

////// FALL 2017

# TEXAS A&M ENGINEER

ENGINEERING RESEARCH AT TEXAS A&M UNIVERSITY

## SERVING THE UNDERSERVED

NEW NSF ENGINEERING  
RESEARCH CENTER



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FROM THE DESK OF

# M. KATHERINE BANKS

VICE CHANCELLOR AND DEAN OF ENGINEERING

I am pleased to present this edition of Texas A&M Engineer, which provides a snapshot of the high quality research conducted by our faculty and students.

With our current research funding of \$282 million, our 525 faculty members utilize 1.5 million square feet of research space to address engineering challenges in health care, energy, national security, infrastructure, materials and manufacturing, and information systems.

The cover story features our newest research center which focuses on development of affordable healthcare technology for underserved communities to combat two of the most common and devastating diseases, diabetes and heart disease. The National Science Foundation recently selected a team of researchers led by Texas A&M to establish a new engineering research center (ERC), the Precise Advanced Technologies and Health Systems for Underserved Populations (Paths-Up). Texas A&M faculty will work with colleagues at Florida International University, Rice University, and the University of California at Los Angeles, as well as several companies and federal agencies to increase access to affordable and easy-to-use health monitoring devices. Led by Professor Gerard Coté, researchers are working directly with patients to ensure the technology is accessible and appropriately designed. With the rising cost of health care and growing populations with less access to medical professionals, it is critical that we offer affordable solutions to communities with the highest need.



**M. Katherine Banks, Ph.D., P.E.**

Vice Chancellor and Dean of Engineering  
Director, Texas A&M Engineering Experiment Station  
University Distinguished Professor  
Harold J. Haynes Dean's Chair Professor



**The PATHS-UP NSF ERC  
will deliver cost-effective  
healthcare technology and  
systems to underserved  
populations.**

Pictured: A wearable device that will be developed to monitor biomarkers for helping patients with diabetes or cardiovascular disease that can then transfer the information to a cell phone app., which could then be sent to the health care provider when needed.



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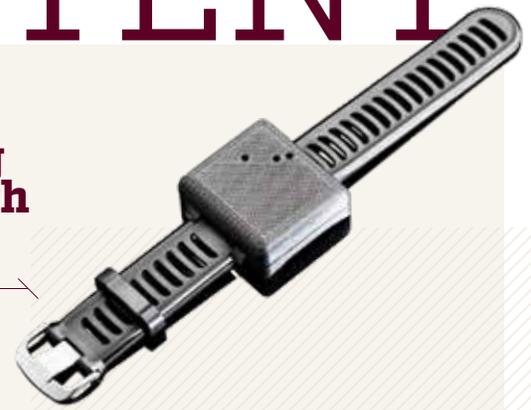
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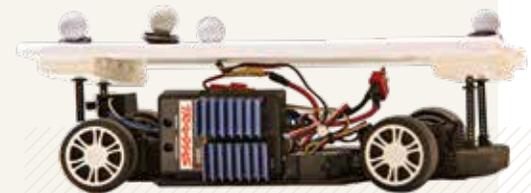
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DEPARTMENT OF BIOMEDICAL ENGINEERING

# Transforming health through technology

Texas A&M researchers tasked with establishing a National Science Foundation-funded Engineering Research Center, **one of the most significant engineering grants an institution can receive**, will develop life-changing healthcare technologies in collaboration with partner universities and underserved communities.

**I**n the fight against the costly and debilitating results of diabetes and heart disease in the United States, innovative technologies are either not available to help people monitor and manage their conditions or are costly and not designed for the vulnerable and underserved rural and urban populations that need them most.

Researchers from the College of Engineering are employing a unique collaborative

design-thinking approach to engage with the underserved and develop transformative engineered systems that integrate simply and easily into these communities.

“On average, every 30 seconds one person in the United States will be diagnosed with diabetes and another will suffer a coronary event like a heart attack,” says Dr. Gerard Coté, holder of the Charles H. and Bettye Barclay Professorship in Engineering and director of the Center for Remote Health

Technologies and Systems. “These diseases are even more devastating in rural and urban underserved communities, where they occur at much higher rates than the national average.”

The National Science Foundation (NSF) selected Coté and his team to establish a new Engineering Research Center (ERC), the Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP).

This NSF-funded effort aims to overcome cost, access and care quality obstacles in these communities. People living in underserved communities typically have less access to preventive care, important screenings and regular health monitoring. This leads to quality-of-life issues, late-stage diagnoses, more emergency hospital admissions and a higher mortality rate.

The Texas A&M University team will work with Florida International University, Rice University, the University of California, Los Angeles, and several companies and federal agencies to develop affordable, accurate, sensitive and robust medical technologies and systems. PATHS-UP will also develop multidisciplinary education programs for undergraduate and graduate students, will reach out to K-12 students and teachers, and will collaborate with communities to prevent usability problems that have hindered previous efforts.

An NSF ERC is one of the most significant engineering grants an institution can receive. It is funded by a five-year base award of \$19.75 million, which can be renewed for another \$15.55 million and a total potential term of 10 years. ERCs often become self-sustaining and typically bring in more than \$50 million in federal and industry research funding during their first decade.

## Community insights are key for successful innovation

“In the past, there have been really good engineers developing really cool technologies, but, in many cases, without any idea of how those technologies would work in the underserved communities,”

Biomedical engineering students work in the lab on research that can help people live healthier lives.





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**An NSF ERC is one of the most significant engineering grants an institution can receive.**

Coté explains. “What works in a hospital or even in one community may not work in a community clinic or another community. It’s getting boots on the ground that’s really key.”

Instead of just introducing technologies into communities unprepared to implement them, the PATHS-UP team is visiting prospective client communities and surveying patients, providers, town officials and other local leaders to ensure medical devices are accessible, affordable, easy-to-use and effective.

“If it’s a wearable technology, how will they wear it?” says Coté. “We’re not just developing technology and telling people to use it, we’re developing the technology in concert with the people it’s meant to help.”

Currently, PATHS-UP researchers are focused on “lab-in-your-palm” and “lab-on-a-wrist” technologies.

The first offers inexpensive remote diagnostic capabilities typically only available in hospitals, while the latter allows for continuous remote monitoring and modelling that they hope will lead to behavioral modifications, improved health, and better quality of life.

**Commercializing technologies for better community health and lower costs**

The work of PATHS-UP researchers is another critical step toward achieving Texas A&M Engineering’s ongoing mission to bring new technology to the patients who need it most, according to Dr. M. Katherine Banks, vice chancellor and dean of the College of Engineering.

“Dr. Coté has a proven track record in developing innovation ecosystems driven by stakeholder input with a clear goal of commercialization of health-enhancing technologies,” says Banks.

“This aligns closely with our new EnMed program in partnership with Houston Methodist, which prepares physician engineer graduates with the clinical skills to diagnose symptoms and treat patients, along with the engineering mindset to solve problems, invent new technologies and rapidly move these innovative ideas to practice in patient care.”

Dr. Deborah Jackson, NSF program director for PATHS UP, emphasizes the important role the center could also play in lowering healthcare costs.

“The PATHS-UP Engineering Research Center is composed of a team of extraordinarily dedicated researchers who aim to develop cost-effective healthcare for underserved populations,” says Jackson. “If PATHS-UP’s chronic disease interventions are successful, they will have tackled a significant source of the skyrocketing national healthcare costs.”



DEPARTMENT OF BIOLOGICAL & AGRICULTURAL ENGINEERING

# SWAT could spur water-smart development

Dr. Jaehak Jeong wants to change the way land is developed to be closer to its natural hydrologic state. He thinks the Soil and Water Assessment Tool (SWAT) can help make that a reality.

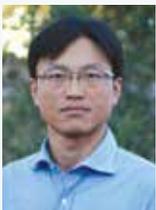
Jeong develops hydrologic models at the Texas A&M AgriLife Research and Extension Center in Temple. Conceptually, SWAT could help prevent flash flooding, erosion, and sedimentation and improve water quality. The tool quantifies and predicts impacts that development and land management practices have on flow, sediment and water contamination within large, complex watersheds of varying soil types, land uses and management conditions.

Simulation modeling is a useful tool for developers, city planners and landscape architects interested in how pavement, concrete, curbs, gutters and rooftops can change the land's hydrology. Furthermore, simulations can help better understand the complexation of watershed hydrology driven by anthropogenic activities such as urbanization, land cultivation for food, or deforestation.

"Every watershed faces different challenges. SWAT modeling can address water issues all under various conditions and how they may change over time," says Jeong.

The SWAT model utilizes geographic information system (GIS) data, including topographical, land-use and soil property maps, then simulates rainfall-runoff processes to determine the area's hydrological properties.

The model can show how stormwater management options, or Green Infrastructure (GI), like sand filters, retention/irrigation basins, porous pavement, and rain gardens and green roofs, can return developed land closer to its natural hydrological balance. Strategically placed GIs can aid absorption, slow or stop runoff, and filter contaminants. ▼



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## DEPARTMENT OF OCEAN ENGINEERING

# Protecting protective ecosystems

When Hurricane Sandy hit the east coast five years ago, in addition to damage from heavy rain and strong winds, the storm caused a lot of coastal erosion. Not only did buildings and roadways disappear, but Sandy significantly disrupted a thriving, biodiverse coastal ecosystem unprepared for such a force of nature.

Coastal ecosystems respond in a complex manner to geomorphologic drivers, eolian forces, wave dynamics and hydrologic variables – changing much faster than others like the flat savannas found in the Brazos Valley.

Unfortunately, instances like Hurricane Sandy are occurring ever more frequently, devastating coastlines. So how can these ecosystems be better protected?

Dr. Ignacio Rodriguez-Iturbe, Distinguished University Professor and Distinguished Texas A&M Engineering Experiment Station Research Professor, is working to answer that question.

“Coastal ecosystems are a deposit of a large biodiversity,” says Rodriguez-Iturbe. “They also contribute to the stability of shorelines and surrounding areas, and are our coastal defense against hurricanes and larger storms.”

Nature impacts every ecosystem in the world, but in coastal ecosystems the forces of nature impacting them are a bit different and more invasive than in other ecosystems. Additionally, most coastal regions in the U.S. are heavily populated, so preserving these ecosystems’ protective effects is a big priority.

Their landscapes – made up of dunes, coastal forms, vegetation and bodies of water are evolving in ways still to be quantitatively described. Rodriguez-Iturbe wants to change that. “I am interested in the interaction between vegetation and the physical variables,” he says.

“All the factors that we have mentioned interact with each other,” Rodriguez-Iturbe says. “Winds interact with vegetation because the wind blows and it deposits sand in the vegetation of the ecosystem. There is also a linkage between vegetation and physical variables like waves, wind and rain. The plants are both a consequence and a cause of the shape of the coastline and of the survival of the coastal ecosystem.” ▼



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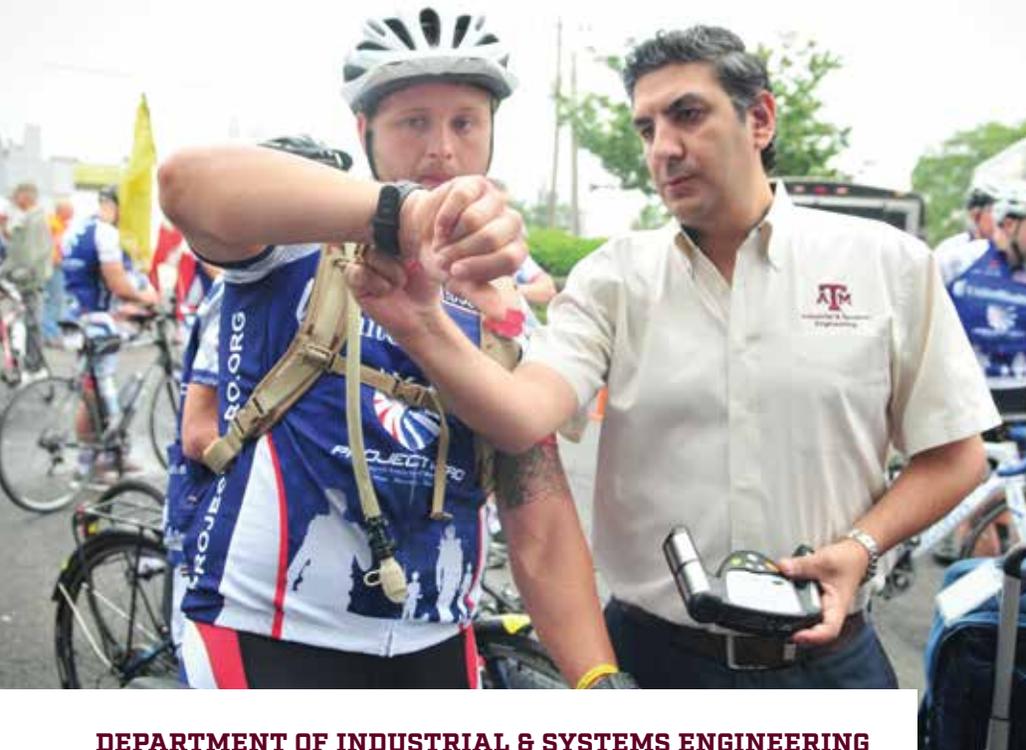
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DEPARTMENT OF INDUSTRIAL & SYSTEMS ENGINEERING

# A hero to PTSD patients



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Partnering with the nonprofit Project Hero, Dr. Farzan Sasangohar has developed the HERO Trak system to help veterans and first responders affected by post-traumatic stress disorder (PTSD) track, identify and deal with their triggers.

By combining the data collected from smartwatches with a self-reporting app, Sasangohar has been able to validate algorithms that can distinguish symptoms of a PTSD episode from regular physical activity.

The research aims to be able to intervene during a PTSD occurrence, for example guiding the wearer through breathing exercises or gently waking them if they are asleep.

“The amount of PTSD triggers that happen during sleep is very significant. Heart rate can rapidly increase and can remain high for up to 20 minutes,” says Sasangohar. “The tool can intervene and gently wake the patient up to reduce their suffering.”

In addition to providing interventions for PTSD episodes, Sasangohar and his team are also exploring how this smart monitoring and intervention technology may be used in surgery, nursing and other fields. ▀

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

# Combating collective attention threats

Collective attention in social media – often “breaking news,” viral videos or popular memes that captivate huge numbers of users – can quickly spread misinformation, propaganda and malware through large-scale social systems, with users becoming involuntary accomplices.

Dr. James Caverlee, associate professor in the Department of Computer Science and Engineering, is devoted to creating a world where every online interaction can be trusted.

Users are typically dependent on system operators to provide protection, but “this one-size-fits-all method ignores individual risk profiles and suffers from either blocking too much content or allowing all content,” says Caverlee.

Instead, Caverlee and his team are developing a personalized awareness app that will communicate to each user his or her exposure to collective attention threats, offering increased control over one’s social experience. The app will also sample evidence of collective attention threats, such as sampling and labeling spam tweets from a trending topic, early in the life cycle of a collective attention phenomenon. Based on this early evidence, the app will be able to identify and eliminate developing threats. ▀



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Institute**



**ARTIE MCFERRIN DEPARTMENT OF CHEMICAL ENGINEERING**

# Working together toward a manufacturing renaissance

The Texas A&M Energy Institute – a joint partnership between Texas A&M University and the Texas A&M Engineering Experiment Station (TEES) – is leading modeling and simulation efforts for the Rapid Advancement in Process Intensification Deployment (RAPID) Manufacturing Institute of the American Institute of Chemical Engineers.

Earlier this year, the Department of Energy called for the establishment of a Manufacturing Innovation Institute on Modular Chemical Process Intensification for Clean Energy Manufacturing. To date, RAPID has enlisted 75 companies, 34 academic institutions, seven national laboratories, two other government laboratories and seven nongovernmental organizations from all regions of the country.

The new institute will transform U.S. industry by creating a manufacturing renaissance around innovative modular, process-intensified manufacturing, while developing a highly skilled labor force through open access to shared research and development and demonstration facilities.

The Texas A&M Energy Institute is leading efforts in the Enabling Technology Area of Multi-Scale Modeling, Simulation, Optimization and Control.

“The breadth of the ability of our collaborators and our team at Texas A&M to take a process intensification solution from concept, to design, to testing, to optimization and control is unmatched in the world,” says Dr. Efstratios Pistikopoulos, TEES Distinguished Research Professor; interim co-director and deputy director of the Texas A&M Energy Institute. ▽



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**“The breadth of the ability of our collaborators and our team at Texas A&M to take a process intensification solution from concept, to design, to testing, to optimization and control is unmatched in the world.”**

– Dr. Efstratios Pistikopoulos, TEES Distinguished Research Professor; Interim Co-Director and Deputy Director, Texas A&M Energy Institute

# Unlocking the mysteries of methane hydrate systems

Three researchers from the Harold Vance Department of Petroleum Engineering are on a quest to improve understanding of methane hydrate system behaviors under a multi-year research project for the U.S. Department of Energy.

Dr. Jihoon Kim, an assistant professor in the department, is working with George Moridis, professor, and I. Yucel Akkutlu, associate professor, Flotek Industries, Inc. Career Development Professor and William Keeler Fellow, to investigate these potential energy sources with many unknown factors.

Hydrates, frozen methane locked in permafrost and subsea ice crystals, change form when subjected to natural, environmental or production recovery factors. Reduced pressure and increased heat break the crystal formations through dissociation, releasing water and methane.

“A model describing hydrates involves coupled flow, thermal and geomechanical processes,” says Kim. “For accurate predictions of behavior, you have to create very strong and robust numerical simulators.”

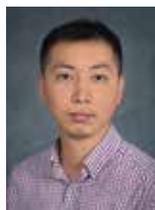
As part of the project, Kim’s team will collaborate with the Korean Institute of Geoscience and Mineral Resources (KIGAM) in South Korea and the Lawrence Berkeley National Laboratory (LBNL) in California.

Moridis’s code of coupled flow and thermal and chemical processes is integral to the project, and is combined with Kim’s geomechanical simulator for field studies of hydrate behavior. Akkutlu, an expert in multiphase flow, phase change and fluids behaviors, will lead geomechanical gas hydrate experiments at Texas A&M University.

KIGAM and LBNL will provide data on measured and recorded gas hydrate behaviors so Kim’s team can create computer programs that predict hydrate reactions to changes in pressure and temperatures, perform validations between numerical and experimental results, and predict the behaviors in actual fields in South Korea and Alaska. ▽



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“This is the kind of research you conduct to address the needs of 20 to 30 years from now. Not today.”

– Dr. George J. Moridis, Professor

DEPARTMENT OF AEROSPACE ENGINEERING

# Banishing the boom

Department researchers lead a team tasked by NASA with designing quiet, shape-shifting supersonic aircraft for commercial flight.

**W**ith global demand for faster air travel growing, commercial supersonic flight represents a potentially new market for aircraft manufacturers and operators. Restrictions on overland flight of supersonic transport (SST) aircraft remain a major barrier due to disruptive sonic boom noise created by the aircraft.

Funded by a \$10 million grant under the NASA Aeronautics' University Leadership Initiative (ULI), NASA has tasked a multidisciplinary team led by Texas A&M University and Boeing Research & Technology with leading research into designing commercially viable, civil SST aircraft that can modify shape during flight under a range of conditions to meet noise and efficiency requirements for overland flight.

## Scientific solutions for supersonic sound

Sonic booms created by supersonic flight are so disruptive that the Federal Aviation Administration (FAA) and U.S. Congress banned supersonic travel over the country back in 1973.

Only two SSTs have been used for commercial flight: the Tupolev Tu-144 and the Concorde. The Concorde flew commercially from 1976–2003, limited to transatlantic travel between

New York City, London, Paris and Washington, D.C., because of the FAA ban.

To be commercially viable, an SST must meet boom noise limits for a range of flight conditions, requiring on-the-spot adaptability. The ULI research team is exploring the potential of small, real-time geometric reconfigurations on the outer mold line of the aircraft to minimize boom signatures and drag in response to changing conditions.

The team will also combine improved supersonic computational fluid dynamic methods, boom propagation models and new atmospheric sensing techniques into a new multidisciplinary design framework, focused on determining if embedding shape-memory alloys (SMAs) will provide solutions for in-flight adjustments of an SST aircraft from takeoff to landing.



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**For commercial flight, supersonic transport aircraft (SST) must meet boom noise limits in a range of conditions.**

**Collaborating for commercial viability**

Texas A&M serves as the lead institution on this endeavor, collaborating with researchers from five other academic institutions, as well as industry partners with a background in successful development and deployment of novel shape-memory and supersonic applications.

Researchers from Texas A&M have collaborated with Boeing Research & Technology for more than a decade, developing SMAs and actuators for conventional subsonic applications with great success. Others have focused on sonic boom mitigation within the Defense Advanced Research Projects Agency (DARPA) Quiet Supersonic Platform program.

The academic institutions will lead the engineering science aspects of research, transferring new technological capabilities to industry partners, who will then provide guidance regarding real-world requirements and commercialization paths. Students from the six participating academic institutions will have the opportunity to gain valuable research experience from world leaders in supersonic platform design and active materials and adaptive structures development. ▽



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# Transforming the landscape of 3-D printing

From aerospace and defense to medical devices and digital dentistry, 3-D printers make it faster and less expensive to test initial design concepts. But because printed parts are made of hundreds or thousands of very thin layers, they do not have enough structural integrity to be used in most real-world applications.

Brandon Sweeney, materials science and engineering Ph.D. candidate, and his advisor Dr. Micah Green, associate professor of chemical engineering, have discovered a way to change that. They have devised a process to weld the layers of printed parts together using precisely applied microwaves to heat a carbon nanotube composite embedded in the printed materials.

“We realized that we needed to borrow from the concepts that are traditionally used for welding, in which you would use a point source of heat to join the interface of the parts together,” explains Sweeney.

The technology is patent-pending and licensed with Essentium, which is working on incorporating the welding process into 3-D printers. The potential for the technology is impressive – it could be incorporated into every industrial and consumer 3-D printer where strong parts are needed. ▽



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**The potential for the technology is impressive – it could be incorporated into every industrial and consumer 3-D printer where strong parts are needed.**



Brandon Sweeney and Dr. Micah Green use welding concepts to create stronger 3-D printed parts.

# ENMED

ENGINEERING & MEDICINE



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## ENGINEERING & MEDICINE

*Creating the future of health at Texas A&M*

Advancements in technology are transforming health care at a rapid pace. The rate of technological change is faster and more complicated than can be absorbed by the medical workforce. A new type of educational program is needed that prepares professionals with the clinical skills to diagnose symptoms and treat patients, along with the engineering mindset to solve problems, invent new technologies and rapidly move these innovative ideas to practice in patient care.



*Where engineering meets medicine*

### **EnMed at Texas A&M**

EnMed will be Texas A&M University's innovative engineering medicine track at Houston Methodist Hospital in the Texas Medical Center. Part of the Texas A&M College of Medicine's MD program and the College of Engineering, EnMed will educate a new kind of doctor with an engineering mindset—a physician engineer – who will invent transformational technology for health care's greatest challenges.

### **Rethinking the Physician**

EnMed students will fulfill all academic and professional requirements of the MD degree, but will also engage in additional experiences involving engineering, innovation and entrepreneurship. These experiences will be embedded within the curriculum from day one, uniquely preparing EnMed graduates to be leaders in inventing and applying cutting-edge technologies into medical practice.

[enmed.tamu.edu](http://enmed.tamu.edu)

# Less expensive, longer-lasting solar cells

Corrosion in photovoltaic cells, which convert light into electricity, can damage connections and reduce or destroy the ability to generate electricity.

Working with scientists at the Sandia National Laboratory, Dr. Jaime Grunlan, professor and director of the Polymer NanoComposites Laboratory at Texas A&M University, is testing cost-effective solutions to prevent corrosion in solar cells, and the resulting discharges of electricity.

Initial testing suggests thin clay-based nanocomposite coatings developed at Texas A&M can reduce or eliminate these arc faults, and could also be used as anti-corrosive layers within the cells to both improve durability and cell lifetime. Grunlan's goal is to lower the long-term cost of solar panels and solar technology.

Slowing down corrosion in solar panels using cheap materials like clay will help the panels last longer and stay more efficient, helping to facilitate faster adoptions of solar technology.

"It's exciting to see how our long-term research in gas barrier and flame retardant coatings is being used to improve the efficiency and longevity of solar cells, and to know we are solving complicated problems using low-cost and environmentally friendly materials," says Grunlan. ▽



**Featured Researcher:**  
Dr. Jaime Grunlan  
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**Title:** Linda & Ralph  
Schmidt '68 Professor,

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# Small particles make a big impact

**“We are solving complicated problems using low-cost and environmentally friendly materials.”**

– Dr. Jaime Grunlan, Linda & Ralph Schmidt '68 Professor, Director of the Polymer NanoComposites Laboratory at Texas A&M

Laser additive manufacturing is revolutionizing design and manufacturing, and gaining better control over materials' melting and solidification processes is critical to its success. Typically, a larger melted zone leads to a larger heat-affected zone, weakening the overall material used in the process. The material is fused, but the strength of the heat-affected structure decreases.

Dr. Chao Ma, an assistant professor working with a team of researchers from the University of California, Los Angeles and Missouri University of Science and Technology, has found success using nanoparticles to effectively control melting and solidification behaviors of materials. This technology can be applied to a wide array of manufacturing disciplines, pharmaceutical processing, energy storage, biomedical implants and even space technology.

“We used nanoparticles to fine-tune thermophysical properties as well as melting and solidification behaviors,” says Ma. “The resulting material could be stronger and have a better surface finish.”

Specifically, Ma and his team added aluminum oxide nanoparticles to pure nickel, changing the way the nickel reacted to laser heat. The melted zone depth of the metal was increased by 68 percent while the corresponding heat-affected zone decreased by 67 percent.

Ma's research and the Texas A&M University Renishaw AM 400 additive manufacturing machine – the best of its kind in the world – could make Texas A&M a source for customized, nanoparticle-reinforced metal parts. ▀

**This technology can be applied to a wide array of manufacturing disciplines, pharmaceutical processing, energy storage, biomedical implants and even space technology.**



**Featured Researcher:**

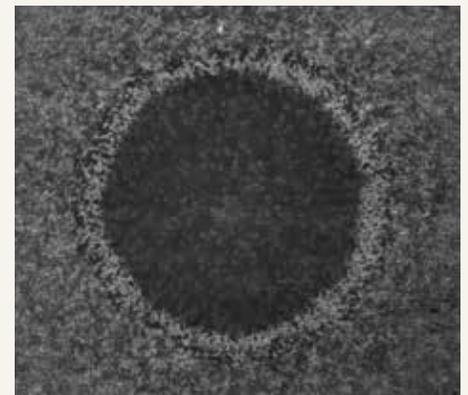
Dr. Chao Ma

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Dr. Zachary Grasley's state-of-the-art grout permeability testing method takes minutes, rather than weeks.

ZACHRY DEPARTMENT OF CIVIL ENGINEERING

# Reducing escape rates of nuclear waste

When the Savannah River National Laboratory (SRNL) sought to ensure its grout mixtures weren't leaking nuclear materials into the environment, staff reached out to a permeability and materials expert from the Zachry Department of Civil Engineering at Texas A&M University.

Dr. Zachary Grasley, professor and Presidential Impact Fellow, developed his state-of-the-art grout permeability testing method as a doctoral student at the University of Illinois, and continues to enhance it at Texas A&M. It takes only minutes, so it has significant advantages over conventional testing techniques that could take weeks to complete.

The SRNL conducts applied research, development and deployment of nuclear materials management and technology solutions at the U.S. Department of Energy's Savannah River Site in South Carolina.

Grasley's measurement method offers dual testing capabilities for both hollow and solid grout cylinders. Tests involve saturating grout samples developed by SRNL with water and subjecting them to high levels of pressure inside a vessel. Pressure on the surface of the sample equalizes to the pressure the vessel was subjected to, causing the material to contract. The pressure level inside the sample remains much lower, however, because the solid structure of the grout is bearing most of the pressure.

Because liquids flow from higher to lower pressure areas, water will begin to flow into the pore network of the sample if pressure is sustained. As water permeates the material, it fills pores in the sample, causing it to expand and regrow. The rate at which the sample expands after initial contraction translates to its permeability.

"This is very critical because it turns out that small changes in the mixture can cause an order of magnitude change in permeability," says Grasley. ▀

**"This is very critical because it turns out that small changes in the mixture can cause an order of magnitude change in permeability."**

- Dr. Zachary Grasley, Professor, Presidential Impact Fellow



**Featured Researcher:**

Dr. Zachary Grasley

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# Combating nuclear threats worldwide

Texas A&M University's Nuclear Security Science & Policy Institute (NSSPI) is developing technology that addresses nuclear security challenges and helps combat nuclear threats from hostile foreign powers and rogue actors around the globe. Headed by Dr. Sunil Chirayath, director, and Dr. Craig Marianno, deputy director, NSSPI works with national and international agencies, giving them the tools to monitor nuclear materials and track them back to their source.

In collaboration with the Los Alamos National Laboratory, NSSPI has helped develop a Self-Interrogation Neutron Resonance Densitometry detector, which improves existing nuclear material accountancy measures for light water reactors.

In a project sponsored by the U.S. Department of Homeland Security, researchers at NSSPI have generated a specialized attribution methodology for analyzing plutonium that will help investigators identify its origin and keep weapons-grade plutonium out of the hands of terrorists. The project provides deterrence against state actors from countries such as Iran and North Korea. "These projects we have worked on and developed are part of the cutting edge of nuclear security and safeguards projects," says Chirayath. "They will give organizations like the International Atomic Energy Agency better tools for verification and accountability." ▾

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**"These projects we have worked on and developed are part of the cutting edge of nuclear security and safeguards projects. They will give organizations like the International Atomic Energy Agency better tools for verification and accountability."**

- Sunil Chirayath, Associate Professor, Director of NSSPI



**Featured Researcher:**  
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**Featured Researcher:**  
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# Making self-driving vehicles safer

The challenges of making automated transportation safe and secure are being investigated by Dr. P.R. Kumar and his team of researchers.



**M**odern vehicles increasingly rely on sensors to provide information, which has enabled various levels of autonomous control. When these sensors are integrated into a larger network that sends and receives information over the internet, it creates the possibility of a fully automated and intelligent transportation system. These systems, however, can be highly vulnerable to malicious cyberattacks and remote hacking.



Cameras record self-driving laboratory vehicles' movement, and vision sensors receive images to calculate their location and orientation.



“If these technologies are to be adopted by society, they will need to be protected against malicious attacks on sensors.”

- Dr. P. R. Kumar, College of Engineering  
Chair in Computer Engineering,  
Distinguished Professor

Dr. P.R. Kumar, University Distinguished Professor in the Department of Electrical and Computer Engineering, along with graduate students Bharadwaj Satchidanandan and Woo-Hyun Ko, are attempting to solve the security challenges associated with automated transportation using a process known as dynamic watermarking.

**The mechanics of intelligent transportation networks**

An intelligent transportation network consists of large numbers of sensors that gather information about the environment and transmit it to the actuators and controls of a vehicle, such as the brakes and steering wheel. The vehicle then uses this information to know when and how much to turn, determine whether it needs to slow down or stop, or make other adjustments. If the sensors are defective or hijacked, they can transmit false information on vehicle speed, orientation, locations or proximity to other objects.

This could result in collisions, something Kumar and his team are working to prevent.

Kumar explains, “The increasing integration of critical physical infrastructures, such as the smart grid or automated transportation, with the cyber system of the internet has also led to new vulnerabilities.”

**Using dynamic watermarking to prevent collisions**

Kumar and his team have been testing the effectiveness of dynamic watermarking in research supported by the National Science Foundation Science and Technology Center on Science of Information, the United States Army Research Office and the Qatar National Research Fund. In their research demonstrations, 10 cameras record the movement of the self-driving laboratory vehicles. The vision sensors in the system receive the images and accurately calculate the location and orientation of the vehicles. Then they transmit this information to a server, which in turn controls the vehicles.

To enhance security, a random watermark or random private signal is added to the data transmissions. The presence of this watermark and its statistical properties are

known to every node in the system, but its actual random values are not revealed. When the measurements reported by the sensors do not contain the proper watermark, the actuators can deduce that the sensors or their measurements have been tampered with. When this happens, the vehicles are programmed to respond accordingly, halting to avoid collisions.

“If these technologies for enhanced automation are to be adopted by society, they will need to be protected against malicious attacks on sensors.” says Kumar. ▀



**Featured Researcher:**  
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**Department:** Electrical & Computer Engineering  
**Title:** College of Engineering Chair in Computer Engineering,  
Distinguished Professor

**Email:** prk@tamu.edu



Electrical and computer engineering student Alfredo Costilla-Reyes' BitGrange system uses sensors to ensure plants' ideal growing conditions.



STUDENT SPOTLIGHT

# Gamifying urban farming

Alfredo Costilla-Reyes, a Texas A&M University student in the Department of Electrical and Computer Engineering, is using technology to revolutionize indoor farming.

Launching BitGrange in 2015, Costilla-Reyes developed a system that senses temperature, light and other environmental variables necessary to grow plants. By connecting the sensors to a network with an extensive database of ideal growing conditions for a wide variety of plants, BitGrange can evaluate the data collected by sensors in real time and send recommendations through a smartphone app. BitGrange is set up for use with hydroponic systems and LED lights, meaning no soil or natural sunlight is needed.

The system is easy to use, inexpensive and highly efficient, notifying growers when plants need to be watered and fed, and whether they need more or less artificial sunlight. Currently, the prototype is still in its first generation and focuses on vegetable and fruit crops, though Costilla-Reyes has also begun testing varieties of flowering plants as well.

One of the main goals of BitGrange is to educate children and spark their curiosity about agriculture, engineering and science, and inspire them to embrace urban farming and use technology to sustainably grow their own fruits and vegetables. In order to help achieve this, Costilla-Reyes has created a four-step process that aims to "gamify" agriculture, inviting BitGrange users to 'Plant, Connect, Sync and Play.'

"My goal is to make indoor agriculture as easy as possible for parents and teachers

with zero experience," says Costilla-Reyes. "By inspiring children with science and agriculture we could very well be training the next generation of entrepreneurs and revolutionizing agriculture for all of us to benefit."

Costilla-Reyes has won several awards for his work, including a Kirchner Food Fellowship. He developed BitGrange's customer discovery strategy through the National Science Foundation's I-Corps program, which facilitates the commercialization of technology, and he eventually wants to launch a Kickstarter campaign to amplify the reach of his startup.

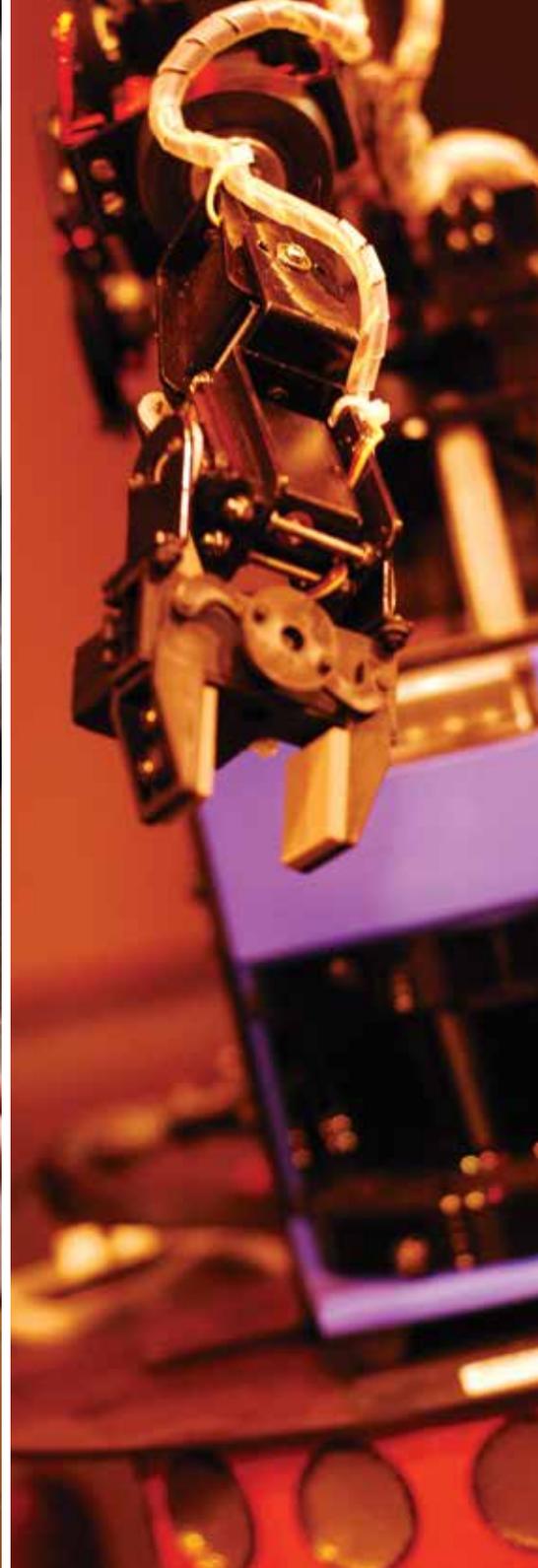
"We live in a disrupting era," says Costilla-Reyes. "Electrical engineering and agriculture on their own may face a lot of competition necessitating innovative, interdisciplinary ideas to power the future of sustainable living."

Recently, Costilla-Reyes was nominated for the Mexico National Youth Award in the Entrepreneurial Ingenuity category. ▽



**Featured Student's Research Advisor:**  
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