how non-degradable plastic is harming the soil and life in the ocean and how human's need for energy is exhausting natural resources is heart-breaking. I believe that to solve a problem, we should start from the source that creates the problem. Therefore, I want to study material. Designing a material that can fundamentally solve the problem is like finding a cure for a disease: its influence can be at the largest scale.

How do you think the minor will impact your time as an undergraduate? What do you hope to get out of the minor?

I'm happy to see that UT is offering the material minor. As a mechanical engineering major, I get to learn about many physical properties of materials and how they would perform in different dynamic systems. However, while studying in Dr. Arumugam Manthiram's lab, I realized that I'm lacking some chemistry perspectives for material synthesis and analysis. Without a thorough comprehension of the properties of metal elements and some organic compounds, one cannot design the right material. A material minor would provide me with the knowledge to design materials and the understanding of how material will perform in different cases.

MRSEC Launches Teacher Training Program

Amanda Lengnick-Hall of Cunningham Elementary (AISD) along with Dr. Brian Korgel and Texas Engineering graduate students.

"WHEN YOU THINK ABOUT IT, EVERY KINDERGARTENER IS AN ENGINEER AND A SCIENTIST." - Dr. Edward Yu

It can already be a challenge explaining basic engineering and science research to the average person. Finding ways to communicate complex STEM-related topics to young children is even more difficult.

Difficult but not impossible, as the current trend away from textbook-led pedagogy to experiential learning has shown the benefits of a more "hands-on" approach to learning for students as well as their teachers.

Thanks to a new pilot program developed by engineering professors at The University of Texas at Austin, local kindergarten-through-fifth-grade teachers will learn new tips and tricks for teaching STEM topics and inspiring excitement among their students.

Launching this summer with four participants from three schools in Austin and Round Rock, Texas, a new Research Experiences for Teachers (RET) program will invite K-5 educators to the Forty Acres for seven weeks to actively engage with cutting-edge engineering and science research. The program will include a workshop aimed at finding creative ways to explain the specialized research in which they will have participated over the previous weeks to their students.

The RET program is being supported by the Cockrell School of Engineering's Materials Research Science and Engineering Center (MRSEC) and the UT-led Industry/University Cooperative Research Center (IUCRC) for Next Generation Photovoltaics. Unlike most other RET programs across the U.S., this UT Austin program is one of the only initiatives developed strictly for pre-middle-school teachers and their students.

"When you think about it, every kindergartener is an engineer and a scientist," said Edward Yu, electrical and computer engineering professor, director of the MRSEC, and one of three UT professors who will welcome a teacher into his lab during RET. "They are constantly asking why, digging around and wanting to know more about the world around them. Children between the ages of 5 and 12 haven't lost that passion to learn more about the world on their own terms."

According to Yu, the thinking behind the program — originally conceived by Brian Korgel, a chemical engineering professor in the Cockrell School, director of the IUCRC for Next Generation Photovoltaics and host to two of the four teachers coming to UT this summer to work in his lab — was to engage with enthusiastic K-5 teachers and help them learn about the research process, the scientific method and how STEM works in an active research setting. Korgel and Yu want to develop a program that

"OUR HOPE IS THAT ALL STUDENTS ARE INTRODUCED TO CREATIVITY AND WONDER OF SCIENCE AND ENGINEERING AT AN EARLY AGE — AND THIS PERHAPS STARTS WITH TEACHERS WHO HAVE EXPERIENCED THIS EXCITEMENT THEMSELVES." - Dr. Brian Korgel

enables teachers to create their own practical lessons and materials to bring back to their classrooms.

"One ambitious long-term goal of the program is to shape the way science and engineering are taught in elementary schools in Texas," Korgel said. "Our hope is that all students are introduced to the creativity and wonder of science and engineering at an early age — and this perhaps starts with teachers who have experienced this excitement themselves."

Another unique aspect of the program is that K-5 teachers won't be the only ones learning from the experience. UT engineering and science graduate students, who will be helping to mentor the K-5 teachers throughout their time on campus, will also be gaining valuable insight into effective ways to teach and communicate these concepts themselves, since many graduate and Ph.D. engineering students go on to serve in faculty positions where teaching is a central part of their role.

"We expect our graduate students to benefit greatly from this experience," said Risa Hartman, director of outreach and education for the MRSEC. "They will work directly with K-5 educators who are already excellent teachers and pedagogical experts, and the graduate students will be able to see first-hand how important effective communication is to our ability to teach."

The three schools participating this summer are Cunningham Elementary in Austin as well as Caldwell Heights Elementary and Neysa Callison Elementary in Round Rock, both of which are dual-language schools.

RET is the newest addition to a growing suite of educational outreach programs already offered by the Cockrell School. Other programs include Engineer Your World, a high school engineering curriculum that has been adopted by over 200 schools in 24 states across the country, as well as an innovative massive open online course, Energy 101, which offers an introductory overview of the technologies, environmental impacts and policies surrounding energy, all within a downloadable app.

Original article from Cockrell School of Engineering Communications

Texas Engineering graduate student mentors teachers as part of the new RET program.

TMI Purchases New JEOL-TEM

JEOL NEOARM. Image courtesy of JEOL.

Coming in late 2018 the Texas Materials Institute will have a new state-of-the-art scanning/transmission electron microscope (S/TEM), the JEOL NEOARM. The new TEM system is one of the first of its class with the ability to achieve < 1.9 Å resolution at 30 kV. Traditionally, aberration-corrected STEM systems have only been able to correct down to 60 kV, thus limiting the types of materials that can be studied. This new capability opens up the door to studying many types of "soft" materials that traditionally have damaged in the TEM.

Another important upgrade for the new TEM is the ease of use. The new TEM has automated alignments; making it easier to use than the current high resolution TEM. The NEOARM has integrated software for auto tuning crystalline samples in STEM to achieve the best resolution with little user interaction, see Figure 1. In addition to automated alignments, image interpretation will be much easier. High-angle annular dark field (HAADF) and most ABF STEM can be directly interpreted, unlike high resolution TEM (HRTEM). To determine atomic structure from an HRTEM image, the user must learn image simulation and have a solid understanding of electron optics, which can take months to years to achieve. Now with aberration corrected STEM, atomic structures can be studied without image simulations.

The new system will have spherical aberration correction in STEM for atomic-level imaging from 30 kV to 200 kV, high angle annular dark field (HAADF) for imaging heavy elements, annular bright field (ABF) detector for imaging light elements such as O and Li, energy dispersive x-ray spectrometer (EDS) with a solid angle of 0.96 sr for quick elemental mapping, electron energy loss spectrometer (EELS) with energy filtering and DualEELS for elemental mapping and electronic bind states with an energy resolution of 0.2 eV, a fast camera (> 300 fps) for in situ videos, a Lorentz lens for field-free imaging of magnetic materials, a heating/biasing holder for in situ studies and a high tilt holder for doing 3D imaging.

There are numerous groups on campus that will benefit from this instrumentation. Aberration corrected STEM imaging has been a very useful tool for researchers in energy related materials, geology, microelectronics, nanomaterials, and structural materials, to name a few, and will greatly benefit groups in these fields on campus. Even more, with 30 kV STEM and 1.9 Å resolution, many groups on campus studying softer materials that have damaged with traditional TEM, such as 2D materials, lithium and sodium ion batteries, oil and gas producing sedimentary rocks, organic photovoltaics, polymer composites, organic molecule on nanoparticles, self-assembled monolayers, and zeolites, may find a new powerful tool for analyzing their materials at the atomic level. To illustrate, figure 2 shows an atomic resolution image graphene collected at 30 kV on a JEOL NEOARM with no detectable damage. Furthermore, with the new enhanced annular bright field detector, users can simultaneously image heavy and light elements, such as oxygen and lithium, see figure 3.

To add to the cutting edge imaging capabilities, the NEOARM will be equipped with two top-of-the-line spectrometers, EDS and EELS, which can be used simultaneously. Figure 4 shows an EDS elemental map of SrTiO3 collected at 30 kV with a large collection angle EDS. Even at 30 kV, atomic resolution of Sr and Ti is achieved. Combining the EDS with the low kV capabilities will allow users to map soft materials,

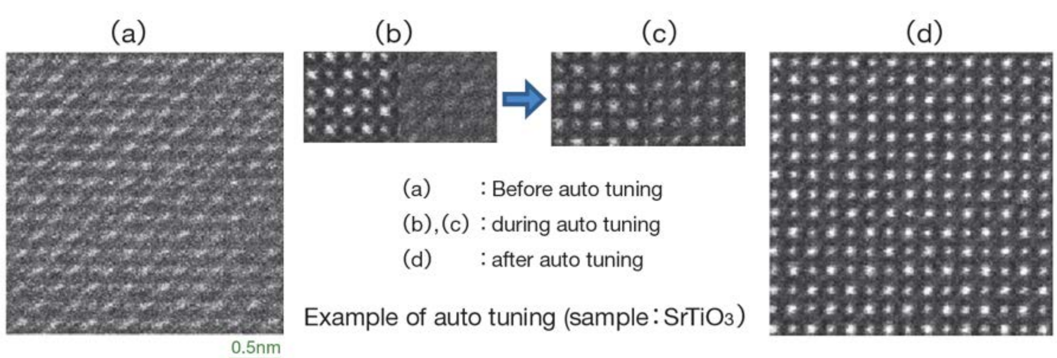


Figure 1. Aberration corrected STEM image before, during and after auto tuning. Image courtesy of JEOL.

such as dopant or impurities in a 2D material. For better sensitivity to low Z elements, higher resolutions mapping, and chemical and electronic state information, user can take advantage of the Quantum energy filtered EEL spectrometer. Researchers can use aberration-corrected STEM with EELS, for example, to understand the oxidation state changes in their battery materials at the atomic level or map the surface plasmons of nanoparticles. This spectrometer is also equipped with DualEELS and energy filtered imaging. DualEELS permits for concurrent collection of low loss and high loss spectra, which provides better calibration, deconvolution of thick samples, and correlation of both high loss energy information (oxidation states, hybridization, electronic binding states) and low loss energy information (surface plasmons, dielectric constants, band gap). Energy filtered EELS is useful for mapping light elements with less beam dose and filtering out inelastic scattering in convergent beam electron diffraction patterns.

The NEOARM will also be furnished with two specialized holder, a high tilt holder for 3D image reconstruction, and our current heating/biasing holder. The high tilt holder, combined with atomic resolution and elemental analysis, will allow users to visualize their structures in 3D and study the elemental homogeneity. The heating/biasing holder combined with a high frame rate cameras, will allow users to observe their material under heat and/or biasing in real time. This could have profound applications in many areas, for example, studying the atomic behavior of battery materials in situ, observing domain switching in thin ferroelectric films, and understanding atomic behavior of 2D materials under biasing.

We are excited to see the cutting edge work that will come out of this new instrument. The NEORAM will be installed in Fall 2018.

Article by Karalee Jarvis, TMI Facility Manager

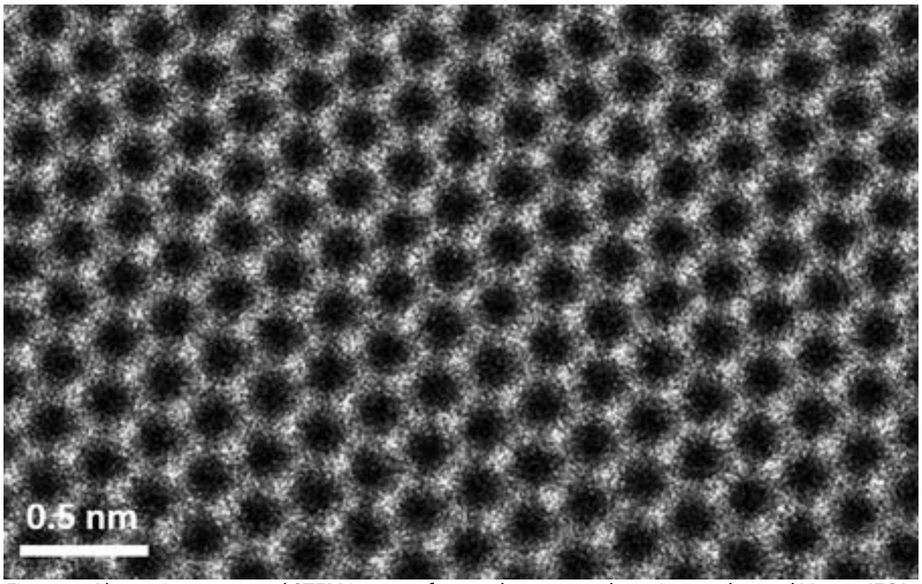


Figure 2. Aberration corrected STEM image of a graphene monolayer imaged at 30 kV on a JEOL NEOARM. Image courtesy of JEOL.

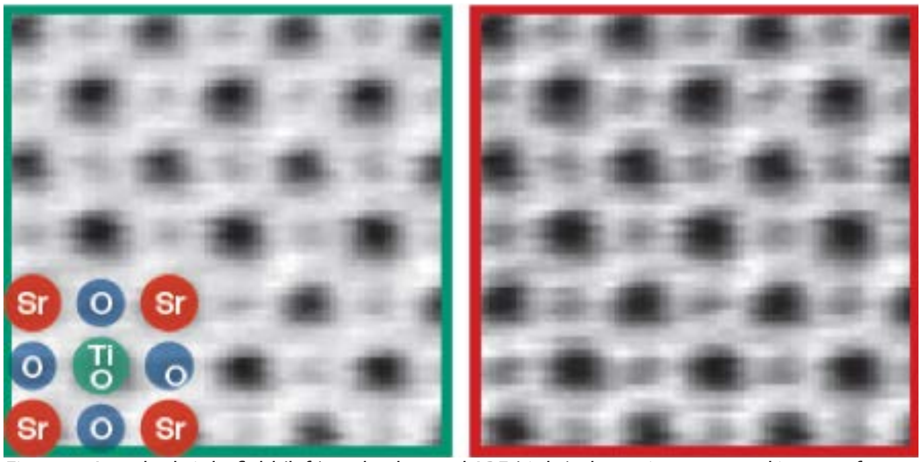


Figure 3. Annular bright field (left) and enhanced ABF (right) aberration corrected image of SrTiO3. Showing contrast of light elements in STEM mode. Image courtesy of JEOL.

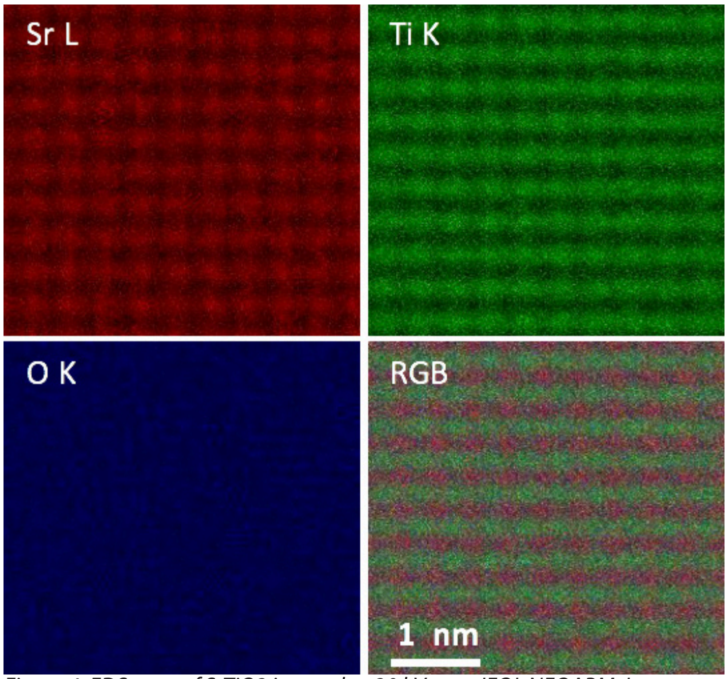


Figure 4. EDS map of SrTiO3 imaged at 30 kV on a JEOL NEOARM. Image courtesy of JEOL.

Faculty Spotlight

Yuebing Zheng (pictured) was awarded the NIH Director's New Innovator Award.

"YOU COULD EFFICIENTLY SCREEN THERAPEUTIC CELLS AND MOLECULES FOR THE OPTIMUM THERAPY OF DISEASES OR OTHER BIOMOLECULES FOR OTHER PURPOSES." - Dr. Yuebing Zheng

Texas Materials Institute is proud to announce that the National Institutes of Health (NIH) awarded a highly competitive research grant of $2.3 million in total costs to Dr. Yuebing Zheng, for his innovative approach to addressing challenges in biomedical research.

Yuebing Zheng, TMI member and assistant professor of mechanical engineering in the Cockrell School of Engineering, will receive the grant over five years. He is part of the NIH Director's New Innovator Awards, established in 2007 to support early-career investigators conducting high-risk, high-impact research. Zheng was one of 55 New Innovators awarded in 2017 and the second from UT Austin. Xiaolu "Lulu" Cambronne, assistant professor of molecular biosciences in the College of Natural Sciences, also received the grant.

"I continually point to this program as an example of the creative and revolutionary research NIH supports," said NIH Director Francis S. Collins. "The quality of the investigators and the impact their research has on the biomedical field is extraordinary."

Zheng will apply his grant to develop and optimize lab-on-a-chip technology for studying interactions between cells that help fight cancer and other diseases or play important roles in processes such as the brain network.

Zheng will develop a mobile device for clinicians and researchers to rapidly identify therapeutic antibodies and other high-performance molecules that attach to targets such as cancer cells. The traditional method for testing how well whole cells or biomolecules adhere to each other is a manual and laborious process.

Zheng's method will exploit a new type of optical manipulation technique that his team developed and which was published this year with preliminary results in the journal ACS Nano. The new technique can trap cells and biomolecules inside a low-power laser beam without requiring expensive or complicated equipment. The light-based nature of Zheng's system would allow for a miniaturized, adhesion-testing device to be developed on a chip that quickly tests different cells for their sticking capabilities.

"If we can develop a high-throughput technology that allows you to measure the adhesion capability of cells as a stream," Zheng said, "you could incorporate the adhesion capability as one of the most important parameters for qualifying cell functions into routine assays. As examples of applications, you could efficiently screen therapeutic cells and molecules for the optimum therapy of diseases or other biomolecules for other purposes."

Original article from Cockrell School of Engineering Communications

Faculty Awards

FACULTY AWARDS

James Chelikowsky
- ICES 2017 W. A. "Tex" Moncrief Grand Challenge Award

Gregory Fiete
- Simons Fellow in Theoretical Physics

Benny Freeman
- Awarded DOE EFRC Center

John B. Goodenough
- Welch Award in Chemistry, 2017
- The Benjamin Franklin Award in Chemistry, 2018

Graeme Henkelman
- ICES 2017 W. A. "Tex" Moncrief Grand Challenge Award

Brian Korgel
- Elected to National Academy of Engineering

Arumugam Manthiram
- Da Vinci Award, UT Austin Department of Mechanical Engineering
- Web of Science Highly Cited Researcher in 2017

Allan MacDonald
- Web of Science Highly Cited Researcher in 2017

Nicholas Peppas
- Elected to the Chinese Academy of Engineering
- Elected Honorary Professor, Beihang University, Beijing
- Honorary Doctorate, University of Santiago de Compostela, Spain
- Elected Honorary Professor, PLA Hospital and Medical School, Beijing, China
- Elected Honorary Professor, Peking Union Medical College
- Elected to the American Academy of Arts and Sciences
- Web of Science Highly Cited Researcher in 2017

Sean Roberts
- Named Cottrell Scholar

Li Shi
- 2018 ASME Heat Transfer Memorial Award in Science

Guihua Yu
- 2018 DOE Early Career Award
- 2018 ACS ENFL Emerging Researcher Award
- 2018 Nano Letters Young Investigator Lectureship
- 2018 Caltech's Resnick Young Investigator

Yuebing Zheng
- 2017 National Institute of Health (NIH) Director's New Innovator Award
- 2017 Early Career Faculty Award, National Aeronautics and Space Administration (NASA)
- 2017 Young Investigator Award, Office of Naval Research (ONR)
- 2017 Chemical Communications Emerging Investigator, Royal Society of Chemistry
- 2018 Materials Today Rising Star Award

James Chelikowsky (far left) and Graeme Henkelman (third from left) both receive the ICES Grand Challenge Award.

John B. Goodenough (far right) at the Awards Ceremony for his Benjamin Franklin Award in Chemistry.

MS&E Student Spotlight

At Texas Materials Institute, we encourage our Materials Science and Engineering students to seek out external fellowships to fund their graduate studies. Many agencies offer excellent fellowship opportunities for graduate students in science and engineering and we are proud to showcase some of the excellent work our students are doing while on fellowship.

JIANHE GUO - HHMI FELLOWSHIP

MS&E Ph.D. Graduate, Supervisor: Dr. Donglei Fan

Jianhe Guo of the Fan Research Group has been on the highly competitive fellowship from the Howard Hughes Medical Institute for international students in predoctoral programs since 2015. The fellowships were awarded to 45 different students from 18 different countries in an effort to help them complete their graduate researches in biomedical and related sciences. The awardees receive $43,000 during each year of the fellowship.

HHMI established the International Student Research Fellowships Program in 2011 to support international students during their third to fifth years of graduate school in the United States. Since then, the Institute has invested $20.8 million in the program, and is currently supporting a total of 231 students from 46 countries. International students in U.S. graduate schools often have difficulty getting funding to support their studies. They are not eligible for federal fellowships or training grant support, or other governmental opportunities that are generally reserved for students who are U.S. citizens. Fifty-seven Ph.D.-granting institutions were eligible to nominate graduate students for this year's fellowships. Three hundred twenty-nine students submitted applications, which were reviewed by a panel of top scientists and graduate educators. Only institutions currently hosting one or more HHMI Investigators could nominate candidates.

Jianhe Guo's Ph.D. research focuses on the design and manufacturing of innovative micro/nano machines, and their applications in biomedicines. He and his co-workers exploited multiple actuation mechanisms for the development of artificial micro/nanomachines, including rotary nanomotors, chemical nanomotors, and plasmonic micro/nanomotors. The rotary nanomotors, assembled from nanoscale building blocks, have ultrasmall footprints less than 1 μm in all dimensions. They are highly reliable and can continuously operate for 80 hours with a total rotation cycles of 1.1 million. It is the record lifetime among all developed rotary micro/nanomotors. Recently, Jianhe and co-workers explored the control of mechanical propulsions from chemical reactions and successfully realized the first electric-field guided chemical nanomotors. The chemical nanomotors can accurately target and pick up cargos in microscale, transport, and release them at desired locations. When assembled on a nanomechanical device, the chemical nanomotors can also harness chemical energy from the surrounding to power the mechanical motions of the device, which is the first of its kind.

More recently, plasmonic nanoparticles are integrated with micro/nanomotors. Molecule behaviors can be readily monitored during the mechanical operations of the plasmonic nanomotors. Unprecedented applications have been demonstrated, including tunable release of biochemicals and acceleration of DNA capture.

Among numerous attentions from the public and academic news media, the work on nanomotors was featured by the National Science Foundation (NSF) and the Institute of Electrical and Electronics Engineers (IEEE). It was selected as #3 of "10 discoveries that will shape the future" by BBC Focus in 2014, one of five finalists for SXSW Interactive Innovation Awards in 2015, and highlighted by the NSF supported NBC Learn in 2016. Jianhe has published 6 first/co-first authored and 7 co-authored journal articles on leading journals during his Ph.D. study, including Nature Communications, ACS Nano, Advanced Functional Materials, and Chemistry of Materials. He also authored 2 book chapters invented 3 patents, one of which has been granted by the United States Patent and Trademark Office.

The fellowship supported Jianhe's Ph.D. study and research by providing both tuition and stipends over the past three years. It also provided grants for his travel to scientific conferences. Jianhe has attended 6 conferences and given 7 oral and poster presentations. He received the Best Symposium Poster Award in the 2017 MRS Spring Meeting & Exhibit. The HHMI fellowship greatly promoted Jianhe's research and helped to prepare him for an upcoming career in academia. Jianhe received his Ph.D. in Materials Science and Engineering in Summer 2018. Post graduation, he will work as postdoctoral fellow in Professor Fan's group to continue his research and is planning to be faculty in the future.

MS&E Student Spotlight and Awards

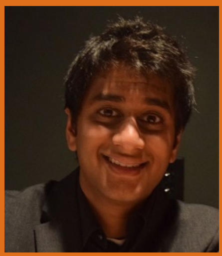
DANIEL SANCHEZ

NSF Fellowship
MS&E Ph.D. Candidate
Supervisor:
Dr. Nanshu Lu

Daniel Sanchez received the 2017 NSF Graduate Research Fellowship Program (GRFP) Fellowship.

He was the only MS&E student this year who was awarded. The NSF Graduate Research Fellowship Program recognizes and supports outstanding graduate students who are pursuing research-based master's and doctoral degrees in fields within NSF's mission. It provides three years of support for the graduate education of individuals who have demonstrated their potential for significant achievements in science and engineering research.

Daniel is a member of Dr. Nanshu Lu's research group where he studies the mechanics of 2D materials and their applications in bio-integrated electronics. His current project involves estimating the adhesion energy of various interfaces in 2D heterostructures. Danny is currently engaged in LGBTQ outreach as President of Out in STEM (oSTEM) at UT Austin, and as a Sponsorship Director at the Out for Undergrad Engineering Conference.



ABHAY GUPTA

NASA Fellowship
MS&E Ph.D. Candidate
Supervisor:
Dr. Arumugam Manthiram

In 2017, Abhay Gupta received the NASA Space Technology Research Fellowship and he was renewed for the 2018 academic year. NASA's Space Technology Mission Directorate (STMD) sought to sponsor graduate student researchers who show significant potential to contribute to NASA's goal of creating innovative new space technologies for the Nation's science, exploration, and economic future. Fellowship awardees perform research at their respective universities and at NASA Centers. In addition to his faculty advisor, Dr. Arumugam Manthiram, Abhay is matched with a technically relevant and community-engaged researcher who serves as his research collaborator.

Gupta's current research focuses on investigating and improving the low temperature performance of lithium-sulfur batteries. He researches and develops new electrolyte formulations and novel electrode architectures for improved sulfur utilization at kinetically limiting conditions, such as low temperatures, high sulfur loadings, and lean electrolyte amounts. The ultimate aim is to develop high energy density lithium-sulfur cells that could one day be used in the cold environments of space. He had the privilege to work on his research at NASA's Jet Propulsion Laboratory this summer in Pasadena, California. Gupta states it was really inspiring working with and learning from a team of engineers who have developed batteries for space missions in the past. It was a lifelong dream of his to work in this sort of environment, and beyond just making strides in his own research, the best part of the experience was how interdisciplinary the research campus was; he had the opportunity to learn about completely different areas critical to JPL's missions, such as spacecraft design and planetary science. These provided Abhay with more context for how to practically go about his own research, and the experience will prove instrumental in his development as a scientist and engineer.

STUDENT AWARDS

Chi-Hao Chang (Manthiram Research Group)
- Fall 2017 Professional Development Award, The Graduate School
-First Place Poster, Science, Engineering and Technology Seminar (SETS)
-Mechanical Engineering Research Award, Graduate and Industry Networking (GAIN) Poster Session,

Tushar Chitrakar (Kovar Research Group)
- Fall 2017 Professional Development Award, The Graduate School

Abhay Gupta (Manthiram Research Group)
- Dean's Prestigious Fellowship Supplement, The Graduate School

Jianhe Guo (Fan Research Group)
- Summer 2018, Professional Development Award, The Graduate School
- NSF Student Travel Award for ASME-NEMB Conference

Jingang Li (Zheng Research Group)
- Spring 2018 Professional Development Award, The Graduate School

Zexi Liang (Fan Research Group)
- Harris L. Marcus Graduate Fellowship in MS&E

Xiaolei Peng (Zheng Research Group)
- University Graduate Continuing Fellowship, The Graduate School
- Spring 2018 Professional Development Award, The Graduate School

Richard Roberts (Akinwande Research Group)
- Spring 2018 Professional Development Award, The Graduate School

Daniel Sanchez (Lu Research Group)
- Fall 2017 Professional Development Award, The Graduate School
- Best Graduate Poster Award, 7th Annual Out in STEM (oSTEM) Conference
- Mechanical Engineering Research Award, Graduate and Industry Networking (GAIN) Poster Session

Yue Zhu (G. Yu Research Group)
- University Graduate Continuing Fellowship, The Graduate School
- Spring 2018 Professional Development Award, The Graduate School

MS&E Graduates

CONGRATULATIONS TO OUR 2017-2018 GRADUATES!

FALL 2017

Charles Amos, Ph.D.
Effect of Chemical Treatment and Trivalent Doping on the Surface Structure and Surface Chemistry of Li1-xNi0.5-yMn1.5+yO4
Supervisor: Dr. John B. Goodenough

Dorothy Silbaugh, Ph.D.
Fluorescent Silicon Nanocrystals for Bioimaging
Supervisor: Dr. Brian Korgel

Zheng Wang, Ph.D.
Integrated Nanophotonics for "More than Moore"
Supervisor: Dr. Ray T. Chen

SPRING 2018

Xinyu Li, Ph.D.
Computational Investigation of Functional Perovskites
Supervisor: Dr. Graeme Henkelman

Zongyao Li, Ph.D.
Physical Properties of Transition Metal Oxides Synthesized by Spark Plasma Sintering
Supervisor: Dr. John B. Goodenough and Dr. Jianshi Zhou

Christopher Roberts, Ph.D.
Selective Laser Melting of Metals Using Elemental Mixtures
Supervisor: Dr. David Bourell

Haley Stowe, Ph.D.
First-Principles Investigation of Aqueous Amine-Based Solvents for Carbon Dioxide Capture
Supervisor: Dr. Gyeong S. Hwang

Zilong Wu, Ph.D.
Plasmonic Moiré Metamaterials and Metasurfaces: Tunable Optical Properties and Nanophotonic Applications
Supervisor: Dr. Yuebing Zheng

SUMMER 2018

Chi-Hao Chang, Ph.D.
An Integrated Development of High-capacity Lithium-sulfur (Li-S) Batteries: Cathodes, Separators, and Lithium-metal Anode
Supervisor: Dr. Arumugam Manthiram

Harry Chou, Ph.D.
Two-Dimensional Materials Synthesis, Characterization, and Devices: Working With Hexagonal Boron Nitride and Graphene
Supervisor: Dr. Sanjay Banerjee

Yu Ding, Ph.D.
Molecular Engineering and Structural Design of Electrochemically Active Organic and Organometallic Materials for Energy Storage Devices
Supervisor: Dr. Guihua Yu

Jianhe Guo, Ph.D.
High-Performance Artificial Micro/Nanomachines and Their Bioapplications
Supervisor: Dr. Donglei Fan

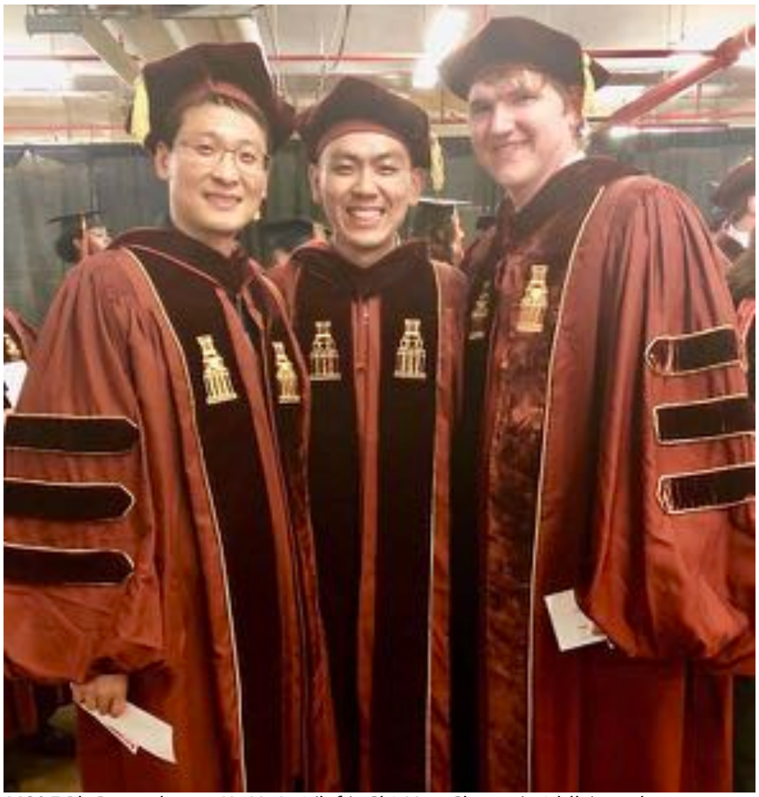
Feng He, Ph.D.
Coherent Phonon Dynamics In Semiconductors
Supervisor: Dr. Yaguo Wang

Ke-Yu Lai, Ph.D.
Development of Electrode Materials with Matched Thermal Expansion for Solid Oxide Fuel Cells
Supervisor: Dr. Arumugam Manthiram

Wangda Li, Ph.D.
Advanced High-Nickel Layered Oxide Cathodes for Lithium-Ion Batteries
Supervisor: Dr. Arumugam Manthiram

Wei Li, Ph.D.
Charge and Energy Transport Properties of Two-Dimensional Transition Metal Dichalcogenides
Supervisor: Dr. Deji Akinwande

Ryann Rupp, Ph.D.
Dynamic Normal Grain Growth In BCC Interstitial-Free Steel During Hot Deformation
Supervisor: Dr. Eric Taleff



MS&E Ph.D. graduates Ke-Yu Lai (left), Chi-Hao Chang (middle), and Christopher Roberts (right) at the Cockrell School of Engineering 2018 Commencement Ceremony.

TMI Seminar Series

2017-2018 SEMINAR SERIES

FALL 2017

Dr. Mauricio Terrones - Pennsylvania State University
Low-Dimensional Nano-Carbons: From Doped Carbon Nanotubes and Doped Graphene to 3-D Hybrids and Biological Applications

Dr. Elsa Reichmanis - Georgia Institute of Technology
Active Organic and Polymer Materials for Flexible Electronics: a path to sustainable systems

Dr. Justin Wilkerson - Texas A&M University
The Role of Crystallographic Defects in the Impact Failure of Armor Materials

Dr. Mostafa El-Sayed - Georgia Institute of Technology
Nanotechnology Enables Gold Nanorods to Stop Cancer Cell Migration and Killing People

Dr. Zhenan Bao - Stanford University
Skin-Inspired Organic Electronic Materials and Devices

SPRING 2018

Dr. Brian R. Bennett - Office of Naval Research
A Century of Science for the Navy: From the Earliest U.S Radar to Today's Electromagnetic Materials Program

Dr. Nasim Alem - Pennsylvania State University
Defect Phenomena in Nanostructures: An Ultrahigh Resolution Aberration-corrected Electron Microscopy Study

Dr. Liangbing Hu - University of Maryland
Materials Innovations for Emerging Energy Technologies

Dr. Yuehe Lin - Washington State University
Functional Nanomaterials for Biomedical Applications

Dr. David Erickson - Cornell University
Point-of-Care Technologies for Infectious Diseases and Nutritional Deficiencies

Dr. Ju Li - Massachusetts Institute of Technology
Materials in Energy: From Nano to Macro

Dr. Cigdem O. Keskinbora - Harvard University
Probing Highly Correlated Quantum Materials via Sophisticated Electron Microscopy Techniques

Dr. Pankaj Sarin - Oklahoma State University
A High Temperature Perspective of Materials through In-situ Experiments

Dr. Alex Zettl - University of California, Berkeley
Adventures in Low-D: From Laminated Planes to Isolated Chains

SUMMER 2018

Dr. Arturo Ponce-Pendraza - University of Texas at San Antonio
Physical Measurements of Materials within a Transmission Electron Microscope and their Atomic Structure Correlation

Dr. Venkat Subramanian - University of Washington
Model Based Design and Control of Lithium-ion Batteries – From Material Synthesis in the Lab to BMS Design for the Dashboard

Dr. Reza Shahbazian-Yassar - University of Illinois at Chicago
In-Situ Transmission Electron Microscopy Studies of Energy Storage Materials

Dr. David Mitlin - Clarkson University
Selenium impregnated monolithic carbons as free-standing cathodes for high volumetric energy lithium and sodium metal batteries

AROUND TMI

(left), Abhay Gupta at NASA's JPL (middle), and Dr. Nicholas Peppas at his induction to CAE (right).

TEXAS MATERIALS INSTITUTE

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THE UNIVERSITY OF TEXAS AT AUSTIN

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Cockrell School of Engineering

The University of Texas at Austin
College of Natural Sciences