NEWS BULLETIN

Texas Materials Institute

Materials Science and Engineering Program

2016 - 2017

TEXAS MATERIALS INSTITUTE

Materials Science & Engineering

THE UNIVERSITY OF TEXAS AT AUSTIN

Greetings from the Director

It has been an exciting and productive year for Texas Materials Institute (TMI) and our Materials Science and Engineering (MS&E) Graduate Program. I am excited to share with you our 2016-2017 Newsletter that offers a glimpse into the remarkable work being done by our faculty, staff, and students, which keep our institution thriving. I want to thank them for their contributions for the continued growth of TMI and the MS&E program.

I am excited and eager to see the relocation of TMI and the MS&E Graduate Program as well as our shared core facilities in the new, state-of-the-art Engineering Education and Research Center (EERC) building. EERC has 430,000 square feet of open and flexible space for interactive learning and hands-on student projects. It serves as the university's new hub for engineering education, research, and innovation and as a center for multidisciplinary collaboration within the Cockrell School of Engineering. It is truly a new era for engineering and TMI at UT Austin.

Researchers at TMI received a $15.6 million grant from the National Science Foundation (NSF) to launch a new Materials Research Science and Engineering Center (MRSEC) at UT Austin. The Center for Dynamics and Control of Materials (CDCM) funded by the MRSEC program will bring an abundance of resources for research and foster TMI's reputation as a leader in modern materials research and education.

This year we had an expansion of the TMI facilities as the Center for Nano and Molecular Science and Technology was merged with TMI. This merger added a cleanroom facility with nano fabrication and characterization capabilities to the already existing broad suit of advanced materials characterization facilities at TMI. Furthermore, we are adding a brand new Small Angle X-ray Scattering Instrument with in-Situ capabilities that was acquired through the Major Research

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Instrumentation (MRI) Program at NSF.

It was a successful year for our faculty and students, with many receiving high honors and awards in the materials field. We are also proud to announce the addition of two new faculty members to TMI and the MS&E Graduate Program. Furthermore, many of our graduate students moved on to reputable positions in the materials industry, national laboratories, and academia. Our recruiting efforts have also brought in an exceptional incoming class that we know will only further our mission of producing exceptional students.

I am delighted to share our achievements with you and I look forward to the future of materials research here at TMI, as we look on to another year ahead.

Sincerely,

Arumugam Manthiram, Ph.D.
Director
Texas Materials Institute

IN THIS ISSUE

ON THE COVER

Opened in Fall 2017, the new Engineering Education and Research Center (EERC) is a state-of-the-art facility where students, faculty, and researchers from across the UT Austin campus will gather to foster an environment of collaboration and innovation.

TMI Prepares for move to New EERC Building

Front entrance for the EERC. Photo courtesy of Christopher Brannen.

"THE NEW SPACE WILL HELP US SHOWCASE THE WORLD-CLASS MATERIALS RESEARCH THAT IS HAPPENING AT TMI."

- Dr. Arumugam Manthiram

UT Austin established TMI in 1998 with the goals of being a first-class materials research center and enhancing the Cockrell School of Engineering's graduate program in materials science and engineering. Historically, at TMI, we have operated in a decentralized capacity, with our various facilities spread across campus. The Engineering Education and Research Center (EERC), the Cockrell School's new central hub for multidisciplinary research and teaching, will help bring TMI together, consolidating our shared facilities and providing a new central headquarter for our leadership and administrative staff.

More than 100 TMI researchers and their graduate students are already pushing the boundaries of materials science at separate labs across campus, but the new hub of shared facilities and tools inside the state-of-the-art EERC will be a boon to the research.

Arumugam Manthiram, Director of TMI, states, "The new space will help us showcase the world-class materials research that is happening at TMI, while also giving us the opportunity to educate more students and grow our brand, influence, and faculty membership."

All TMI members have appointments in the Cockrell School of Engineering or the College of Natural Sciences and conduct materials research and engineering in a variety of areas. TMI's doctoral program accepts about 15 Ph.D. students per year.

To continue to compete with similar programs at the nation's top engineering schools, Manthiram plans to update and add critical research equipment that will help deepen the understanding of the intricacies of materials. The new space in the EERC will also help TMI's efforts to recruit top faculty in different areas at UT Austin, increasing our breadth, and creating more collaborative opportunities for researchers to innovate.

"For nearly two decades, TMI has been innovating in energy materials, electronic materials, structural materials, soft materials and many other areas," Manthiram said. "We are excited to have a new, dedicated space inside the EERC to address societal challenges for many decades to come."

Inside the EERC

The Engineering Education and Research Center is now the Cockrell School's largest multidisciplinary building, where faculty, researchers, and students across engineering and the entire UT Austin campus will come together to learn, collaborate, and innovate. The vision for the EERC began nearly a decade ago, when the school and university leadership committed to enhancing engineering education in the 21st century and ensuring the Cockrell School remains among the top engineering schools in the world.

Inside this transformative facility, students will engage in hands-on projects and gain the skills necessary to succeed in diverse careers. This building brings us 430,000 square feet of open and flexible space for interactive hands-on learning. Faculty and researchers will push boundaries to advance and develop new technologies with state-of-the-art teaching and research facilities. Thought leaders across disciplines will work together to find solutions to society's most critical problems, create new technologies, and solve real-world problems. Take a look inside:

THE ATRIUM: Greeting anyone walking through the EERC, the atrium serves as a hub for sharing and cultivating ideas on the UT Austin campus.

NATIONAL INSTRUMENTS STUDENT PROJECT CENTER: As a centerpiece of the EERC, the project center provides students with 23,000 square feet of space for creating, making, and doing.

THE JAMES J. AND MIRIAM B. MULVA CONFERENCE CENTER AND AUDITORIUM: The 299-seat engineering auditorium — where faculty, students, and visitors can gather for lectures, speaker series, and events — is the Cockrell School's largest teaching space.

RESEARCH TOWERS: Inside the EERC's North Tower is 50,000 square feet of large-scale, multidisciplinary research labs. The South Tower is home to the Cockrell School's Department of Electrical and Computer Engineering and houses seven research neighborhoods focused on developing new technologies in computing, power, electronics, and wireless networking.

INNOVATION CENTER: The Cockrell School's Innovation Center is located inside the EERC, becoming the first space dedicated to entrepreneurship training and commercialization programming.

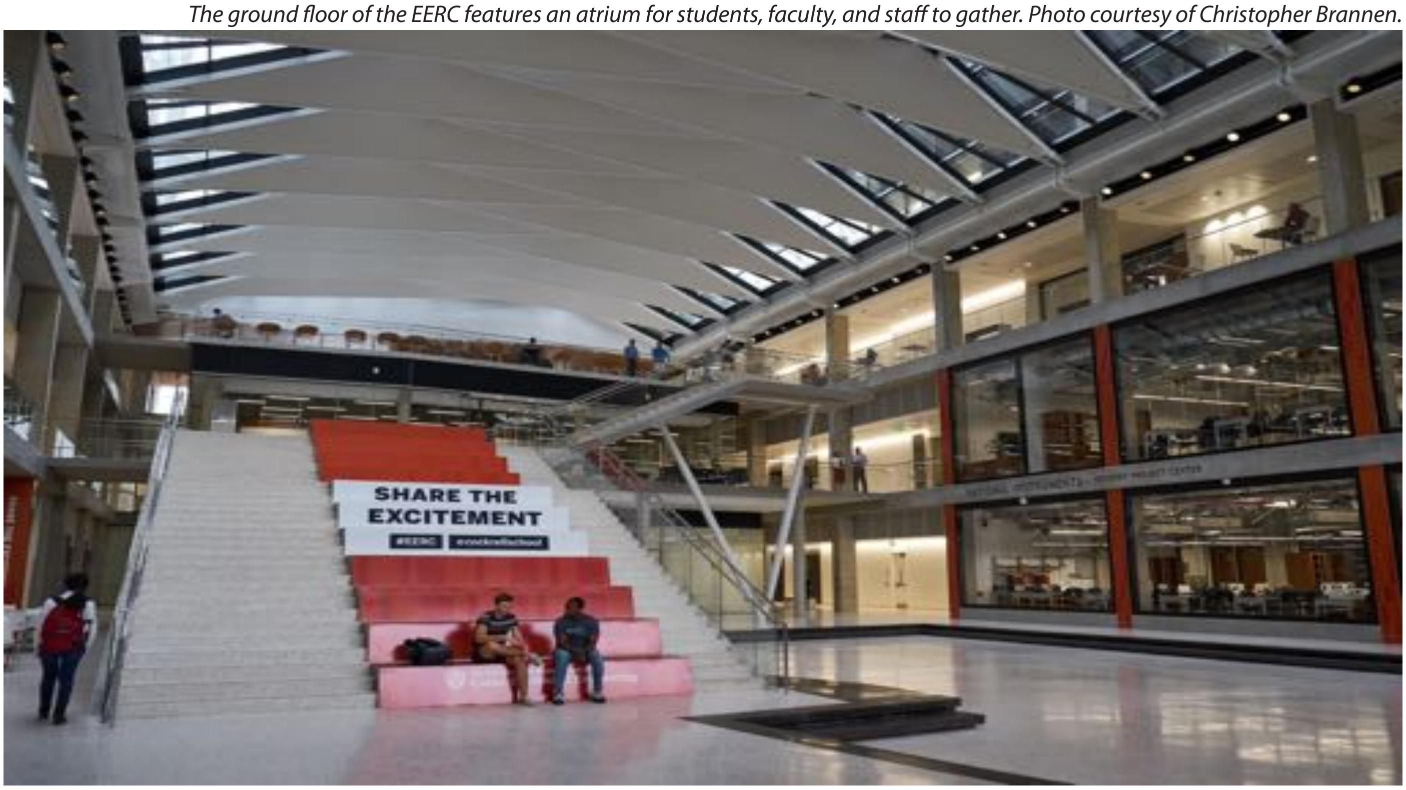
TEXAS INSTRUMENTS LABORATORIES: Equipped with the latest Texas Instruments technologies, the TI teaching and project labs give students space to design and build sensors, robots, wearable technologies, and more.

THE E-LOFT: Overlooking Waller Creek, the modern E-Loft provides an inspiring area for students to study and collaborate.

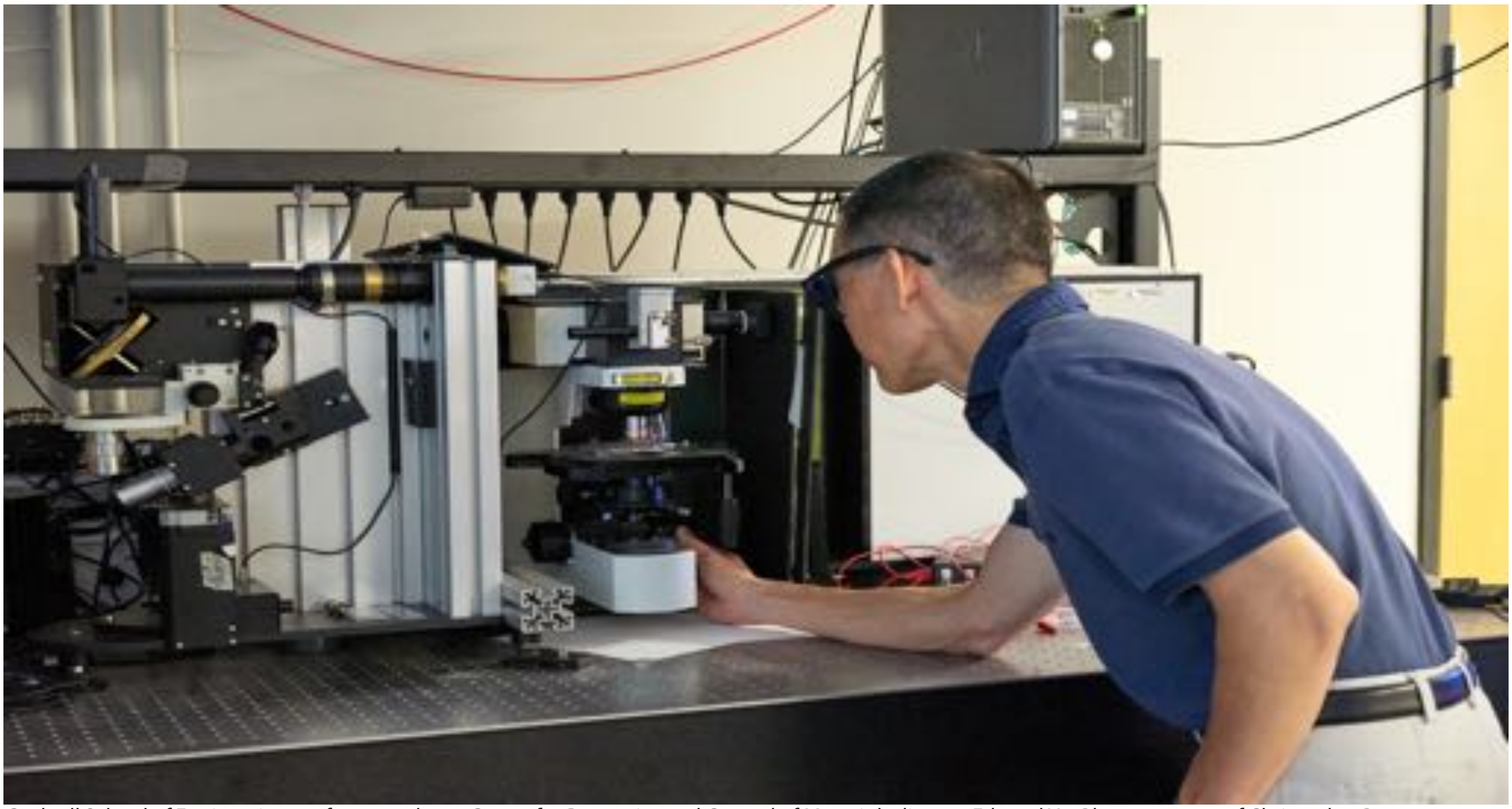
The Research Towers will be home to TMI and house our central facilities and staff.

Original article from Cockrell School of Engineering Communications

The ground floor of the EERC features an atrium for students, faculty, and staff to gather. Photo courtesy of Christopher Brannen.



NSF MRSEC Grant Awarded to TMI



Cockrell School of Engineering professor and new Center for Dynamics and Control of Materials director Edward Yu. Photo courtesy of Christopher Brannen.

Researchers in the Cockrell School of Engineering and the College of Natural Sciences at The University of Texas at Austin have received a $15.6 million grant from the National Science Foundation (NSF) to discover and advance new types of materials for use in many applications including energy storage, medical devices and information processing.

The NSF grant, distributed over a six-year period through its Division of Materials Research, will launch a new Materials Research Science and Engineering Center (MRSEC) headquartered at UT Austin and aimed at advancing materials through fundamental science. The UT Austin Center for Dynamics and Control of Materials (CDCM) will include 23 faculty members from the university's Cockrell School and College of Natural Sciences and one researcher from Rice University. The grant will go toward funding research, graduate student researchers, and K-12 and undergraduate education outreach.

Created by the NSF to support multidisciplinary materials research and education while addressing fundamental problems in science and engineering that are important to society, the MRSEC program now encompasses a network of more than 20 centers located at academic institutions throughout the United States, each with its own focus area. UT Austin's will be only the second MRSEC ever headquartered in Texas.

Researchers at the UT Austin center are particularly interested in developing materials that have the ability to form, reform, and reconfigure with different properties as they are being used. These new capabilities could pave the way for new technologies in medicine, electronics, and other areas.

"In addition to pursuing scientific goals, our hope is that the CDCM will enable substantial progress toward expanding the way people think about materials science and engineering and its potential to advance technology and benefit society," said Edward Yu, the CDCM's director and a professor in the Department of Electrical and Computer Engineering.

Today, researchers tend to think about materials in terms of their structure (how the atoms are arranged), the way they are processed (how they are created), how they are assembled, their properties (electronic, optical) and their performance. Materials are typically thought of as static structures, meaning they don't change.

The CDCM's mission is to explore various aspects of how to dynamically control the structure and properties of materials as a function of time and to reconfigure the structure of materials to allow for a change to their functionality.

The concept of dynamic control can be found in the natural world in

"OUR HOPE IS THAT THE CDCM WILL ENABLE SUBSTANTIAL PROGRESS TOWARDS EXPANDING THE WAY PEOPLE THINK ABOUT MATERIALS SCIENCE AND ENGINEERING AND ITS POTENTIAL TO ADVANCE TECHNOLOGY AND BENEFIT SOCIETY." - Dr. Edward Yu

applications like camouflage, Yu said. "Many of us are familiar with the gecko's ability to lighten or darken its skin depending on the brightness of its immediate environment or with the octopus's ability to mimic the appearance of its surroundings. Essentially, we are working to bring this same type of dynamic control and reconfigurability to a wide range of material properties."

UT Austin's new center will boast two interdisciplinary research groups that will bring together experts from various disciplines including physics, chemistry, mechanical engineering, electrical engineering, molecular biosciences, and chemical engineering.

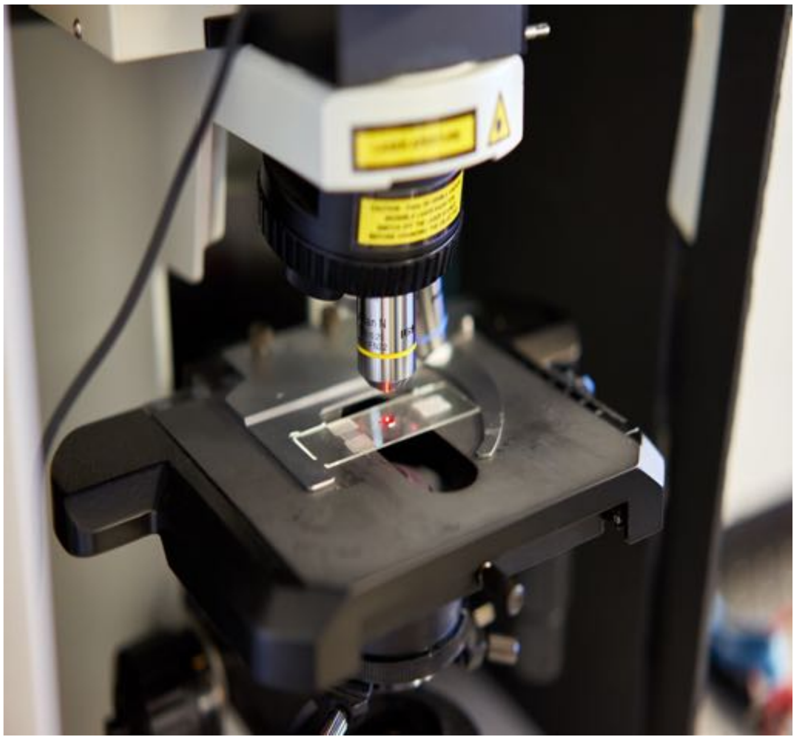
The first research group, called Porous Nanoparticle Networks, will explore solid nanoparticles connected to each other by various types of molecules. Research advances in this group are expected to enable responsive, reconfigurable materials based on the integration of nanoparticles and macromolecules for applications in drug delivery, mechanical actuators, components of energy systems, materials for sensing, electrolytes for energy storage, and robust membranes for water purification. Chemical and materials engineer Delia Milliron and organic chemist Eric Anslyn will lead this effort.

The second research group, called Materials Driven by Light, will explore a rapidly emerging area of study that uses illumination to control the structure of a material and its properties. Research advances in this group are expected to lead to a better understanding of material behavior by using temporally structured light, with potential applications in a broad range of technologies for communications and information processing. Physicists Elaine Li and Greg Fiete will lead this group.

As part of the NSF grant, Brian Korgel, professor in the McKetta Department of Chemical Engineering, will lead efforts to develop and implement education and outreach programs to increase interest in materials science and the diversity of young people entering the field. CDCM participants plan to train elementary school teachers and help them design new tools to engage younger students in science and engineering. Additionally, they will leverage existing efforts, such as UT Austin's Freshman Research Initiative, to connect undergraduates to the materials research on campus and create new programs to connect graduate students and postdoctoral researchers to mentors in the research, commercial, and entrepreneurial communities. Through an artist-in-residence program, artists will work closely with scientists to make scientific ideas more accessible through their art.

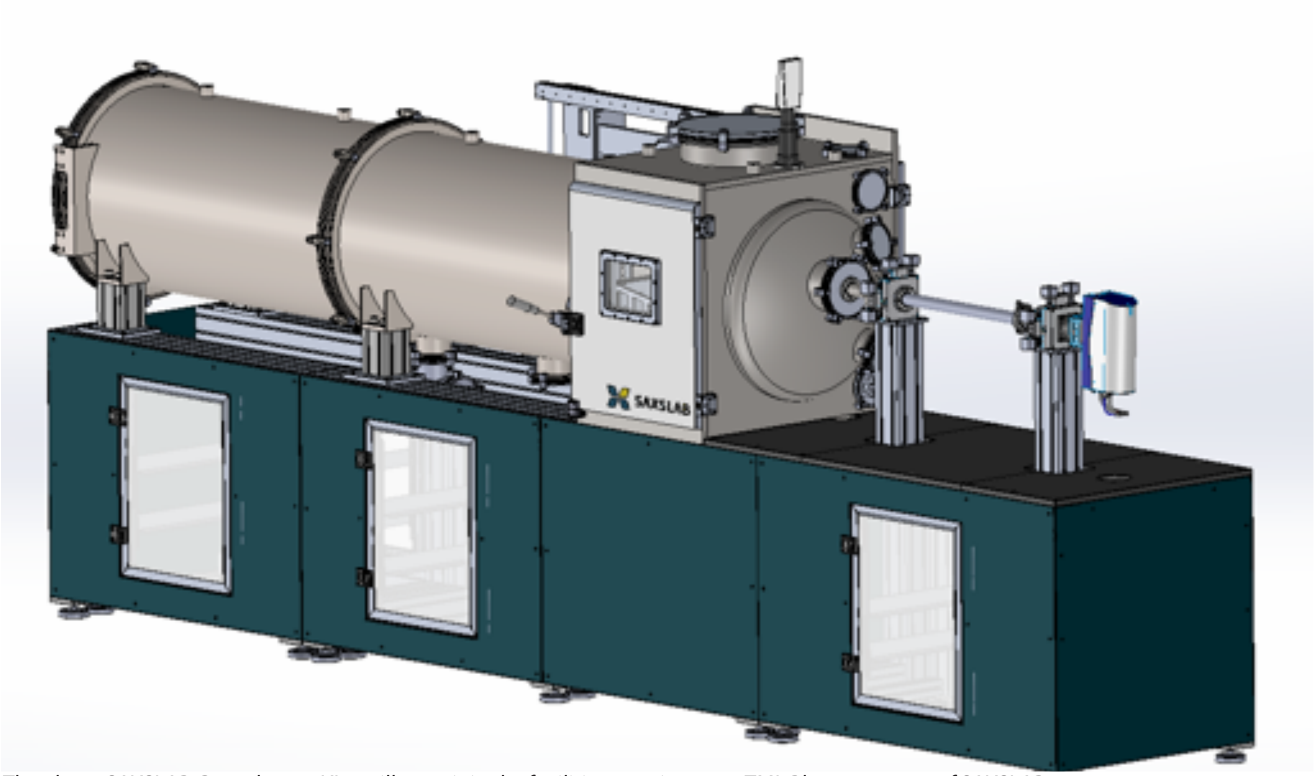
"We think artists will provide a unique perspective and help us improve the accessibility of many scientific concepts," Yu said. "And, on the other hand, we believe they will inspire new and interesting materials science and engineering."

Original article from Cockrell School of Engineering Communications Team.



Raman spectroscopy in Professor Yu's laboratory provides detailed information about atomic-scale structure, composition, and bonding in materials. Photo courtesy of Christopher Brannen.

Introducing New SAXS Equipment to TMI



The above SAXSLAB Ganesha 300XL+ will soon join the facilities equpiment at TMI. Photo courtesy of SAXSLAB.

In Fall 2016, TMI was awarded an NSF grant to aquire a Small Angle X-ray Scattering Instrument with In Situ Capabilities (SAXS). TMI faculty member Dr. Delia Milliron led the effort as Principal Investigator along with Dr. Brian Korgel of TMI and Dr. Katherine Brown of UT Austin College of Natural Sciences, both as Co-Principal Investigators.

This project will allow our PI and co-PIs to acquire a powerful small angle X-ray scattering (SAXS) instrument equipped with a collection of in situ sample stages that will accelerate and enhance a broad range of research activities in priority areas at the University of Texas at Austin (UT Austin) with an impact on advanced manufacturing, clean energy, and bioscience for human health. The new instrument will be incorporated into the existing TMI facility infrastructure at UT Austin, ensuring its availability to a diverse user base. In particular, the instrument to be acquired substitutes and in some ways exceeds the capabilities of remote facilities, allowing more materials characterization research to be carried out on campus without requiring students to travel. As such, the diverse undergraduate student population of UT Austin, who are very active in research, will be exposed to state-of-the-art X-ray scattering methods as a result of the acquisition.

The proposed SAXSLAB Ganesha 300XL+ system features a high brilliance microfocus X-ray source, scatterless slits, and a high dynamic range Pilatus 300k detector. These specifications will bring to UT Austin the ability to interrogate low-contrast samples such as block copolymers and bio-molecular assemblies; studies that have previously been confined to synchrotron-based investigations. Besides readily exchangeable sample stages for quantitative scattering on solutions, bulk samples, and thin films (including grazing incidence), the proposed instrument features a number of in situ stages to enable investigation of dynamic evolution of mesoscale structures. These capabilities in a user-accessible, campus-based instrument are ideally suited for investigating structural evolution in biological environments, informing design of adaptive materials systems, developing effective materials processing strategies, and diagnosing materials degradation pathways. Currently, researchers at UT Austin fulfill a majority of their need for SAXS by traveling to synchrotron facilities, though none are located nearby. The existing SAXS instrument at UT Austin predates modern advances in bench top X-ray instrumentation from the source to the detector. A modern instrument, well-equipped for both routine and sophisticated in situ experiments, will have an immediate and major impact on research activities at UT Austin.

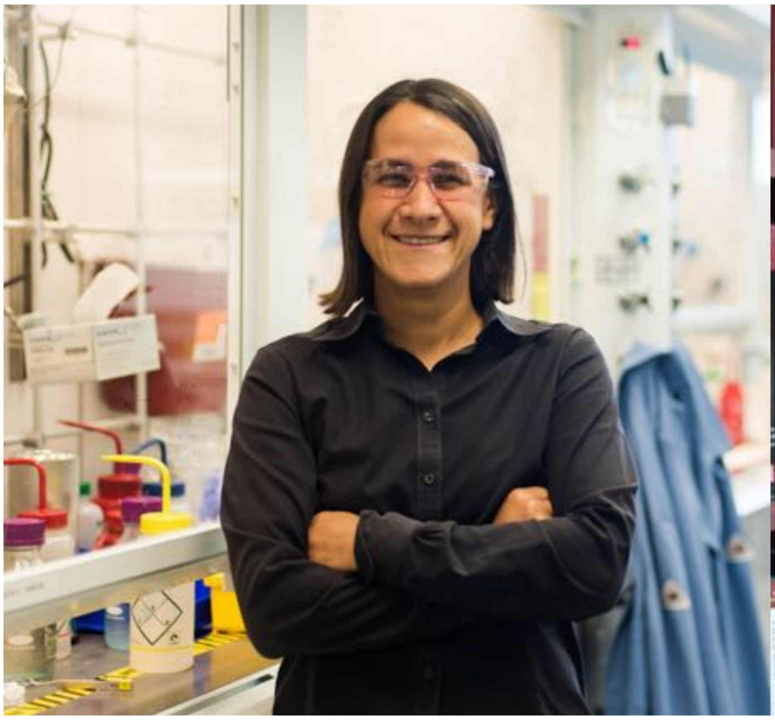
The proposed SAXS system will be a central and enabling instrument for a broad range of on-going and emerging research. Innovations in materials processing for lithography, membranes, catalysis, and energy will be accelerated by rapid feedback and in situ monitoring of mesoscale structures under processing and operating conditions.

Time-sensitive samples such as protein solutions and bio-molecular assemblies can be measured within a few minutes of their preparation in science and engineering labs nearby the centrally-located user facility that will house the proposed instrument. Considering the unique opportunities afforded by the proposed instrument, major research avenues to be pursued include: (1) mesoscopic assemblies of block copolymers and polymer-nanoparticle composites, (2) assemblies of nanocrystals in superlattices and gels, (3) seeded nanoparticle and nanolayer growth on semiconductors and oxides, (4) micro- and mesoporous materials, (5) inorganic nanoparticles and assemblies for bio-imaging, and (6) bio-molecular assemblies with applications to drug delivery. Overall, the proposed instrument will dramatically enhance our ability to interrogate nano- and mesoscale structures in these wide-ranging systems and to follow structural evolution under processing and operating conditions. New strategies for materials design and new understanding of biological processes are readily anticipated outcomes of the proposed research activities.

The SAXS instrument with in situ capabilities will be integrated into the existing X-ray scattering user facility of the Texas Materials Institute (TMI) at UT Austin, where it will be broadly accessible for both research and research training purposes. Many of the proposed research activities have transformative potential for energy technologies, biotechnology, or advanced manufacturing. The instrument will also enhance the training and education of students at UT Austin. Staffed by professional, experienced, PhD-level facility managers, TMI has an excellent track record of training postdoctoral researchers, graduate students, and undergraduate researchers to be qualified independent users on instruments similar to the proposed SAXS system. Undergraduates at UT Austin are especially diverse and research-active. Hence, the proposed instrument will make modern SAXS accessible to a large group of diverse student-researchers for the first time. The features and capabilities of the proposed instrument will also be incorporated into an existing pair of courses covering X-ray diffraction to provide a robust education in fundamentals and practical applications of SAXS to advanced undergraduates and graduate students across disciplines.

Original abstract written by Dr. Delia Milliron

Dr. Delia Milliron (left) was lead PI for the grant while Dr. Brian Korgel (right) the Co-PI, both of TMI.

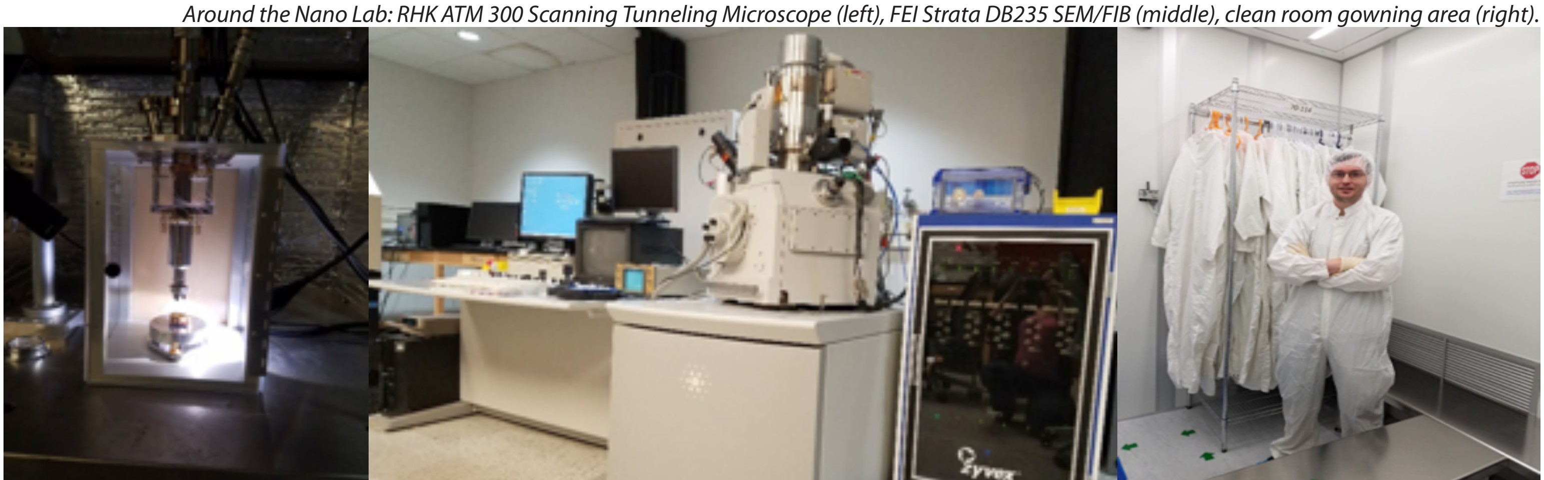


TMI Merged with CNM to Expand Facilities

A core value at Texas Materials Institute is providing instrumentation and affiliated infrastructure needed to conduct cutting-edge research in the field of materials. To fulfill this mission, TMI manages a variety of core central facilities, all of which are supported by facility managers. Our facility managers are Ph.D. level technical staff who oversee the use and maintenance of our specialized instruments, provide new user training, and coordinate usage and billing information for our equipment.

During the Fall 2016 semester, TMI merged with the Center for Nano and Molecular Science, previously housed within the College of Natural Sciences. This expansion has increased our core facility units with the addition of a Nano Lab and awarded us the opportunity to offer an even larger assortment of equipment to our students, faculty, and researchers. We are proud to announce that we now manage seven broad categories of facilities at TMI.

Around the Nano Lab: RHK ATM 300 Scanning Tunneling Microscope (left), FEI Strata DB235 SEM/FIB (middle), clean room gowning area (right).



NANO LAB

Lab Manager: Raluca Gearba, Ph.D.

Within the Nano Lab, there are several facilities: fabrication, thin film deposition, electrical characterization, spectroscopy, and microscopy.

Fabrication facilities include photolithography and electron beam lithography (EBL), allowing users to create patterned features out of solution-deposited plastic (or resist) films on solid substrates. These plastics react with light or the electron beam such that it changes the local solubility of the plastic in certain solvents, allowing pieces of the plastic film to be rinsed away. Structure feature size can range from the nanometer scale used for microelectronics up to the centimeter scale for microfluidic devices. Photolithography allows for high throughput of large area structures with features down to the micron scale while EBL generates the smallest structure feature sizes (25 nm) at the expense of being very time consuming. In addition, patterns with a resolution down to 20 microns can be produced by direct printing using precisely formulated nano-inks.

Films of metals, semiconductors and ceramics can be grown using a variety of methods such as evaporation and sputtering. Evaporation methods occur by heating a material until it melts and begins to boil. Once boiling, the material enters the vapor phase and deposits onto anything at a lower temperature it comes into contact with. Sputtering is accomplished by driving high-energy atoms at a material. The impact from the collision knocks small pieces of the material out and the momentum carries the sputtered material to the sample of interest. Thin films grown with these methods are used for a myriad of purposes depending on the material. They are used for such things as electrodes for small electronics and electrochemical cells, substrates for single monolayer assemblies, insulating layers in capacitor devices and sacrificial layers for more complex device structures to name a few.

The electrical characterization faciltiy includes the photovoltaics characterization facility, the electrical characterization facility (SUSS Probe station) and wire bonder.

The UV-VIS –NIR spectrometer (Cary 5000) and fluorimeter (Fluorolog 3) are standard spectroscopic characterization tools that utilize the absorption and emission of light to provide information about the excited state of different systems. The spectrometer measures the absorption of specific wavelengths of light for a given sample and can be used to determine sample concentration. The fluorimeter is capable of measuring the emitted light as a function of wavelength to generate fluorescence spectra. It is also capable of time-correlated single photon counting. This provides information about the number of emitting states in a molecule as well as the lifetimes of these excited states.

The Microscopy facility includes an FEI Scanning Electron Microscope, two Scanning Tunneling Microscope and an Atomic Force Microscope.

HITACHI AND QUANTA SEM

Lab Manager: Dr. Andrei Dolocan

The Hitachi S5500 scanning electron microscope (SEM) provides direct visualization of surfaces with sub-nanometer resolution. A very sharp electron beam (less than one nanometer) is raster scanned across a surface and the resulting knocked-off (secondary) electrons are recorded as a function of the electron beam position. An SEM image presents the morphology of the surface under investigation. This is equipped with five detectors, including bright field (BF) and energy-dispersive X-ray spectroscopy (EDS) detectors, which provide the morphology of a very thin sample in transmission and the elemental composition, respectively.

FEI Quanta 650 SEM features three imaging modes: high vacuum, low vacuum and environmental SEM (ESEM). The latter enables charge-free imaging and microanalysis of non-conductive specimens without preparation. An energy-dispersive X-ray spectroscopy (EDS) detector provides chemical analysis. It is also equipped with a Quorum Cyro-stage to image specimens in their "natural" hydrated state or frozen completely. The frozen state can be used for particle size distribution analysis when dynamic light scattering (DLS) is unable to help.

JEOL-TEM

Lab Manager: Dr. Karalee Jarvis

The TMI JEOL 2010f TEM/STEM has many well-known capabilities that include defect imaging, lattice imaging, nano-beam diffraction, elemental mapping, spectroscopy, orientation mapping, phase mapping, and in situ heating. In addition, our TEM has advanced capabilities that are not well known: Magnetic Domain Imaging and In Situ Electrical Biasing.

With the first, users are able to image magnetic domains in magneto-electronics. Subsequently, a magnetic field can intentionally be produced with the objective lens to study the behavior or the domain walls in a magnetic field. Recently, our heating holder was upgraded to do both heating and electrical biasing in situ. Currently, users can study particles, nanowires, and some thin films. We are in the process of learning how to place devices, such as solid state batteries, solar cells, and integrated circuits, onto the heating and biasing chips for in situ studies.

CHARACTERIZATION LAB

Lab Manager: Dr. Richard Piner

The TMI Characterization Lab was designed for an ideal environment for precision measurement. Both mechanical and electronic noise are very low allowing high resolution imaging.

The Wyko profilometer has the same vertical sensitivity as AFM but a much larger field of view. Having both types of instruments in the same room allows quick evaluation of sample topology across a broad range of length scales. The micro-Raman spectrometer, is also able to measure photo-luminescence (PL) spectra. The instrument can map spectra in three dimensions, X, Y & Z as well as measure spectra as a function of time. The SEM has very high resolution due to the field emission source and very low floor vibration. The EDS crystal is the largest on campus and hence most sensitive. The ESEM feature allows imaging difficult samples such as anodized aluminum.

KRATOS XPS AND POLYMER LAB

Lab Manager: Dr. Hugo Celio

The surface analysis laboratory at TMI is going strong and is expected to do even better in the coming year with assisting students and post-doctoral fellows with the capability to reliably and safely transfer air-sensitive materials to the time of flight secondary ion mass spectrometry (TOF-SIMS). During these past 3 years, the sample transfer rate has been 100% successful, i.e., no samples have been lost or damaged due to accidental air exposure or due to translation problems during the transfer from a glove box to the transfer interface of these instruments. In the coming months, the installation of an argon ion milling inside a glove box will be carried and a process will be developed to prepare cross sectional areas of air-sensitive samples for surface analysis. To our knowledge, TMI will be one of the first academic facilities in the country to install and develop this process for surface analysis of air-sensitive materials.

X-RAY

Lab Manager: Dr. Steve Swinnea

The TMI X-ray Scattering facility consists of three major groups of equipment. For basic x-ray powder diffraction, there are two Rigaku Miniflex powder diffractometers. One of these is equipped with an automated sample changer. For more advanced work, there is a multi-purpose Rigaku Ultima IV diffractometer. This instrument is generally configured to investigate thin film materials including obtaining in-plane patterns. Further capabilities include texture mapping, high temperature diffraction, and diffraction from materials contained in capillaries.

The X-ray facility also has small angle scattering capabilities. The current instrument is being replaced with the new state-of-the-art SAXS Labs Ganesha instrument.

TOF-SIMS

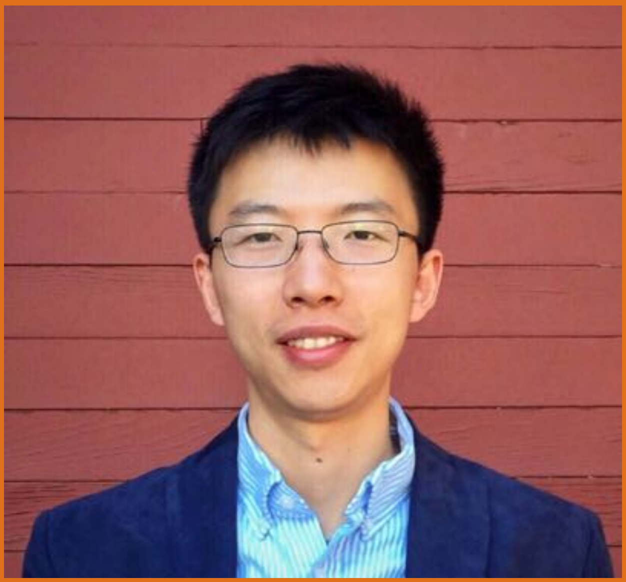
Lab Manager: Dr. Andrei Dolocan

The TOF-SIMS is essentially an ultra-high resolution mass spectrometer that possesses both high elemental and surface sensitivity, which can reach parts-per-billion and a few atomic layers, respectively. In short, it can detect the elemental composition of the few outermost atomic layers of a sample with parts-per-billion sensitivity. The instrument can provide simple surface spectroscopy with parts-per-billion elemental and molecular sensitivity and less than 1 nm surface sensitivity. The mass resolution that can be achieved is 0.001 atomic mass units. One can also perform surface imaging with less than 100 nm lateral resolution while parallel detecting various masses of interest to map their location.

Further, one can do depth profiling with a depth resolution of less than 1 nm. Depth profiling can be used to study the chemical composition of thin layers from less than 1 nm to micron thickness. One unique feature of depth profiling is that it can provide the atomic mixing length at buried interfaces, which cannot be otherwise observed. Finally, by combining the surface imaging and depth profiling, one can render the three-dimensional (3D) distribution of various chemical species of interest in the sputtered volume. Applications vary from doping/contamination distribution with depth in semiconductors to mapping the intricate electrode/electrolyte interface in lithium batteries or two-dimensional (2D) atomic crystals.

TMI Welcomes New Faculty

At Texas Materials Institute, it is our goal to seek the best and brightest minds in materials research to join our team at UT Austin. TMI is excited to welcome two new faculty members this year: Dr. Yuanyue Liu and Dr. Filippo Mangolini.



DR. YUANYUE LIU

Dr. Yuanyue Liu received his B. S. degree from University of Science and Technology of China (USTC) in 2008, and Ph.D. from Rice University in 2014, both in materials science and engineering. He worked at Lawrence Livermore National Laboratory (LLNL) as a summer student in 2013. He began the postdoc training at National Renewable Energy Laboratory (NREL), and then joined Caltech as a Resnick Postdoc Fellow. He has received a number of awards, including Chinese Government Award for Outstanding Students Studying Abroad (2012), Franz and Frances Brotzen Award (Rice University, 2014), and Resnick Prize Postdoc Fellowship (Caltech, 2015).

Dr.Liu's research focuses on materials theory and simulations for electronics, optoelectronics, energy conversion, and energy storage (e. g. transistors, solar cells, batteries, supercapacitors, electricity/light-fuels conversion). He is particularly interested in emerging materials, such as 2D materials and topological materials. He uses a variety of simulation techniques, including quantum-mechanical methods (e.g. DFT), and classic force-field methods (e.g. ReaxFF). He works closely with experimentalists on a wide range of topics, spanning from materials synthesis, to structures, to properties, and to applications.

DR. FILIPPO MANGOLINI

Dr. Filippo Mangolini received his Master's in Materials Science and Engineering at Polytechnic University of Milan in 2006 and his Ph.D. in Materials Science at the Swiss Federal Institute of Technology (ETH Zurich, Zurich, Switzerland).

During his Ph.D., Filippo was awarded the Field Best Presentation Award at the World Tribology Congress 2009. Upon completion of his Ph.D. In 2011, Filippo received a Swiss National Science Foundation Postdoctoral Fellowship and joined the group of Prof. R.W. Carpick at the University of Pennsylvania where he developed one of the first few laboratory-based environmental X-ray photoelectron spectrometers (E-XPS), which allowed him to investigate in situ the thermally-induced structural evolution of amorphous carbon surfaces. He was awarded a Marie Curie International Outgoing Fellowship for Career Development, which allowed him to extend his stay at the University of Pennsylvania and to subsequently move to Ecole Centrale de Lyon (France). Between October 2015 and November 2017, Filippo was a University Academic Fellow at the University of Leeds (UK), where his work focused on the investigation of the surface reactivity of advanced lubricants. In February 2016, Filippo was the recipient of a Marie Curie Individual Fellowship, while in May 2016 he was awarded the Mazzucotelli Award by the Analytical Spectroscopy Group of the Italian Chemical Society in recognition of the originality, quality, and relevance of his work.

New Additions to our MS&E Graduate Program

The MS&E graduate program is supported by 38 graduate program faculty who make up our Graduate Studies Committee (GSC). Each holds a tenure-track position in various home departments across campus but partner with TMI to teach and supervise our graduate students. This year we are proud to announce that we have added two

DR. JUNG-FU "AFU" LIN

Dr. Lin joined the University of Texas at Austin as a faculty in the Department of Geological Sciences and Texas Materials Institute in 2008. Dr. Lin's research focuses on understanding materials properties under extreme conditions through direct high pressure-temperature experiments in a diamond anvil cell coupled with synchrotron X-ray and laser spectroscopies. He aims to understand the physical and chemical properties of planetary interiors as well as high-pressure condensed matter physics and materials science.

He obtained a Ph.D. degree in Geophysical Sciences from The University of Chicago in 2002, and then became a Carnegie Postdoctoral Fellow at Geophysical Laboratory of the Carnegie Institution of Washington in 2002-2003. In 2005-2008, he was awarded the prestigious Lawrence Livermore Fellow at Lawrence Livermore National Laboratory. Prof. Lin was named Fellow of the Mineralogical Society of America in 2015. He was awarded an Early Career Award in Geophysics Program of the National Science Foundation. He has published about 150 peer-reviewed papers.

DR. S.V. SREENIVASAN

Dr. S.V. Sreenivasan is a Professor of Mechanical Engineering and the Joe C. Walter Endowed Chair in Engineering at The University of Texas at Austin. His research is in the area of high throughput nanomanufacturing as applied to electronics, photonics, flexible, and wearable devices, terabit density data storage, and emerging biomedical and clean energy applications. Dr. Sreenivasan has received several awards for his work, published over 100 technical articles and holds over 100 U.S. patents in the area of nanomanufacturing.

He is co-director of the NASCENT Center, a National Science Foundation Engineering Research Center. NASCENT Center is an interdisciplinary research effort in the area of high throughput nanomanufacturing systems to enable future generations of mobile computing and mobile energy technologies. He co-founded Molecular Imprints Inc. (MII), a spin-out from UT Austin, in 2001. The semiconductor business of MII was acquired by Canon Corporation in 2014.

Honors and Awards

FACULTY AWARDS

Deji Akinwande
- Bessel Research Award, Humboldt Foundation
- American Physical Society Fellow

Vaibhav Bahadur
- NSF CAREER Award

David Bourell
- SME Sargent Award

Gregory Fiete
- American Physical Society Fellow

Benny Freeman
- Inaugural Fulbright Distinguished Chair at CSIRO, Melbourne, Australia

John Goodenough
- Electrochemical Society Fellow
- Elected to The National Academy of Inventors
- C.K. Prahalad Award for Global Sustainability

Paul Ho
- 2017 IEEE CPMT (Component Package Manufacturing Technology Division) Technology Award

Delia Milliron
- 2017 Norman Hackerman Award, Welch Foundation

Nicholas Peppas
- American Academy of Arts and Sciences Fellow

Sean Roberts
- NSF CAREER Award

Li Shi
- Invitation Fellowship for Research, Japanese Society for the Promotion of Science

S.V. Sreenivasan
- Elected to The National Academy of Inventors

Grant Willson
- 2016-2017 Billy and Claude R. Hocott Distinguished Centennial Engineering Research Award

Guihua Yu
- Royal Society of Chemistry (FRSC) Fellow
- 2017 Camille Dreyfus Teacher-Scholar Award
- 2017 TMS Early Career Faculty Fellow Award
- 2017 Small Young Innovator Award

Yuebing Zheng
- NASA Early Career Faculty Award
- National Institutes of Health Director's New Innovator Award

STUDENT AWARDS

Bharath Bangalore-Rajeeva (Zheng Research Group)
- 2016-2017 Friends of Alec Graduate Student Fellowship, The Cockrell School of Engineering

Chi-Hao Chang (Manthiram Research Group)
- University Graduate Continuing Fellowship, The Graduate School

Yu Ding (G. Yu Research Group)
- Professional Development Award, The Graduate School
- Materials Research Society Fall 2016 Graduate Student Silver Award
- Materials Research Society Fall 2016 Graduate Student Travel Award
- University Graduate Continuing Fellowship, The Graduate School

Jianhe Guo (Fan Research Group)
- Professional Development Award, The Graduate School
- Gordon Research Conference (GRC) Graduate Student Academic Scholarship
- Materials Research Society (MRS) Meeting Symposium Poster Award
- Research Poster Contest Award, UT Austin Mechanical Engineering

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

Karl Kreder (Manthiram Research Group)
- First Place, UT Energy Week Poster Contest

Ke-Yu Lai (Manthiram Research Group)
- Professional Development Award, The Graduate School

Lele Peng (G. Yu Research Group)
- Professional Development Award, The Graduate School

Christopher Roberts (Bourell Research Group)
- Harris L. Marcus Graduate Fellowship in MS&E

Daniel Sanchez (Lu Research Group)
- NSF Graduate Research Fellowship

Ye Shi (G. Yu Research Group)
- Materials Research Society Spring 2017 Graduate Student Gold Award

Laura Spinella (Ho Research Group)
- S.C. Sun Best Student Paper, 2016 IEEE International Interconnect Technology Conference

Zheng Wang (Chen Research Group)
- Professional Development Award, The Graduate School

TMI Seminar Series

2016-2017 SEMINAR SERIES

FALL 2016

Dr. Shen Dillon - University of Illinois
In-Situ Characterization of Reaction Mechanisms and Degradation Processes in Energy Conversion and Storage Systems

Dr. Guozhong Cao - University of Washington
Fundamental Considerations in the Search for Better Intercalation Electrodes for Lithium-Ion Batteries

Dr. Kevin Huang - University of South Carolina
Development of Membrane Reactors for Simultaneous Electrochemical CO Capture and Conversion

Dr. Michael Strano - Massachusetts Institute of Technology
Mass and Energy Manipulation Using Carbon Nano technology

Dr. Rong Fan - Yale University
Microvasculature-on-a-chip for Tissue Engineering and Precision Medicine

Dr. Nicholas Kotov - University of Michigan
Self-Assembly of Nanoparticles

Dr. Tom Mallouk - Pennylvania State University
Assembly and Disassembly of Layered Materials

SPRING 2017

Dr. Sungho Jin - University of California, San Diego
Nano Structure Control for Enhanced Functional Materials

Dr. Tobin Marks - Northwestern University
How Do We Design Organic and Inorganic Materials for Flexible, Transparent Electronic Circuitry?

Dr. Jeff Wang - Johns Hopkins University
Discerning Rare Disease Biomarkers by Micro- and Nanotechnologies

Dr. Miquel Salmeron - University of California, Berkeley
Water Interfaces - From molecules ice and bulk liquid

Dr. Ali Dhinojwala - University of Akron
Getting a Grip Underwater

Dr. Ramamoorthy Ramesh - University of California Berkeley
Electric Field Control of Magnetism

SUMMER 2017

Dr. Ricardo Ruiz - Western Technologies
Self-Assembly of Polymer-Grafted Nanocrystals via Solvent Annealing

FALL 2017

Dr. Mauricio Terrones - Pennsylvania State University
Low-Dimensional Nano-Carbons: Form 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



Ye Shi with MRS Gold Award (left), Dr. Grant Willson, pictured with Dean Sharon Wood, receives Hocutt award (middle), and Yu Ding with MRS Silver Award (right).

TEXAS MATERIALS INSTITUTE
Materials Science & Engineering
THE UNIVERSITY OF TEXAS AT AUSTIN

Materials Science and Engineering
Texas Materials Institute
204 East Dean Keeton St. C2201
Austin, TX 78712

CONGRATULATIONS TO OUR 2016-2017 GRADUATES!

Will Hardin, Ph.D.
Tuning the Electrocatalytic Activity of Perovskites and Related Oxides and the Elucidation of New Catalyst Design Criteria
Supervisor: Dr. Keith Johnston

Michael Klein, Ph.D.
Understanding the Electrochemistry and Reaction Mechanisms of Solid-State Sulfides with Application to the Lithium-Sulfur Battery System
Supervisor: Dr. Arumugam Manthiram

Lele Peng, Ph.D.
Rational Synthesis and Structural Engineering of Two-Dimensional Inorganic Nanosheets for Electrochemical Energy Storage
Supervisor: Dr. Guihua Yu

Somayesadat Rasouli, Ph.D.
Study of Atomic-scale Mechanisms for Deposition of Nanostructured Films from Nanoparticles
Supervisor: Dr. Paulo Ferreira

Ye Shi, Ph.D.
Rational Design of 3D Nanostructured Conductive Polymer Gels for Electrochemical Energy Storage and Responsive Electronic Device
Supervisor: Dr. Guihua Yu

Laura Spinella, Ph.D.
The Scaling and Microstructure Effects on the Thermal Stress and Reliability of Through-Silicon Vias in 3D Integrated Circuits
Supervisor: Dr. Paul Ho

Karl Kreder, Ph.D.
Synthesis and electrochemical characterization of novel electroactive materials for lithium-ion batteries
Supervisor: Dr. Arumugam Manthiram

Yu-Hao Tsai, Ph.D.
First Principle Study of Transition Metal Oxide (Catalytic) Electrodes for Electrochemical Energy Technologies
Supervisor: Dr. Li Shi

The University of Texas at Austin
Cockrell School of Engineering

The University of Texas at Austin
College of Natural Sciences