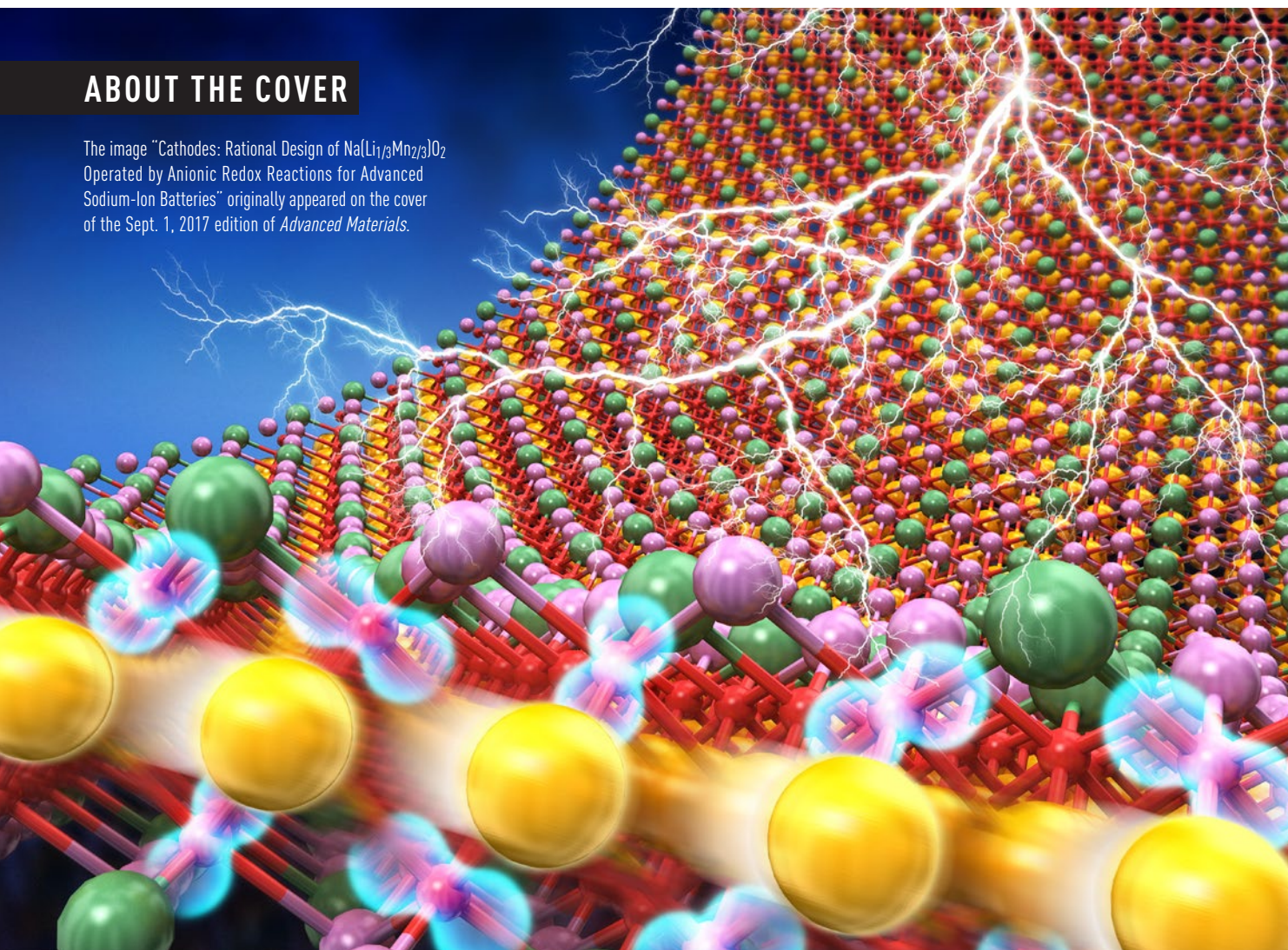


**MATERIALS
SCIENCE
AND
ENGINEERING**

ABOUT THE COVER

The image "Cathodes: Rational Design of $\text{Na}(\text{Li}_{1/3}\text{Mn}_{2/3})\text{O}_2$ Operated by Anionic Redox Reactions for Advanced Sodium-Ion Batteries" originally appeared on the cover of the Sept. 1, 2017 edition of *Advanced Materials*.



The cover art shows an artistic illustration of high capacity battery cathode materials designed and experimentally synthesized to validate model predictions from the laboratory of Dr. Kyeongjae (KJ) Cho. His related battery materials research was published in *Advanced Materials* in 2017, *Nature Nanotechnology* in 2018 and *Advanced Energy Materials* in 2019. Battery materials research is a focus area of his current research activities including lithium ion batteries, sodium ion batteries, solid state batteries, lithium-sulfur batteries and zinc ion batteries for electric vehicles and grid-scale energy storage applications. Cho's materials modeling research works have been

twice selected by the U.S. President's Office to highlight the emerging key role of materials design based on quantum mechanics simulations.

Cho is a professor of materials science and engineering in the Erik Jonsson School of Engineering and Computer Science at The University of Texas at Dallas. His main area of research and teaching is multiscale modeling and simulation of nanoscale materials with the goal of realizing the vision of materials by design. The modeling methods include atomistic and quantum simulations. Research topics include clean energy materials such as batteries, fuel cells and pollution control catalysts as well as electronic device materials including nanomaterials, oxides and

atomic layer deposition (ALD) growth.

Cho was elected as a fellow of the American Physical Society in 2016, a fellow of the Institute of Physics in 2004 and a Terman Junior Fellow in 1997. He currently leads the Multiscale Simulation Lab at UT Dallas focused on electronic device and energy storage materials modeling and experimental validation. During his academic career, Cho has published more than 355 journal articles earning more than 20,000 Science Citation Index (SCI) citations, with an SCI index of 62. He has supervised 19 completed PhDs, including eight currently working as professors at academic institutions.



DEPARTMENT HEAD'S WELCOME

Dear friends,

D Welcome to our second annual news brochure! Much has changed since our last publication. In this edition, you will find some of the most recent developments and achievements of our students, faculty, staff and alumni. Visit our website to learn more about our highly accomplished faculty members and state-of-the-art facilities available in the Department of Materials Science and Engineering (MSE) at The University of Texas at Dallas.

We have experienced an unbelievably challenging few months due to the new coronavirus pandemic, and we recognize the impact of these extraordinary times on our society as well as higher education. However, our department's mission to provide excellence in teaching and

research for our students has not changed. I would like to extend my appreciation to all members of the department: you have worked tirelessly in supporting our mission and continue to prepare students for productive and meaningful lives, while also making a difference in our community.

Our faculty members and students continue to produce exciting research. Inside this newsletter, you will find details about new grants, awards and prizes awarded to MSE faculty members and students. Notably, a company founded by Dr. Orlando Auciello was awarded the international InnoSTARS prize, and research from Dr. Jiyoung Kim was selected three consecutive times as Editor's Pick in Applied Physics Letters. Pavel Bolshakov PhD'19 won the best PhD dissertation award from the UT Dallas Office of Graduate Education. Alumnus Cheng Gong PhD'13 now serves as a faculty member at the University of Maryland, and Santosh KC PhD'14 MS'11 has joined the faculty at San Jose State University.

Finally, I am honored to announce that as of July 1, 2020, I will serve as the new department head for our outstanding students, faculty, staff and alumni. On behalf of the department, I sincerely thank Dr. Amy Walker for her dedicated service as interim head and wish her the best in her new role as Jonsson School associate dean for undergraduate education.

Best regards,

Dr. Manuel Quevedo

Professor of Materials Science and Engineering
Head, Materials Science and Engineering



ON THE BACK COVER:

Tiles from the Natural Science and Engineering Research Laboratory (NSERL) building, which houses MSE and is itself a work of art.

DEPARTMENT HEAD

Dr. Manuel Quevedo

ASSISTANT DIRECTOR

Tonya Griffin

EDITORS

LaKisha Ladson MA'18
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DESIGNER

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CONTACT US

**Department of Materials
Science and Engineering**

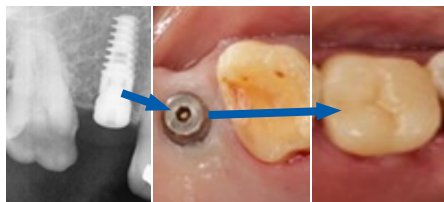
The University of Texas at Dallas
800 West Campbell Road, RL10
Richardson, TX 75080

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AUCIELLO WINS TOP PRIZES FOR ENTREPRENEURIAL VENTURE

In December 2019, Dr. Orlando Auciello, professor of materials science and engineering (MSE) and bioengineering (BE), took the top prizes for his companies Original Biomedical Implants, OBI-USA and OBI-México, in the semifinal and final competition for high-tech U.S. start-ups participating in the InnoSTARS U.S.-China Innovation Alliance competition held in China. The top sixteen companies were selected as finalists among 200 start-ups.

Auciello, holder of the Distinguished Chair in Engineering at UT Dallas, received the prizes in the science and technology categories for his companies' revolutionary biocompatible ultrananocrystalline diamond (UNCD) coating technology applied to two key technologies. Interdisciplinary research and development for the technology in both materials science engineering and biomedical engineering is currently



From left: An X-ray of the implanted UNCD-coated dental implant, top view of implanted UNCD-coated dental implant, and the completed implant with a ceramic crown document the first revolutionary UNCD-coated dental implant from the clinic of Dr. Gilberto López-Chávez in Querétaro, México. Ten people have received UNCD-coated dental implants in clinical trials in México since 2018.

underway at UT Dallas in collaboration with OBI-USA and OBI-México.

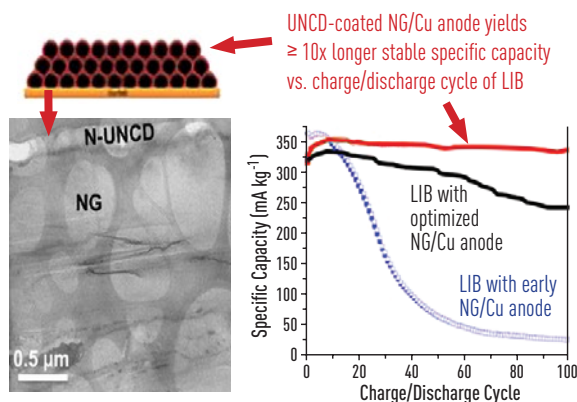
One project focuses on the development of the first UNCD-coated commercial titanium alloy dental implant for humans worldwide. Under Auciello's direction, Karam Kang MS'17, then a master's student in BE, developed the process at UT Dallas and OBI-México to cover commercial dental implants with the unique UNCD coating. The new dental implants are projected to enter the market by 2021 or 2022.

The other project focuses on developing a unique, electrically conductive nitrogen atoms-doped N-UNCD coating to cover commercial graphite copper (NG/Cu) anodes. This coating eliminates lithium ion chemical degradation of graphite-copper anodes, enabling a new generation of lithium ion batteries (LIBs) with superior stable specific capacity versus charge and discharge cycles, as well as safer functioning, as compared with current commercial LIBs with uncoated graphite-copper anodes.

Research and development is being conducted in Auciello's laboratories, with funding from the Secretaría Nacional de Ciencia Tecnología y Innovación (SENACYT) Panamá grant. Contributors include co-principal investigator



Dr. Elida de Obaldia, senior associate scientist at UT Dallas and professor at the Universidad Tecnológica-Panamá, with key science contribution by Dr. Jean F. Veyan, research scientist from MSE. Graduate researchers include Daniel Villareal, a current PhD student in MSE, funded by a unique scholarship from SENACYT-Panamá, directed by Auciello and de Obaldia, and Benjamin Stein, a UT Dallas BE PhD student directed by Auciello and Dr. Walter Voit, associate professor of MSE and mechanical engineering.



HSU NAMED TO ACADEMIES' REVIEW PANELS

Dr. Julia Hsu, professor of MSE and Texas Instruments Distinguished Chair in Nanoelectronics, was appointed to serve on two review panels for the National Academies of Sciences, Engineering, and Medicine. One panel reviews Propulsion Sciences at the Army Research Laboratory (ARL), and the other panel reviews the Engineering Laboratory at the National Institute of Standards and Technology

(NIST). These panels gather a group of experts in academia and industries to evaluate the technical quality of research — benchmarked nationally and internationally — focusing on qualification of research teams, facilities and resources, as well as opportunities and challenges. Both reviews take place in 2020, and peer-refereed reports will be published by the National Academies.

RESEARCH ON AI HARDWARE COMPONENTS WINS POSTER COMPETITION, RECOGNIZED IN TOP JOURNAL



Dr. Jiyoung Kim, professor of materials science and engineering at The University of Texas at Dallas, and researchers in his lab were recognized for developing a high-performance selector and for publishing research on emerging non-volatile memory (NVM). Developing artificial intelligence (AI) hardware receives considerable attention for its potential, particularly because of its significantly enhanced power efficiency. Developing a more advanced selector and new memory components can help create hardware components that operate at low power, a must for enabling widespread use of AI technology.

Jiyoung Kim's laboratory housed at the Erik Jonsson School of Engineering and Computer Science is making strides toward solving this big problem. PhD student Harrison Kim won best student presentation prize at the Non-Volatile Memory Technology Symposium in October 2019 for his work on developing a selector of crossbar arrays for potential AI applications. The Non-Volatile Memory Technology Symposium is a highly selective, invitation only event for academic and industry researchers working on conventional non-volatile memory. Researchers from Sandia National Laboratories, Intel, Microns, Applied Materials,

STM Microelectronics, IBM and more sent representatives to the event.

Developing emerging NVM is equally important as developing a high-performance selector. Principal Investigator Jiyoung Kim and his group contributed research towards articles which were selected three times consecutively as an Editor's Pick and featured article at *Applied Physics Letters*. Dr. Yongchan Jung, Dr. Heber Hernandez-Arriaga and Akshay Sahota from Jiyoung Kim's group were co-researchers for the selector and NVM work.

Applied Physics Letters is widely considered a premiere publication for materials science researchers and features a strict publication process. The group's research addressed techniques to solve common problems with creating commercial ferroelectric random-access memory (FRAM), an alternative type of random-access memory which uses about 99% percent less electricity than conventional dynamic random-access memory (DRAM).

Ferroelectrics can help in performing analog type NVM operations which can act as a hardware component for deep learning. Such ferroelectric materials were fabricated at a low temperature, 400 degrees Celsius. Mohan, who has been studying ferroelectric materials for his PhD, said, "These low temperatures can help in easy integration to the back end of line, or the second part of integrated circuit fabrication."

Jiyoung Kim works closely with other UT Dallas materials science researchers including Dr. Luigi Colombo and Dr. Chadwin Young. His team's work is highly esteemed within his field, attracting researchers across the globe.

"Without hesitation, I joined Dr. Kim's laboratory," Harrison Kim said. "The work is comprehensive and multidisciplinary. I was also interested in hands-on processing, working on the fundamentals of electronics and devices."



Left to Right: Jaidah Mohan, Harrison Kim, Akshay Sahota

Harrison Kim, who previously studied atomic layer deposition (ALD), a technique used for creating nanoscale electronics, while earning his master's degree in South Korea, indicates that non-volatile memory is as important as a reliable selector in nanoelectronics. The group's work toward reducing power dissipation, with billions of devices working on a single chip, will effectively enable AI technology to consume significantly less energy.

INNOVATIVE LEADER NAMED ASSOCIATE DEAN OF UNDERGRADUATE EDUCATION



Dr. Amy Walker is the new associate dean for undergraduate education in the Erik Jonsson School of Engineering and Computer Science. Walker previously served as interim head of the Department of Materials Science and Engineering. She is also the current president of AVS, a professional society of academic, industrial, government and consulting professionals with about 4,500 members worldwide.

"I consider the role of associate dean for undergraduate education one of the most critical in the Jonsson School in terms of improving long term outcomes for our students," said Dr. Stephanie G. Adams, dean of the Jonsson School and Lars Magnus Ericsson Chair. In addition to Amy's demonstrated success as a leader and researcher, I have found Amy to be passionate, energetic, enthusiastic and visionary. She is a collaborative, solutions-oriented and diligent leader. I know she will work hard toward improving the student experience for all our students."

At The University of Texas at Dallas, Walker researches surface chemistry and materials science, manipulating interfacial chemistry in order to develop simple, robust materials with complex 2- and 3-D surfaces.

She has worked with UT Dallas undergraduates pursuing certificate programs in nanoscience and nanotechnology and has supervised

undergraduate researchers throughout her career. In her new role as associate dean for undergraduate education, which started July 1, her goals include increasing diversity and inclusion, improving the pipeline of women and underrepresented minorities in engineering and computer science, and improving retention, engagement and the student experience – all areas in which she has already demonstrated success.

INCREASING DIVERSITY AND INCLUSION

The Jonsson School student population currently includes around 20 percent women. While its population is diverse, it does not reflect the population of Texas, particularly among Black and Hispanic students.

In 2018 Walker secured funding from the Louis Stokes Alliance for Minority Participation, a program operated by the National Science Foundation (NSF), to support the Bridge to the Doctorate program, which supports underrepresented minority students for the first two years of a doctoral program. She was also the principal investigator of a NSF Research Experience for Undergraduates (REU) Program in the UT Dallas Department of Materials Science and Engineering from 2012-2018. Of the sixty students that participated, half were women, one-third were members of an underrepresented minority group, and many attended graduate school and earned professional degrees.

"We know students from underrepresented groups need several things to be successful – family and financial support, a sense of belonging, academic confidence – which we can focus on through social support and mentoring," Walker said. "What will higher education do for you? You might not know. It didn't occur to me that I would enter academia until a mentor sat me down with a cup of tea and said, 'Now when you earn your PhD...' If you don't have someone giving you these messages, you don't know what you can do."

Walker has served on the faculty of the Department of Materials Science and Engineering since 2009, following a previous appointment at Washington University in St. Louis. She holds a bachelor's degree in physics and a PhD in chemistry from the University of Cambridge in England.

RETENTION AND ENGAGEMENT

Walker aims to improve public understanding of how engineering impacts society. While many students pursue careers in engineering and computer science following graduation, many emergent careers require interdisciplinary skill sets, including non-STEM skills in business, communications and the arts.

Walker's 2025 target plans include expanding the undergraduate population to 7,000 students, expanding the applicant pool, and increasing yields of inquiry, application and enrollment, while simultaneously increasing demographic diversity and improving retention.

"When we think about retention, we ask the question: 'What makes you come back to complete the degree?'" she said. "If we provide a range of services, we can support as many students as possible."

Many undergraduates are from the North Texas region, so recruitment efforts will include training alumni ambassadors and focusing on transfer students from community colleges. Additionally, she aims to increase competitive scholarships available to undergraduates. Students from Louisiana, New Mexico, Oklahoma and Arkansas, in particular, may be attracted to the strong economy in the Dallas-Fort Worth metroplex, she said.

ENHANCING THE STUDENT EXPERIENCE

In order to improve the student experience, Walker will focus on services such as peer mentoring, tutoring and the Student Success Center.

Walker noted that programs such as UTDesign® EPICS, which link students with real-world service projects, have been remarkably successful in attracting and retaining both women and underrepresented groups including Black and Hispanic students. The EPICS program is designed for students to receive course credit for a real-world project and can be taken early on in the undergraduate career. Students directly apply their skills and work in multidisciplinary teams.

“I think the EPICS program is

really fantastic,” Walker said. “The more experiential learning we do, the better off we are. Students want to see the real-world connection — how what they’re learning will enable them to make a difference.”

She also highlights the importance of professional organizations. “I am the student chapter advisor at AVS DFW and current president of AVS,” Walker said. “This group is more for graduate students, but it has helped me to understand the importance of building a network.

Professional societies provide homes for connection – students might turn to people they meet many years later.”

While Walker notes that students will have an exceptional year due to COVID-19, she looks forward to discovering ways the Jonsson School can better serve students.

“Dean Adams is so supportive of these ideas,” Walker said. “With supportive leadership and our already fantastic school and students, we are all bound to be successful.”

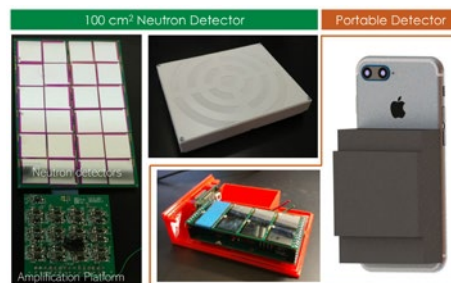
QUEVEDO DEVELOPS NEUTRON DETECTOR FOR LARGE AREA RADIATION

The flexible and large area nanoelectronics group led by Dr. Manuel Quevedo has developed several high efficiency neutron and gamma ray detectors currently under consideration by the U.S. Department of Homeland Security (DHS) for potential deployment. In collaboration with Texas Instruments Inc. (TI), the Air Force Office of Scientific Research, Nanoholdings and the DHS, the group demonstrated the first of its kind neutron detector using novel solid-state sensors fully fabricated at UT Dallas.

With TI’s help, unique circuitry was

designed to render a 100 cm² prototype for the detection of special nuclear materials typically used to make dirty bombs. The technology developed at UT Dallas demonstrates, for the first time, a cost-effective platform for the detection of nuclear threats over ultra-wide areas such as ports of entry, airports, metro stations, public areas and even entire cities.

Other important developments include low power consumption, low weight and size, portable detectors for personal use or to be mounted on unmanned aerial surveillance aircrafts. State-of-the-art



sensor design and the innovative use of advanced materials enabled the group to bring detection efficiency from the traditional 4% value in planar silicon sensors to greater than 25%.

HSU AND VANDENBERGHE SECURE NSF FUNDING FOR SOLAR CELL RESEARCH

Dr. Julia Hsu and Dr. William Vandenberghe, professor and assistant professor of MSE, respectively, recently received a \$421,422 award from the National Science Foundation to support a project entitled “Dilute-Donor Organic Solar Cells: Breaking the Fullerene Monopoly”.

Their research will build on the recent discovery that when a small concentration of donor molecules is mixed into fullerene “carbon balls” material, remarkably effective solar cells can be fabricated, outperforming previous solar cell designs. How exactly this small concentration of donor molecules affects the fullerene behavior

is not well understood. How can high photocurrent be generated when, due to the low concentration of donor molecules, no percolation pathway for holes, or positively charged carriers, to reach the electrode can exist? If not percolating, how do holes reach the electrode and generate photocurrent?

Combining efforts, Hsu, holder of the Texas Instruments Distinguished Chair in Nanoelectronics, and Vandenberghe will perform a joint experimental and modeling study of the dilute-donor organic solar cells. They will analyze the effects of relative energy level positions, molecular interaction strength and morphology on photocurrent generation.

PhD student Lakshmi Murthy is performing materials characterization and device fabrication and testing in close collaboration with PhD student Aaron Kramer, who is performing first principles and Monte Carlo calculations. To accelerate research progress, mechanical engineering undergraduate Marcus Ochoa is participating in morphological studies.

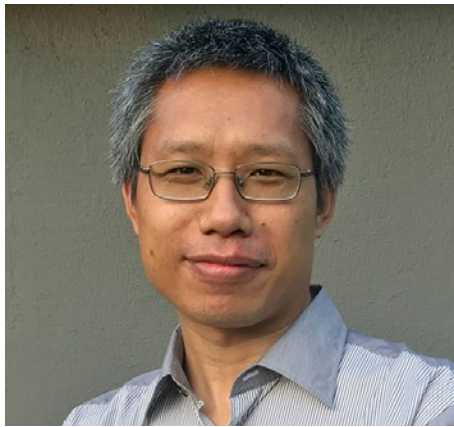
International collaborations include donor molecules produced at National Taiwan University, Monte Carlo simulations performed at Technical University of Munich and advanced X-ray scattering experiments at Air Force Research Laboratory.

VIRTUAL DISSERTATION DEFENSES

As the Spring 2020 semester began, four MSE PhD students, Ava Khosravi, Harrison Kim, Arul Ravichandran and Qingxiao Wang, began preparing their final dissertation defenses. Each student conquered their first big hurdle – securing a defense date that worked for every member of their supervising committee. With all four defense dates lined up in late March, each student worked diligently to prepare their final dissertations for their big day.

Then, in mid-March, the COVID-19 pandemic caused the University to shift its classes and most services online, including all remaining doctoral defenses. Although this sudden change almost certainly added an extra layer of stress to an already stressful time for our PhD candidates, they persevered. With close guidance from the University Office of Graduate Education staff members, each student conducted their defense remotely via videoconferencing platforms.

Despite the major disruption, all four PhD candidates successfully passed their virtual defenses. While their success was largely due to their own preparedness, they recognized and appreciated the support they received to help them secure their achievement. “I am so thankful to you and the materials science and engineering team for working so hard during these difficult times and making it possible



Top Left to Right: Dr. Harrison Kim and Dr. Arul Ravichandran
Bottom Left to Right: Dr. Qingxiao Wang and Dr. Ava Khosravi

for us to do our defense without any delay,” wrote one student to the interim department head, Dr. Amy Walker. Another student said, “I would like to take this opportunity to personally thank you and other materials science staff members for helping students complete their dissertation defenses in a timely and well-organized manner.”



BEST DISSERTATION AWARD

Pavel Bolshakov BS’15, PhD’19 in materials science and engineering earned the Best Dissertation Award from the UT Dallas Office of Graduate Education for his dissertation entitled, “Investigation of Critical Interfaces of Transition Metal Dichalcogenide Devices for Future Devices”. His research mentor was Dr. Chadwin Young, associate professor of MSE. Bolshakov is now employed at Intel Corp.

**Congratulations
to our Spring
2020 graduates!**



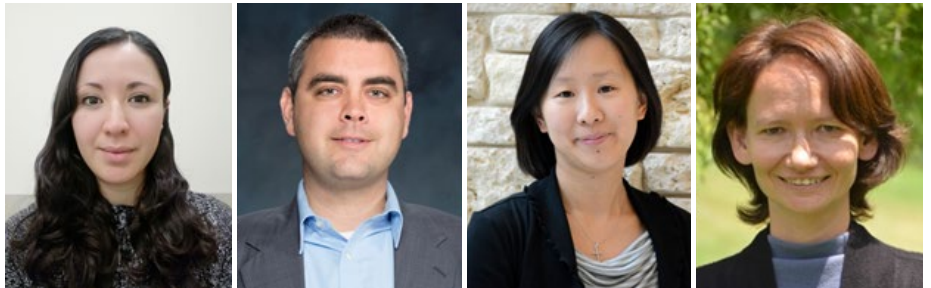
MSE ALUMNI HOMECOMING

In the fall of 2019, we hosted our inaugural MSE Alumni Homecoming. Several alumni returned to connect during a social gathering and mingle with current students. This occasion featured a special seminar where fellow alumni, Dr. Marcela Mireles and Dr. John Murphy, presented their current research projects. The event concluded with an alumni panel with both presenters joined by Connie Manz and Dr. Katy Roodenko who discussed their career journeys and networking, then answered questions from graduate students.

Our alumni enjoyed the experience. "I really enjoyed my time there and greatly

appreciate the opportunity and effort of providing current students and alumni to connect," Mireles said. Murphy echoed, "It really was a pleasure to return and share about my current work, the lab and my perspective on transitioning from school to 'the real world'. I had a great time during the event. I caught up with some folks and our discussions may spark future collaborations."

Our department's theme this year has been "making things that matter." This is the true spirit we wanted to capture in bringing everyone together. We hope more alumni will join us in the future to expand our network and continue building relationships.

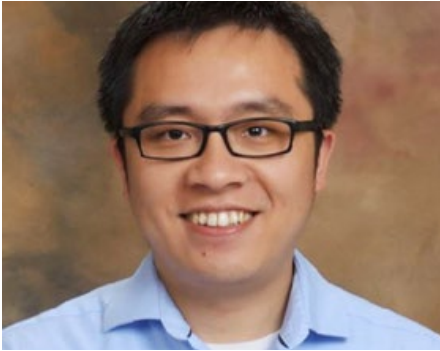


Left to right: Dr. Marcela Mireles from Rochester Institute of Technology, Dr. John Murphy from Lawrence Livermore National Laboratory, Connie Manz from Qualia Inc. and Dr. Katy Roodenko from Max-IR Labs.

Making Things That MATTER.

Department of Materials Science & Engineering
The University of Texas at Dallas

ALUMNI SPOTLIGHT



Cheng Gong PhD'13 joined the Department of Electrical and Computer Engineering at University of Maryland, College Park, in August 2019. He is a tenure track assistant professor and conducts research at the department's Quantum Technology Center. His research focuses on magnetic, electronic and optical properties of two-dimensional materials, nanostructures and nanodevices, studied by optical and electrical approaches in synergy with density functional theory calculations. Applications include data storage, sensors, energy and quantum technologies. Prior to joining the University of Maryland, he was a postdoctoral scholar at the University of California, Berkeley.



Santosh KC, PhD '14, MS'11 was appointed as an assistant professor in the Department of Chemical and Materials Engineering at San Jose State University (SJSU) beginning in fall 2019. As a student at UT Dallas, KC was a graduate researcher in Dr. Kyeongjae (KJ) Cho's group. After earning his PhD in materials science and engineering in 2014, KC worked at Oak Ridge National Laboratory (ORNL) in Tennessee as a post-doctoral researcher. After three years at ORNL, he was a research associate at the University of California, Santa Barbara.

KC enjoys teaching undergraduate and graduate students along with his research. Currently, he is establishing a materials modeling and simulation research group and teaching online materials engineering courses at SJSU.

IN THE PAST YEAR, OUR GRADUATES HAVE BEGUN THEIR CAREERS WITH THESE COMPANIES, NATIONAL LABS AND UNIVERSITIES:

Applied Materials Inc.

Aerospace Research Institute of Special Material and Processing Technology, Beijing, China

Ares Materials Inc.

University of Wisconsin

Haverford College

HEE Solar

Intel Corp.

Lam Research Corp.

Lawrence Berkeley National Laboratory

Micron Technology Inc.

Panasonic Eco Solutions Solar, New York

Sandia National Laboratories

Shenzhen Institutes of Advanced Technology, Shenzhen, China

The University of Texas at Austin

The University of Texas at Dallas

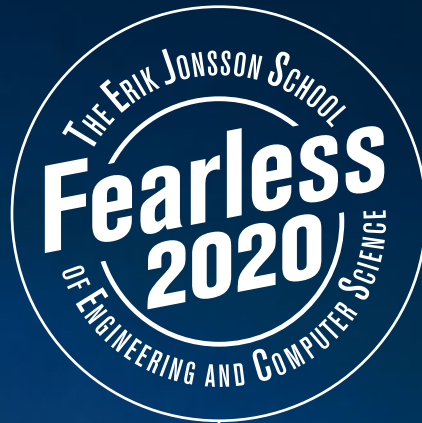
SPECIAL ACKNOWLEDGMENTS

Our department leaders and faculty wish to extend a special thanks to our administrative staff for their excellent service in assisting our students. The staff play a key role in students' overall program experience and graduate success. For many students, UT Dallas becomes their home away from home. As students become acclimated to campus and the department community, our staff also trains students in essential tasks such as purchasing, travel and reimbursements that support their research. The staff strives to ensure students stay on

track and provides deadline reminders for important academic milestones. During the 2020 coronavirus pandemic, the staff has supported our students virtually with a seamless transition.

Left to Right From Top:
Ashley Willess, Curriculum/Graduate Advising Coordinator; Julieta Terry, Human Resources Coordinator; Aura Thomas, Admissions / Recruitment Coordinator; Michele Brown, Purchasing Coordinator; Shunverie Barrientez, Program Manager for LSAMP Bridge-to-Doctorate program; Petrit Begolli, Travel and Seminar Events Coordinator; Monica Krause, Business Manager; Tonya Griffin, Assistant Director / Team Lead.





\$20 MILLION BY 2020

Fearless 2020 has two core priorities — to impart knowledge in teaching and research to the next generation of global leaders and to enable greater access to higher education for underrepresented and non-traditional students — a gift of talent to North Texas and the world.

Materials Science and Engineering has demonstrated an unwavering commitment to extending opportunity and promoting diversity among students and faculty alike.

To propel the Erik Jonsson School of Engineering and Computer Science forward and continue to attract top-tier students, we invite alumni, corporate partners and the broader community to make an investment that will last.

Be fearless with us!

For more information on MSE fellowships, faculty research and other initiatives, please contact:

Senior Director Brittany Huber

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engineering.utdallas.edu/fearless2020



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