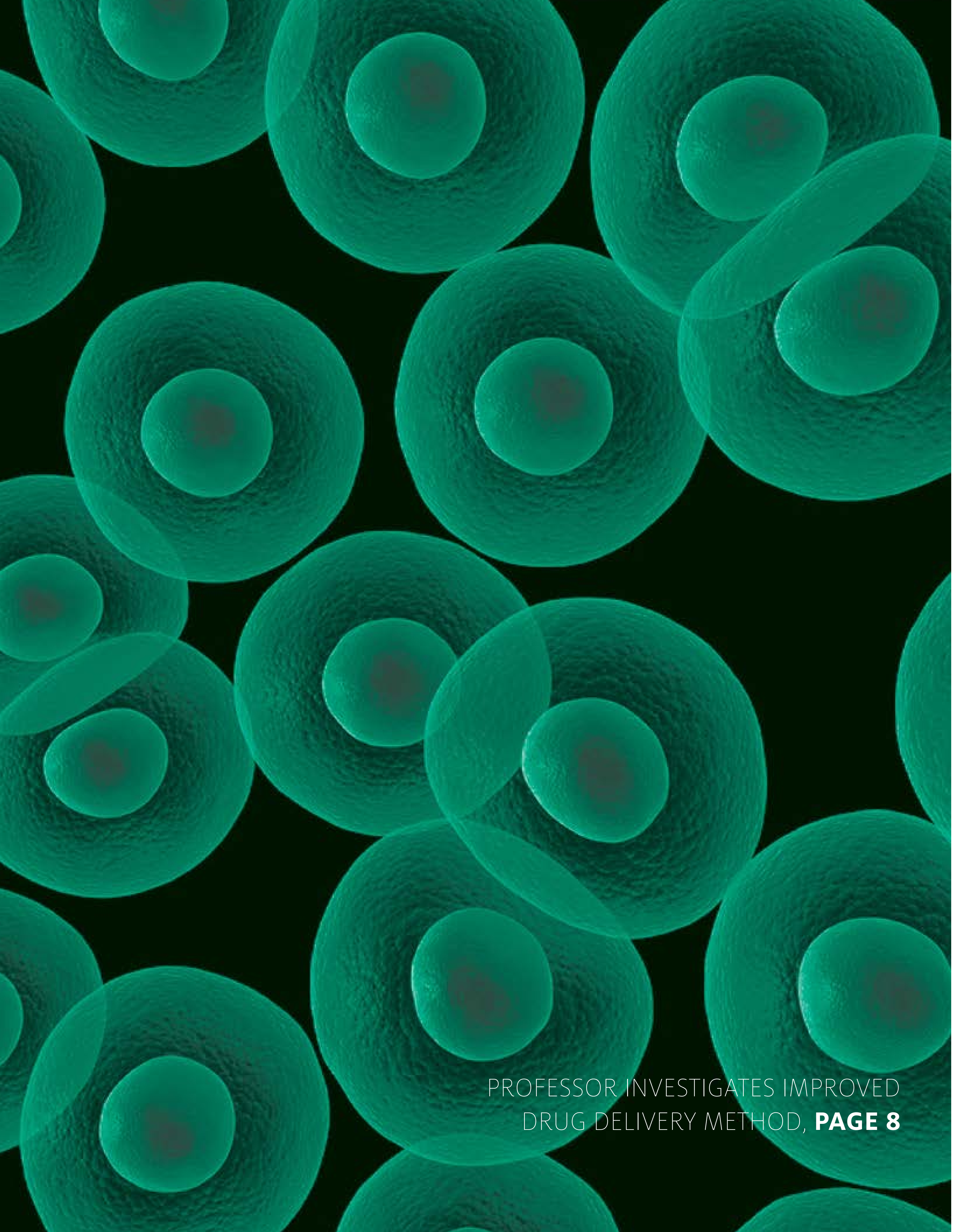
UNIVERSITY of HOUSTON | DEPARTMENT of CHEMICAL & BIOMOLECULAR ENGINEERING

TRANSPORT

Cullen College Department
of Chemical & Biomolecular Engineering Magazine | Fall 2016

(RE) ENGINEERING THE CHEMICAL WORLD

ONE MOLECULE AT A TIME



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Transport is published by the University of Houston Cullen College of Engineering, Office of Communications.

Communications Director	Audrey Grayson
Editor-in-Chief	Natalie Thayer
Art Director	Rachel Ward
Graphic Designer	Jose Cruz
Photography	Carlos Landa
Contributing Writers	Audrey Grayson Natalie Thayer Jeannie Keaver

Office of Communications
Cullen College of Engineering
University of Houston
Engineering Bldg. 2
4722 Calhoun Road, Suite E311
Houston, Texas 77204-4009
Phone: 713-743-4220 Fax: 713-743-8240

Contact ChBE:
Phone 713.743.4300
Website www.chee.uh.edu

cullen college news
@uhengineering
uhengineering
UHCullenCollege
University of Houston Cullen College of Engineering

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CHAIR'S MESSAGE

Dear Alumni and Friends of UH ChBE,

As the UH Department of Chemical and Biomolecular Engineering (ChBE) embarks on a new academic year, we are proud to highlight the many exciting accomplishments of our students and faculty in this issue of *Transport Magazine*.

This past year, the UH ChBE Department climbed from No. 39 to No. 33 in the annual *U.S. News and World Report* rankings of chemical engineering programs. This subjective ranking is catching up to the more objective National Research Council rankings, which puts our chemical engineering doctoral program at No. 15 among our U.S. peers. So, the word is getting out!

This is in no small part due to the success of our faculty and students in tackling research with a real, direct impact in the city of Houston and beyond. Our faculty, together with their graduate students and postdocs, are publishing their works in the top journals in the field at an annual rate of about five per faculty member. Our students are doing top-tier research and are very active and visible at international conferences.

These world-class researchers are conducting innovative, interdisciplinary research spanning catalysis and reaction engineering, nanomaterials, polymers, soft matter and biomolecular engineering to solve critical problems in energy and healthcare. Whether it's discovering sustainable polymers, developing new catalysts to convert methane into valuable chemicals and remove harmful pollutants from engine exhaust, inventing new immunotherapy methods to fight cancer and inhibitors to stop malaria, or safely recovering offshore energy resources, the UH ChBE Department is a pioneering research leader.

The success of our alumni continues to shine. Students graduating from the UH ChBE Department leave with the skills and training required to exceed the expectations of their employers in industry, government and academia. Our alumni can be found in leadership positions throughout the chemical and energy industries. Without their continued success and support, the improving reputations of our academic and research programs would not be possible.

I look forward to seeing how all of these world-class engineering Cougars will continue to shape our world and our future for the better. Please consider joining our UH Chemical Engineering Alumni Group on LinkedIn (http://www.linkedin.com/groups?gid=1872800) to share your successes with us and receive updates from the college and the department!

I look forward to hearing from you and seeing you at upcoming departmental, college and University events!

Sincere regards and "Go Coogs!",

Mike Harold
Chair of Chemical and Biomolecular Engineering;
M.D. Anderson Professor of Chemical and Biomolecular Engineering;
Cullen College of Engineering
University of Houston

CULLEN COLLEGE OF ENGINEERING *FAST FACTS*

BEST ENGINEERING SCHOOL OF 2017

(SOURCE: *U.S. NEWS AND WORLD REPORT*)

$26M + IN RESEARCH EXPENDITURES

13 NATIONAL ACADEMY OF ENGINEERING FACULTY MEMBERS

80% OF UH ENGINEERING UNDERGRADS ARE EMPLOYED IN TEXAS WITHIN ONE YEAR OF GRADUATION

CHEMICAL ENGINEERING AT UH BY THE NUMBERS

BEST ENGINEERING PROGRAM OF 2017

33RD BEST CHEMICAL ENGINEERING PROGRAM IN THE U.S

(**SOURCE**: *U.S. NEWS AND WORLD REPORT*)

657 TOTAL UNDERGRADUATE STUDENTS

136 TOTAL GRADUATE STUDENTS

CHEMICAL ENGINEERING STARTING SALARY

$100,000

$69,196 AVERAGE STARTING SALARY FOR RECENT CHEMICAL ENGINEERING GRADUATES WITH **BACHELOR'S DEGREES**

$100,000

$79,894 AVERAGE STARTING SALARY FOR RECENT CHEMICAL ENGINEERING GRADUATES WITH **MASTER'S DEGREES**

$100,000

$98,889 AVERAGE STARTING SALARY FOR RECENT CHEMICAL ENGINEERING GRADUATES WITH **DOCTORAL DEGREES**

(**SOURCE:** *NATIONAL ASSOCIATION OF COLLEGES AND EMPLOYERS SALARY SURVEY, 2016*)

UH CHEMICAL ENGINEERING GRAD PROGRAM CLIMBS U.S. RANKINGS, EARNS SPOT ON LIST OF NATION'S BEST PROGRAMS

The University of Houston's chemical and biomolecular engineering graduate programs earned a coveted spot among the nation's top engineering programs in the most recent *U.S. News and World Report* rankings.

The UH Cullen College of Engineering's chemical engineering graduate program was ranked No. 33 in the nation and named one of the Best Engineering Programs of 2017.

Overall, the Cullen College climbed from No. 76 to No. 73 in the *U.S. News and World Report* national rankings for graduate-level engineering programs.

"We are a college on the move, and the most recent *U.S. News and World Report* rankings are a wonderful reflection of this," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the UH Cullen College of Engineering.

U.S. News and World Report is a leading source for rankings of colleges, graduate programs, hospitals, mutual funds and cars. Each year, the publication ranks professional school programs in business, education, engineering, law, medicine and nursing. The data for the rankings come from statistical surveys of more than 1,900 programs and from reputation surveys sent to more than 18,400 academics and professionals.

Suresh Khator, associate dean of graduate programs and computing facilities at the Cullen College, said the recent rankings reflect not only the success of the college's professors and students, but also the relevancy of its programs to the city of Houston and the entire nation.

"Graduate programs at the UH Cullen College of Engineering are designed to immerse students in the grand challenges of engineering represented in our city, and our programs encourage students to conduct research that finds solutions to some of the most pressing challenges facing our city and our world," Khator said.

"UH engineers are making major contributions to society both nationally and globally, and it is wonderful to see our programs recognized among the best in the country," he added.

Chemical engineering was one of four graduate programs from the Cullen College that were ranked among the top in the nation – the college's civil, mechanical, computer and electrical engineering programs also earned the status of Best Engineering Program of 2017.

The UH Cullen College of Engineering offers MChE non-thesis, M.S. course-based and Ph.D. degrees in chemical engineering.

FOR THE FULL LIST OF RANKINGS from *U.S. News and World Report*, please visit *http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-engineering-schools*

UH RANKED AMONG GREAT VALUE COLLEGES WITH BEAUTIFUL CAMPUSES

By Mike **Emery**

With its lush green spaces and robust public art collection, the University of Houston offers students a cozy, colorful campus. Cougars aren't the only ones in the know about UH's many attributes. The University recently was ranked among the most beautiful campuses in the country by online guide *Great Value Colleges*.

UH ranks 19th in this list of 35 Great Value Colleges with Beautiful Campuses. In its profile of UH, *Great Value Colleges* cited UH's Public Art Collection, architecture and landscape as campus highlights.

"One would be surprised to know that within one of the largest cities in Texas sits the University of Houston, which is comprised of 667 acres of lush greenery with eye-pleasing art and structures," wrote Gabrielle Gibeily, *Great Value Colleges* writer. "Nearby Brays Bayou offers students a scenic hike and bike trail, and the campus has a community garden, multiple fountains, well-groomed lawns and parks that are abundant with trees."

Great Values Colleges cited UH's status as the first Texas state university to establish a Percent for Art program, committing one percent of each facility's budget to public art. Among the most recent additions to its Public Art Collection is "The Snake Is Out" by renowned minimalist Tony Smith. *Great Value Colleges* also lauds the University's historic Ezekiel W. Cullen Building and the neighboring Cullen Family Plaza.

Great Value Colleges selected institutions for its beautiful campuses list based on affordability, awards, notable features, location and student enjoyment. UH's inclusion on this *Great Value Colleges'* list complements previous recognition for its scenic campus. In 2014, UH ranked second in *Profascinate's* Top 10 Most Beautiful College Campuses.

Great Value Colleges is an online college guide that assists students in selecting value-added educational institutions. The site features rankings on topics that include top colleges for an online degree, colleges that promote healthy living, most affordable college towns, best colleges for veterans and LGBTQ-friendly colleges.

FOR MORE DETAILS, VISIT *www.greatvaluecolleges.net*

UH ENGINEERING EXPANDS INTO KATY WITH ENERGY-FOCUSED COURSE OFFERINGS

In the fall of 2016, the UH Cullen College began offering one petroleum engineering and one subsea engineering course in the Houston Community College (HCC) building in Katy.

The new UH campus in Katy will offer degrees most relevant to current industry demands, including engineering, business and nursing. A grand opening of the UH Katy facilities is tentatively scheduled for 2018.

Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College, said the college's administrators didn't want to wait that long to begin offering engineering courses in the Katy area.

"Katy is one of the fastest growing areas in the Houston region, and the demand for energy, health and engineering talent in Katy has never been greater. We want those who live in the Katy area to have access to a world-class engineering education in their own backyard," said Dean Tedesco.

The first-ever course offerings in Katy include a petroleum engineering course on pressure transient testing and a subsea engineering course on pipeline design. Both master's level courses are worth three-credit-hours and can be applied towards a certificate in petroleum or subsea engineering.

FOR MORE INFORMATION, VISIT *www.egr.uh.edu/engineering-katy*

CULLEN COLLEGE HOSTS 2016 AICHE SOUTHWEST REGIONAL CONFERENCE

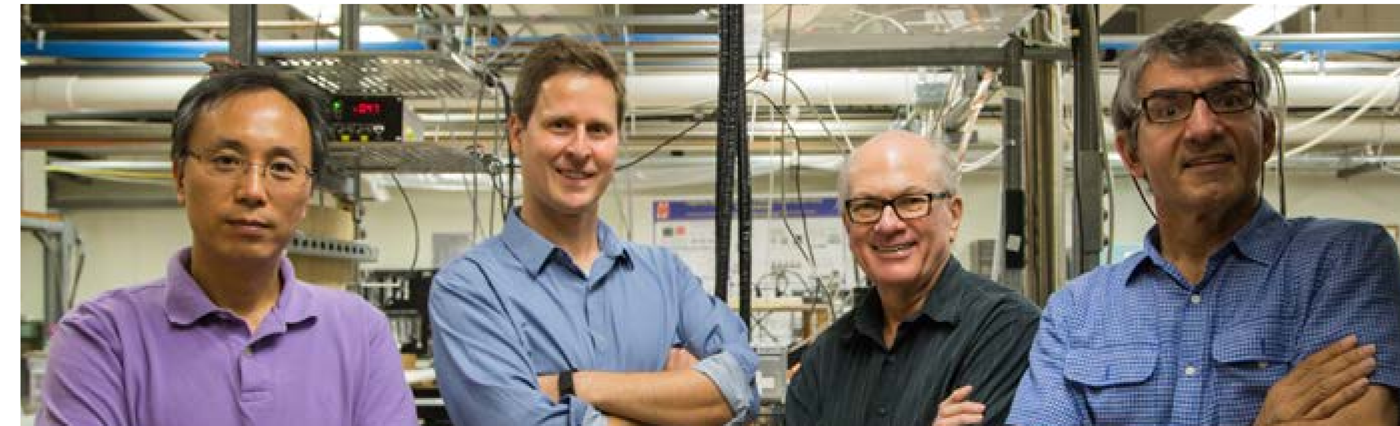
By Natalie **Thayer**

The University of Houston's American Institute of Chemical Engineers (AIChE) student chapter hosted the 2016 AIChE Southwest Student Regional Conference on the UH campus from April 8-10.

The conference brought together over 170 chemical engineering students and 30 industry professionals from the southwest region for networking, professional development and academic enrichment opportunities. The conference included various workshops, plant and lab tours, a research paper competition, a regional Chem-E-Car competition, a Jeopardy-style game and an awards banquet. Justine Smith, vice president of global business management oilfield solutions at BASF Corporation, delivered the keynote address during the awards banquet.

Two undergraduate Cullen College of Engineering students, Nora Elghetany and Priya Patel, organized the event in conjunction with UH AIChE student officers, student volunteers and Cullen College faculty.

The conference was sponsored by the Cullen College's chemical engineering department, BASF, Vinmar International, the South Texas Section of AIChE, Albemarle and Pilot Ceritas CO2, LLC. Other contributors included Celanese, Chevron, Sabic and Shell.



ENGINEERS EARN $1.5 MILLION TO PURSUE INNOVATIVE NANOPATTERNING TECHNOLOGY

From left: Jiming Bao, Paul Ruchhoeft, Vincent Donnelly, Demetre Economou

Four UH Cullen College of Engineering professors earned a four-year grant amounting to almost $1.5 million from the National Science Foundation (NSF) to pursue their nanopatterning discovery that could lead to next-generation transistors for integrated circuitry, among other advanced nanodevices.

With new capabilities developed through this grant, the researchers can explore potential materials to replace ubiquitous silicon transistor switches, the building blocks of computers that are reaching their technological limitations. Specifically, they are studying the effects of nanopatterning on the scientific super-material, graphene, to invent faster transistors for computers of the future that consume less energy as they operate more quickly.

Several years ago, **Vincent Donnelly**, principal investigator on this project, and **Demetre Economou**, both Cullen College chemical and biomolecular engineering professors, along with **Paul Ruchhoeft**, Cullen College electrical and computer engineering associate professor, invented nanopantography, a novel nanopatterning technique. An array of lenses disperses a broad ion beam into billions of beamlets that each bend to the same spot, approximately 100-times smaller than the diameter of one lens, on a 2-D substrate. The substrate is then tilted so each beamlet can simultaneously etch the desired pattern on its surface.

"In the initial stages of this research, we were able to make features as small as 10 nanometers, which approaches state-of-the-art," Donnelly said. "More recently, we have reduced features to 3-nanometers, and we believe we can go even smaller, which is something no one has done."

The lens array was originally fabricated permanently on the substrate, which presented challenges from a long-term manufacturing perspective. Ruchhoeft joined the new project to develop a reusable stencil mask lens array that the engineers can move to cover large substrate surface areas.

The stencil mask is fabricated with posts that secure a 1-micrometer gap between its lens array and the substrate. The positive voltage applied to the lens array for etching also electrostatically clamps the mask to the substrate. Removal of the voltage after processing releases the stencil mask for repeated use on other substrates, the print-and-repeat process.

"We improved the throughput and resolution of this nanopatterning method with a two-step process," Donnelly said. "Nanopatterns are first formed in a very thin masking layer by nanopantography and then transferred to the underlying material by highly selective plasma etching."

Donnelly, Economou and Ruchhoeft are collaborating with **Jiming Bao**, another Cullen College electrical and computer engineering associate professor. Bao joined the project to provide expertise in the development of applications for graphene. He intends to explore potential for creating transistor channels from the nanopatterns etched on the highly conductive one-atom-thick carbon sheets. Four doctoral students and several graduate students will also work on the project.

"The proposed work will provide students with rich scientific and educational payoffs," Donnelly said. "We will also incorporate nanopatterning of 2-D materials into our NSF-seeded, multidisciplinary Nano-Engineering Minor Option (NEMO), a subset of the undergraduate curricula."

Economou and Donnelly are developing molecular dynamic simulations to follow atomic evolution of the system, primarily the effects of ion bombardment energy on substrate surfaces, to determine the smallest features that exhibit the desired behaviors.

"With this grant, we will develop a unique tool that prints over large areas through the print-and-repeat process, we will demonstrate nanopatterning of graphene sheets and other 2-D materials, and we will measure and characterize these materials," Ruchhoeft said. "It's not just a continuation of existing integrated circuit manufacturing approaches since we will have an opportunity to develop new and better performing materials that can displace those currently used."

PROFESSOR INVESTIGATES POLYMERIC MICELLES FOR DRUG DELIVERY WITH NSF AWARD

Finding improved methods for drug delivery is a hot topic among researchers all over the world. One method in particular, which utilizes polymeric micelles to deliver drug molecules to their intended targets inside of the body, has had very promising results in recent years.

By Audrey **Grayson**

Now, an engineering professor at the UH Cullen College of Engineering is uncovering the fundamental science of using block copolymer micelles for drug delivery with a three-year, $165,000 award from the National Science Foundation.

Megan Robertson, assistant professor of chemical and biomolecular engineering, is examining how drug molecules interact with polymers within a micelle and quantifying how these interactions change the structure of the micelle as well as the release of the drug inside of the body.

"If we understand the effect of the drug on the micelle structure, dynamics and release rate, it will help us to design new and improved micelle systems," Robertson said.

Her team will begin by studying Doxorubicin, a chemotherapy drug, but the results from this research could be generalized to other drugs, Robertson said.

Robertson's research collaborator is Louis Madsen, an associate professor in the department of chemistry at Virginia Tech. Madsen is an expert on NMR (nuclear magnetic resonance) spectroscopy, a technique used to determine the structure of organic compounds, atoms and molecules. One of Robertson's areas of expertise is neutron scattering, an experimental technique used to investigate the nanometer to sub-micron scale structure of materials.

In this project, Robertson and Madsen are combining NMR and neutron scattering techniques to further investigate the use of block copolymer micelles for drug delivery.

"I think we can learn more about this system by using a combination of these techniques rather than by one technique alone," said Robertson.

To understand micelles, think about the behavior of a detergent added to a bucket of water: the detergent molecules join together, forming a type of micelle. Molecules like detergents form micelles because they are composed of two parts: one part is hydrophobic (water-hating) and the other is hydrophilic (water-loving). The micelle aggregate keeps the hydrophobic part separate from the water, while the hydrophilic part is surrounded by water.

When used for drug delivery purposes, drug molecules are stored inside the hydrophobic core of the micelle, and then released in the vicinity of the target, such as a tumor. This can increase the drug's efficiency and, in some cases, decrease the number and severity of side effects caused by the drug.

One example is chemotherapy drugs, which wreak havoc on the patient's entire body in order to deliver toxic agents to a tumor site. If researchers can find drug delivery systems that guarantee that the chemotherapy drug will be released only at the site of the tumor, the drug would be more effective at killing the tumor cells and the cancer patient would experience fewer side effects as a result of the medication.

One tricky part of using micelles for drug delivery, however, is achieving the desired micelle structure, which can contain a spherical core, a cylindrical core, or even adopt a vesicle morphology (vesicles are capsules that contain a water-filled hydrophilic core surrounded by a hydrophobic membrane or shell). In some cases the polymers themselves transfer from one micelle to another through a process called single chain exchange. Robertson and Madsen will identify the micelle structure and examine the rate of single chain exchange.

Loading up the core of a micelle with drug molecules may have an impact on the micelle's structure. If the interaction between the drug molecules and the polymers cause the micelle's structure to change, this may have an impact on the timed release of the medication inside of the micelle's core. Robertson and Madsen will also investigate the release rate of the drug using fluorescence techniques.

With the completion of this project, researchers will have a model of how drug molecules can change the structure and dynamics of micelles, as well as the timed release of drugs within the micelle's core. This knowledge will enable the design of new and improved drug delivery materials.

> "IF WE UNDERSTAND THE EFFECT OF THE DRUG ON THE MICELLE STRUCTURE, DYNAMICS AND RELEASE RATE, IT WILL HELP US TO DESIGN NEW AND IMPROVED MICELLE SYSTEMS."
>
> — MEGAN ROBERTSON

INNOVATIVE GENETIC TOOL ADVANCES SYNTHETIC BIOLOGY, METABOLIC ENGINEERING

Patrick Cirino, associate professor of chemical and biomolecular engineering at UH Cullen College of Engineering, earned a three-year, $300,000 National Science Foundation grant to continue developing and implementing genetic tools that advance synthetic biology and metabolic engineering. Cirino's research group focuses on biocatalysis, which involves the engineering of proteins, metabolic pathways and entire microorganisms to produce various biochemicals.

A powerful approach to engineering these complex biological systems is directed evolution. After introduction of genetic diversity and creation of a gene library, a search strategy is employed to identify rare variants showing improvement in the property of interest, such as production of a biochemical.

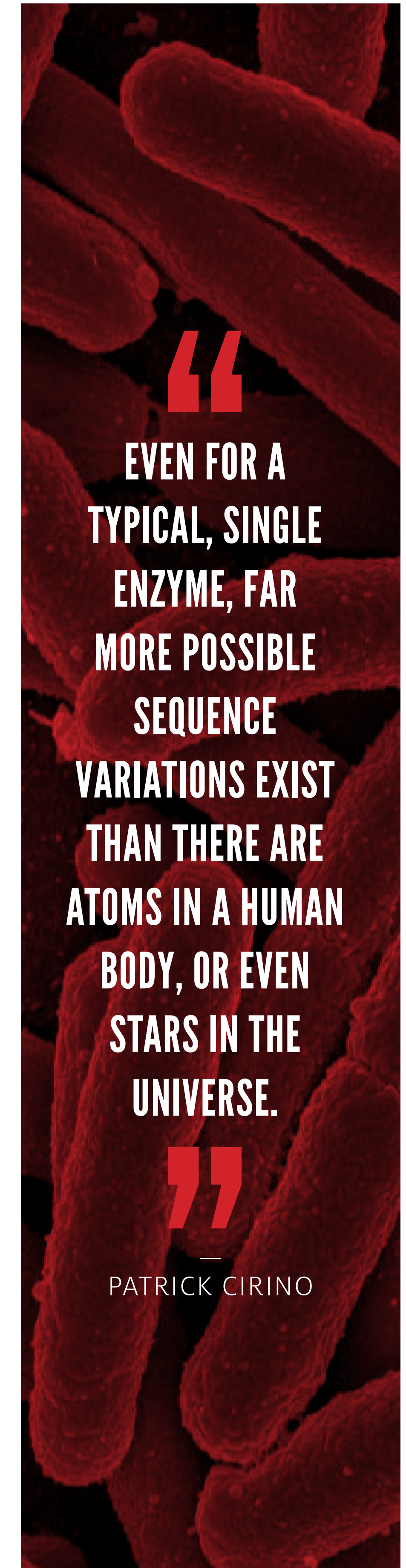
The development of an accurate, sensitive and high-throughput search is a significant challenge associated with directed evolution. In the simplest cases, the growth of cells expressing the gene library is correlated with evolution of the desired property, so the fastest growers are easily identified using any number of growth-dependent assays. Alternately, high-throughput spectroscopy methods are used to find the winning cells when the desired biochemical or its derivative has unique and easily detected spectral properties. However, such simple screens are not options in many instances.

Research supported by this grant focuses on development and application of new approaches for screening large libraries of mutant microorganisms to identify rare mutants not correlated with cell growth and not distinguished by unique chemical or spectral properties that are capable of new or enhanced biosynthesis of desired products. In lab research and industrial bioprocessing, various E. coli strains are popular for their genetic amenability, metabolic versatility, fast growth and successful track record for engineering applications.

Genetically modified E. coli strains already exist for a variety of applications, including overproduction of biofuels and high-value protein therapeutics. Still, yields and productivities are often far from optimal, owing to complexly coordinated and poorly understood metabolic constraints. Metabolic engineers use as much information as is available from studies in systems biology, protein biochemistry and microbial physiology to make predictions about best designs for new microorganisms, and these rational design attempts are often greatly enhanced when combined with combinatorial genetic approaches. Such experiments are much like searching for a needle in a haystack.

"Even for a typical, single enzyme, far more possible sequence variations exist than there are atoms in a human body, or even stars in the universe," Cirino said. "So it's a great challenge to narrow our search and to find new and poorly understood genetic modifications that are both compatible with the host's natural metabolism and allow for novel or improved production of a desired chemical."

Cirino's group has addressed this challenge by developing in vivo molecular reporters. Their approach is to modify a protein called AraC, which naturally regulates gene expression in E. coli. The modified AraC activates desired genes, which translates to production of desired proteins, in response to specific chemicals produced in the cell. These designed biosensors can then correlate the improved production of a compound by rare



library members with the production of an easily measurable protein, such as green fluorescent protein.

"We can easily screen 100 million different cells in one day, if its fluorescence we are looking for," Cirino said. "In many cases, we want to force cells to produce chemicals by directly competing with their natural objective of growing and using carbon and energy sources efficiently."

Overcoming many, coordinated metabolic constraints that limit such biochemical production requires a large number of synergistic genetic modifications, without excessive compromise to cell viability. To accomplish this, Cirino's proposed research aims to combine recent technological advancements for rapid creation of high-fidelity genome libraries with his group's unique customized molecular reporting capabilities. They will focus on large, expression-level libraries containing combinations of many genes that are key to E. coli central metabolism in their search for enhanced production of chemicals like mevalonate and triacetic acid lactone, whose biosyntheses utilize precursor metabolites that compete directly with central metabolic pathways.

Unique combinations of genome modifications identified through this work will allow engineered E. coli to more efficiently convert abundant and renewable sugars derived from biomass into precursor metabolites and a variety of chemical products, such as biofuels and building blocks for producing natural products. The same recombineered genome libraries will also be available to the metabolic engineering community for future studies.

In addition to advancing understanding in sustainable biochemicals production, Cirino's research will yield new insights into metabolism and microbial physiology, thereby contributing broadly to many biology-related disciplines. His work will also support educational activities for four UH graduate students as well as underrepresented undergraduate and high school students.

UH ENGINEERS DISCOVER SUPERIOR METALLIC MONOLAYER CATALYST

By Audrey **Grayson**

Researchers at the UH Cullen College of Engineering have synthesized and characterized a novel metallic monolayer catalyst with far superior catalytic properties than those currently used in industry.

Stanko Brankovic, professor of electrical and computer engineering, and **Lars Grabow**, professor of chemical and biomolecular engineering, published their findings in a special issue of the journal *Surface Science*.

Out of the more than 25 papers chosen for publication in the special issue, Brankovic and Grabow's paper, titled "Novel 2D RuPt core-edge nanocluster catalyst for CO electro-oxidation," was chosen as the journal's featured cover story.

Brankovic said this research began about a year ago with a seemingly innocuous idea: "I got the idea to create a small, two-dimensional monolayer made up of clusters of one metal, such as ruthenium, with a perimeter made up of another metal, such as platinum." After some trial and error, Brankovic and his Ph.D. student, Qiuyi Yuan, successfully synthesized these tiny nanostructures inside of his laboratory.

"But what was truly remarkable," he said, "was their catalytic properties were way better than anything we could explain."

It didn't take long for Brankovic to mention the puzzling phenomenon to Grabow, whose primary research interest is in running complex computer simulations to predict how and why some catalysts perform better than others in certain chemical reactions.

"Lars had a hunch that the reason this material performs so well as a catalyst is due to the finite size effect," Brankovic said.

The finite size effect relates to the bonds that form between atoms in a cluster. In a body of atoms, the atoms in the center of the cluster form strong bonds with the surrounding atoms. Atoms located on the periphery of the cluster, however, form weaker bonds because there are no atoms on the other side to keep them in equilibrium.

Grabow, along with his graduate student Hieu Doan, began running computer simulations to try to identify structures that could obtain extremely favorable catalytic properties due to the finite size effect. Using theoretical calculations to test their hypothesis, Grabow and Doan confirmed that the finite size effect contributed to the materials' catalytic qualities.

"They found that the finite size effect in this particular system is huge and leads to reconstruction of the whole cluster, where the morphology of the monolayer has ripples," Brankovic said.

The unique ripples in this system have positions for higher energy absorption and lower energy absorption, Brankovic added. "This leads to a net spectacularly high catalytic effect, so the finite size effect in particular systems such as this one can promote catalytic properties that until now have not been understood."

After characterizing precisely what was happening inside of the metallic catalyst, Brankovic, Grabow, Yuan and Doan tested the material in carbon monoxide oxidation. The team used spectroscopy to measure the absorption energetics in the reaction.

"It turned out that everything Lars and Hieu had calculated was reconfirmed in these tests," Brankovic said.

In addition to discovering a new method of synthesizing monolayer metallic catalysts, Brankovic and Grabow noted that this research represents a turning point for monolayer catalysis in general.

"Many catalysts can do the job, but chemical reactions can go many different pathways," Brankovic said. "This particular structure of catalyst takes a pathway in the chemical reaction that has the most desired outcome, with better activity and selectivity."

Although the researchers noted that more fundamental research is needed in this area, they hope that in the future these catalysts can be used for methanol or ethanol fuel cells as well as synthetic oxidation, such as the conversion of natural gas to methanol.

Both Brankovic and Grabow are winners of prestigious National Science Foundation CAREER Awards, which helped partially to fund this research. Funding for this work also came in the form of a University of Houston GEAR Award for both researchers, which offers seed funding to young researchers looking to get projects inside their laboratory off the ground.

"There's a lot left to do in this area, and we hope to continue working on this. Our ultimate hope is to attract more funding to continue this work," Brankovic said.

UH ENGINEER LEADS NEW EFFORT TO IMPROVE CLEAN-UP AFTER OIL SPILLS

By Jeannie **Kever**

A researcher at the University of Houston Cullen College of Engineering earned a $1.8 million grant from the Gulf of Mexico Research Initiative to determine how the use of dispersants to break up an oil spill affects the natural cleaning role played by bacteria.

Jacinta Conrad, Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering, said the work will answer fundamental questions important to understanding how bacteria – microscale organisms that naturally occur in marine environments – can help in cleaning up spills during offshore drilling and production.

The Gulf of Mexico Research Initiative was formed in 2010 after BP's Deepwater Horizon drilling rig exploded about 50 miles off the coast of Louisiana, killing 11 men and spilling several million barrels of oil in the five months before the well was sealed. BP pledged $500 million over 10 years for an independent research program to study how the spill and efforts to clean it up have affected the Gulf and coastal states.

The initiative is seeking answers in several areas, including the environmental impact of the oil and dispersants, the public health impacts and the development of new technology to use in future spills.

Conrad's project builds on her previous work in colloid and interfacial science – the study of how complex fluids move, including the movement of bacteria across surfaces. For this project, she will lead a team of three investigators: Roseanne Ford from the University of Virginia, Arezoo Ardekani from Purdue University, and Douglas Bartlett from the University of California-San Diego's Scripps Institution of Oceanography.

Crews attempting to limit damage caused by oil spilled from the Deepwater Horizon used chemical dispersants – chemicals sprayed onto a surface oil slick – to break the oil into smaller droplets. Preliminary studies have questioned whether the dispersant worked the way it was intended.

But there also is a natural remedy for oil spills – hydrocarbons are a source of food for various strains of bacteria in the water, and Conrad and her team will look at whether the dispersants affected the movement of these bacteria toward the spilled oil.

"An oil spill in the ocean is a big, glowing beacon of food to bacteria," she said. "Our work will test whether dispersants changed the rate at which bacteria moved towards the oil and the rate at which they consumed it."

"The really critical question we are asking is how human intervention – the dispersants – interacts with natural cleaning processes – the bacteria," she added. "If dispersants lowered the rate at which bacteria removed the oil, then human efforts to clean up the spill may have been costly and counter-productive."

Her ultimate goal is to determine whether the dispersants helped draw bacteria to the oil and, if so, to measure the impact.

UH PROFESSOR AMONG EXPERTS TO PUBLISH REVIEW OF NONCLASSICAL CRYSTALLIZATION

The U.S. Department of Energy sponsored a 2013 workshop in Berkeley, California that brought together 15 of the nation's top crystallization researchers to discuss the rapidly emerging but still obscure area of nonclassical crystallization.

Jeffrey Rimer, Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering at UH Cullen College of Engineering, was among members of the group who gathered to compose a review article that was published in *Science*.

"*Science* is a high-profile interdisciplinary journal that reaches a wide audience and covers a broad range of applications," Rimer said. "Examples of nonclassical crystallization are mounting in the literature, and this review article presents the most comprehensive overview of what is currently known about this topic."

The workshop afforded experts from various fields, including geoscience, materials science, chemistry and chemical engineering, an opportunity to meld their ideas to create a more cohesive framework for exploring nonclassical crystal growth. They established nomenclature and methodologies for reference among researchers working on papers for future publication, and they defined the term crystallization by particle attachment, or CPA, to encompass all pathways of crystal growth not characterized by classical monomer-by-monomer incorporation of atoms, molecules or ions.

"I was asked to join the group because of my work with zeolites, which are one of the first materials identified to grow by these routes," Rimer said. "Our review summarizes what we know about various natural, biological and synthetic crystals that grow by CPA, and it highlights open questions and challenges we face with respect to characterizing their pathways of formation."

Researchers have studied mechanisms of classical crystallization for centuries, but evidence of nonclassical crystallization pathways emerged only a couple of decades ago. In the mid-1990s, researchers discovered crystallization by addition of a wide range of particles, including multi-ion complexes, oligomeric clusters, crystalline or amorphous nanoparticles and monomer-rich liquid droplets.

They postulated that the presence of these particles contributed to growth of the rough-surfaced, spheroidal crystals they observed, which were unlike their classical counterparts. Layered monomer-by-monomer pathways of classical crystallization were known to produce well-defined faceted crystals with smooth surfaces.

Rimer was the first to provide in situ evidence of zeolite growth by CPA in a paper that was published in *Science* in 2014. Using atomic force microscopy, AFM, he definitively determined that the zeolite silicalite-1 grows by concerted processes of nonclassical particle attachment and classical monomer-by-monomer addition. Advanced in situ capabilities of AFM and electron microscopy have allowed researchers to visualize unknown and unpredictable nonclassical growth processes in real time. Prior to these advancements in technology and instrumentation, scientists relied on microscopy images taken after crystal growth had already occurred to infer mechanisms of formation.

One of the key takeaways from the workshop was that many crystals display evidence of both nonclassical and classical growth, so crystallization does not necessarily follow a single pathway. Many of the unanswered questions about nonclassical crystallization relate to dynamic intermolecular interactions that exceed the scope of classical theories. In their studies, researchers must account for multiple factors including roles of solvents, roles of ions in solutions and orientations of particles as they sample crystal surfaces.

"Right now, there are more question marks than periods in terms of understanding these pathways of growth, but there is a relatively small but growing list of materials that have been identified, or are at least believed, to grow by these routes." Rimer said. "We can subdivide this list into those materials we postulate grow by CPA processes based on inferences from ex situ experiments, and those we can directly visualize growing by these routes."

Understanding mechanisms of nonclassical crystallization would provide researchers with a platform for rational design of crystals at molecular levels for biological and industrial applications. The Rimer Group has already used knowledge of CPA mechanisms to engineer zeolites as catalysts for products ranging from gasoline to commodity chemicals.

As an established leader in zeolite research, Rimer's work was familiar to many of his workshop collaborators who attended prior conferences where he delivered presentations. Professor Patricia Dove of Virginia Tech and James De Yoreo of Pacific Northwest National Laboratory, prominent names in crystallization research, selected the group of researchers and composed much of the paper that summarized their discussions. Professor Pupa Gilbert of the University of Wisconsin-Madison and Professor Lee Penn of the University of Minnesota were also instrumental in coordinating the workshop.

Aside from nonclassical zeolite crystallization, Rimer studies many types of biogenic crystals that grow classically. With knowledge of classical mechanisms of crystal growth, he has designed drugs for kidney stone disease and determined ways antimalarial drugs operate in cases of malaria.

"Fundamental theories of nonclassical crystallization have yet to be established," Rimer said. "As the list of materials exhibiting CPA mechanisms continues to increase in conjunction with technological advancements to capture the dynamics and molecular-level details of their growth, we will undoubtedly gain a much better understanding of the interactions and processes governing these pathways."

> **"RIGHT NOW, THERE ARE MORE QUESTION MARKS THAN PERIODS IN TERMS OF UNDERSTANDING THESE PATHWAYS OF GROWTH."**
>
> - JEFFREY RIMER

UH CHEMICAL ENGINEER HARNESSES HIGH PERFORMANCE COMPUTING POWER TO DESIGN IMPROVED ZEOLITE CATALYSTS

Jeremy Palmer, assistant professor in the UH Cullen College's chemical and biomolecular engineering department, was awarded the American Chemical Society Petroleum Research Fund's Doctoral New Investigator Grant. The prestigious award supports fundamental, high-caliber research in the petroleum field and promotes the careers of young engineers and scientists.

Palmer will use the two-year, $110,000 award to design improved zeolite catalysts using computational modeling techniques.

Zeolites are three-dimensional, crystalline minerals used in a wide variety of industrial processes and commercial products. They occur naturally, but can also be mass-produced synthetically. The petrochemical industry commonly uses zeolites as catalysts because they efficiently speed up chemical reactions and can be produced relatively cheaply.

"Zeolites help make many chemical reactions economically-feasible on an industrial scale," said Palmer.

Their topography, with thousands of tiny pores, makes them uber-effective as industrial catalysts. These tiny holes can temporarily trap individual molecules during a chemical reaction, thereby lowering the energy required to chemically-convert those molecules into more valuable compounds.

Compounds converted by zeolites are used in products ranging from fuels and plastics to value-added chemicals. Zeolites also help to make industrial processes more sustainable by minimizing the production of wasteful byproducts.

Palmer's work is inspired by experiments done at the Cullen College by Jeffrey Rimer, Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering. In Rimer's group, much has been discovered about the importance of the size and shape of zeolite crystals. Naturally-growing zeolites tend to form large crystals, but smaller crystals perform better as catalysts.

"Experimental work at UH has shown that smaller zeolite crystals last longer and give higher product yields. Both properties reduce waste and improve process sustainability," said Palmer.

To control crystal size and shape, Rimer and his collaborators introduced growth modifiers – chemicals like amino acids and alcohols – into the growth solutions used to synthesize zeolites. When these compounds are present during crystallization, zeolite growth is systematically altered to produce a desired size and shape. The crystals can be tuned to form thin platelets, for example, when normally they would grow into the shape of large cylinders.

While experimental techniques have primarily been used to search for effective growth modifiers, Palmer's work uses computer simulation to add predictive capability to the process.

"We want to identify classes of growth modifier compounds that are likely to work to get the desired crystal shape and size," said Palmer. "This is slow and expensive to do experimentally, so we are harnessing the power of molecular modeling and the supercomputing facilities at UH's Center for Advanced Computing and Data Systems to expedite the process."

After identifying the growth modifier compounds that are most likely to cause the desired changes in crystal shape and size, Palmer will build computational models of zeolites to study how the chemical compounds interact with the surface of the zeolites. When the surface interactions are understood, Palmer will know how the growth modifier compounds will alter the crystal's shape and size.

It seems the smaller the zeolite, the larger the potential for impact on the oil and gas industry and the world around us. Looking to the future, small zeolites may help convert natural gas into products like polyethylene that have traditionally been derived from petroleum. Palmer said he hopes his team will help to realize that potential using his computer models.

ENGINEERING RESEARCHERS DEVELOP ADVANCED CELL SCREENING TECHNOLOGY FOR CANCER IMMUNOTHERARPY

By Jeannie **Kever**

Researchers have created a new method for screening cells used in immunotherapy cancer treatments, allowing high-performing immune system cells to be studied in isolation and potentially expanding the number of patients for whom the breakthrough treatment proves successful.

Engineers from the University of Houston, working with physicians from the University of Texas MD Anderson Cancer Center, describe the method – Time-lapse Imaging Microscopy in Nanowell Grids, or TIMING – and its ability to more accurately analyze large numbers of cells for use in the cancer therapy, in a paper published in *Bioinformatics*. They also demonstrated its potential in research evaluating how effective various types of T cells – a type of white blood cell key to fighting infection – are in killing cancer cells. Papers on that work were published last year in *Cancer Immunology Research* and in *OncoImmunology*.

"This is a case of biologists, clinicians and computer scientists coming together toward a common purpose," said Badri Roysam, chairman of the UH Cullen College of Engineering's department of electrical and computer engineering and lead author of the *Bioinformatics* paper.

Roysam and **Navin Varadarajan**, assistant professor of chemical and biomolecular engineering at UH, collaborated with MD Anderson's Laurence J.N. Cooper on the research, along with a number of other UH researchers.

Clinical studies have reported life-saving results from cancer immunotherapy, a biological therapy which uses the immune system – or specific cells of the immune system – to fight cancer. But they don't work for everyone, not even everyone with one of the cancers for which the treatments have proven most successful.

TIMING could change that by allowing researchers to study many more interactions between immune cells and cancer cells, thanks to its ability to automatically analyze thousands of cell interactions at a time. Conventional analysis is done manually, the researchers said, making it impossible to study every combination.

Most conventional methods assess a limited number of samples from a test – between 10 and 100, compared with the 10,000 or even 100,000 samples that can be assessed with the new method, according to the paper. That matters, the researchers wrote in *Bioinformatics*, "since many biologically significant cellular subpopulations like tumor stem cells, multi-killer immune cells and biotechnologically relevant protein secreting cells, are rare."

TIMING works like this: A nanowell grid – an expandable structure – allows discrete samples of immune cells and cancer cells to be confined and studied over time, via time-lapse video recording.

"We've developed a game-changing piece of software that can accurately analyze an entire grid of nanowell videos and make quantitative measurements," Roysam said.

It is essentially, he said, "the combination of a supermicroscope and a supercomputer to screen cell-cell interactions on a large scale."

"The proposed algorithms dramatically improved the yield and accuracy of the automated analysis to a level at which the automatically generated cellular measurements can be utilized for biological studies directly, with little/no editing," the researchers wrote.

Varadarajan said the system allows "high-performing outliers" to be identified for further research. Several types of immune cells were used, including T cells, CAR cells – T cells modified with chimeric antigen receptors, which allow them to hone in on and kill cancer cells – and what are known as NK, or "natural killer" cells, which can detect tumors without modification. Researchers used both leukemia cells and melanoma cells in their testing.

"If you know the best cells to fight a particular cancer, it just becomes a manufacturing problem," Varadarajan said. "But right now, we don't always know which cells are the best."

Using the TIMING system, the researchers have deepened the scientific understanding of immunotherapy, including how different types of T cells function against cancer cells. As a result, they demonstrated for the first time at a single-cell level that CD4 T cells directly participate in the killing of multiple tumor cells.

CD8 T cells are known for their tumor-fighting properties, but Varadarajan said the finding, published in *Cancer Immunology Research*, suggests that CD4 cells also would be effective. Research on this question is ongoing.

SMARTPHONES DOUBLE AS RAPID DIAGNOSTIC TESTS

From left: Andrew Paterson and Bala Raja

A professor and two alumni of the UH Cullen College of Engineering are developing a technology platform that transforms smartphones into medical devices that can rapidly detect bacteria, viruses and proteins in tiny blood and other human-derived fluid samples in less than 15 minutes. Initially, they are focusing on validation of the smartphone reader platform for detection of infectious diseases including chlamydia and dengue fever.

Bala Raja and **Andrew Paterson**, both recent alumni of the UH chemical engineering doctoral program, founded a startup company called Luminostics Inc. to commercialize the platform. Paterson first developed the technology in the laboratory of **Richard Willson**, UH Huffington-Woestemeyer Professor of chemical and biomolecular engineering, who continues to serve as a technical adviser to Luminostics.

“Our vision is to ultimately sell over-the-counter rapid tests for common diseases and medical conditions at affordable prices in drug stores,” Raja said.

To use the device, a few drops of blood or other fluid samples are added to a disposable test cartridge containing glow-in-the-dark nanoparticles called nanophosphors. The cartridge is inserted into a smartphone attachment that is similar to a protective case. A smartphone application automatically controls the phone’s camera and flash to capture images of the luminescence emitted by the nanophosphors. The app then analyzes the images and displays a positive, negative or quantitative result for the user.

The light-based readout provides more sensitive, quantitative and reliable results than other over-the-counter, rapid diagnostic tests – for example, pregnancy tests – that sometimes require reading faint-colored lines with the naked eye. Furthermore, existing tests cannot detect low levels of diagnostic targets for many diseases as Luminostics’ test can.

The nanophosphor research began with funding from the Western Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research. A $50,000 National Science Foundation Innovation Corps (I-Corps) award in 2014 with Raja as entrepreneurial lead helped the team evaluate business aspects of the technology and partially fund the development of the smartphone reader platform.

The Centers for Disease Control and Prevention Dengue Branch in Puerto Rico recently funded a pilot project for the UH team to develop a diagnostic test using the nanophosphors and smartphone platform for dengue fever, a mosquito-borne infectious disease. Additionally, Johns Hopkins University’s Center for Point-of-Care Testing for STDs recently awarded Luminostics with a $50,000 contract to develop a smartphone-based point-of-care test for chlamydia.

> “OUR VISION IS TO ULTIMATELY SELL OVER-THE-COUNTER RAPID TESTS FOR COMMON DISEASES AND MEDICAL CONDITIONS AT AFFORDABLE PRICES IN DRUG STORES.”
>
> — BALA RAJA

Jeffrey Rimer

CHEMICAL ENGINEERING PROFESSOR HONORED WITH OWENS CORNING EARLY CAREER AWARD

By Natalie **Thayer**

Jeffrey Rimer, Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering at the Cullen College, received the 2016 Owens Corning Early Career Award from the American Institute of Chemical Engineers (AIChE) for his multifaceted research on crystallization.

The Owens Corning Early Career Award, administered by the Materials Engineering and Sciences Division (MESD) of AIChE, recognizes researchers under the age of 40 who have contributed outstanding work in the broad field of materials science and engineering. The award is given to only one individual each year. As the 2016 recipient, Rimer received a plaque and $1,500 honorarium. He was also invited to deliver a plenary lecture at the 2016 AIChE Annual Meeting in San Francisco.

Rimer's research explores both classical and nonclassical crystallization, and his work has led to the development of drugs for kidney stones and malaria. Rimer's extensive research on zeolites, a crystalline material used in a variety of everyday products, led to the first in situ evidence of how zeolites grow, which was published in *Science* in 2014.

Rimer and his colleagues developed a new technique to study the growth of zeolites using solvothermal atomic force microscopy, or AFM, that allows researchers to view crystal growth in real time and in realistic environments. With AFM, Rimer's research group was able to identify that zeolites grow by complex processes involving nonclassical crystallization. In 2015, he was among a group of 15 researchers to publish a review of nonclassical crystallization in *Science*.

Aside from zeolite crystallization, Rimer studies many types of biogenic crystals that grow classically, such as kidney stones.

According to the National Kidney Foundation, more than half a million people visit the emergency room for kidney stones each year and an estimated one-in-10 people will develop a kidney stone during their lives. The most common type of kidney stone is formed when calcium and oxalate combine in urine due to inadequate calcium and fluid intake. By uncovering the fundamentals of crystal growth, Rimer's group identified a potential therapy for kidney stones using a natural supplement.

Knowledge of classical mechanisms of crystal growth allowed Rimer and his colleagues to determine how antimalarial drugs operate in cases of malaria. In collaboration with **Peter Vekilov**, John and Rebecca Moores Professor of chemical and biomolecular engineering, Rimer developed a platform to characterize and screen antimalarial drugs.

"There are many hypotheses [in the scientific community] about how antimalarial drugs work, and we've been able to develop a unique system to test and validate these hypotheses," said Rimer.

Rimer said he's deeply grateful to all of the collaborators and students he's worked with over the years to advance this research. Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College of Engineering, said Rimer is highly regarded for his innovative teaching style and unwavering commitment to his students.

"From helping UH students commercialize his inventions to inviting undergraduates to conduct research in his laboratory, Dr. Rimer has always gone above and beyond expectations to enhance the education of his students," said Dean Tedesco.

"I've been very fortunate to work with excellent students and postdocs over the years, and I think this award speaks to that," said Rimer. "I really owe a lot to my research group. They are the reason why many of our initial ideas have come to fruition."

CHEMICAL ENGINEERS' PAPER NAMED BEST OF AICHE SOUTH TEXAS SECTION

By Audrey **Grayson**

In 2014, a professor and student in the chemical and biomolecular engineering department at the UH Cullen College of Engineering published an article in *Science* outlining a surprising discovery about gold's unexpected catalytic properties. Their paper, which was the first to ever fully explain what happens during the catalytic oxidation of carbon monoxide, was chosen as Best Fundamental Paper of 2014 by the South Texas Section (STS) of the American Institute of Chemical Engineers (AIChE).

Assistant professor **Lars Grabow** conducted this research alongside his Ph.D. student, **Hieu Doan**. Their collaborators on this project were Bert Chandler, Johnny Saavedra and Christopher Pursell at Trinity University in San Antonio. The award was announced at the 7th Southwest Process Technology Conference in Galveston, Texas last year.

One of the most desirable qualities of gold is its ability to resist rusting and tarnishing thanks to its inertness – that is to say, it's lack of reactivity with other substances. However, gold nanoparticles have long been used as catalysts to oxidize carbon monoxide (CO) into carbon dioxide (CO_2).

For over 25 years, researchers have observed the catalytic behaviors of gold and proposed many explanations as to why an inert metal would help to speed up a chemical reaction. Before Grabow and Doan conducted this research, no single model had completely explained what takes place during a reaction wherein gold is used to help transform CO into CO_2.

Using the best available experimental and theoretical methods in combination, the team was able to provide direct evidence of the role each element plays in this particular chemical reaction, and proposed a novel reaction mechanism that addresses longstanding questions.

"The answer is water," Grabow said. Although water is not one of the reactants in this chemical reaction, Grabow's team was able to prove that it serves as a co-catalyst for the reaction.

But if water isn't intentionally added to the chemical reaction, how does it get there in the first place? "Well, water is everywhere," Grabow said. "It's in the air and we know it as humidity. More importantly, it's in pretty much every chemical reactor that we're operating unless it's inside of an ultra-high vacuum."

The presence of tiny amounts of water is what essentially drives the reaction on the surface of the gold catalysts. A thin layer of water, approximately two molecular layers, settles on the surface of the catalyst, and protons (positively charged hydrogen atoms) from inside the water layer can detach from the water molecules and attach themselves to oxygen molecules. Those protonated oxygen molecules are then absorbed onto the surface of the gold catalyst, allowing the reaction to proceed very quickly. When the reaction is complete, the protons return once again to the water layer on the surface of the catalyst.

"We imagine that the layer of water is like a sea of protons. Protons swim in that water layer like fish, they jump out to facilitate the reaction and then they jump back into the water layer," Grabow said.

Doan ran calculations to determine the role each element plays in the oxidation of carbon monoxide. Once completed, Doan used this data to create a model to describe precisely what is happening in the reaction.

"I came up with a model to describe what's happening in this reaction so we can visualize all of the elements of the catalyst and bring them together in a scientific way," he said.

The Best Fundamental Paper Award has been given by the STS section of AIChE each year since 1959. STS is the largest local section of AIChE, the world's largest organization for chemical engineering professionals.

NEUTRON SCATTERING SOCIETY OF AMERICA ELECTS UH ENGINEER AS 2016 FELLOW

By Natalie **Thayer**

Ramanan Krishnamoorti, professor of chemical and biomolecular engineering at the University of Houston Cullen College of Engineering, was recently elected as a Fellow of the Neutron Scattering Society of America (NSSA). He was one of only 11 NSSA Fellows elected this year.

The NSSA was formed in 1992 to advance neutron scattering research in the United States by identifying and bringing together the national neutron scattering community, identifying the needs of the community, promoting the broader use of neutron scattering technology and carrying out educational activities across the nation. The society is made up of leading researchers, scientists and others with an interest in neutron scattering research spanning a wide spectrum of disciplines.

Krishnamoorti was elected for his pioneering neutron scattering studies on soft materials and nanocomposites, and for his sustained service to the neutron scattering community.

Krishnamoorti is highly active across the UH community. In addition to his role in the Cullen College, he serves as a professor of chemistry in the College of Natural Science and Mathematics, the interim vice president and vice chancellor for Research and Technology Transfer, and the chief energy officer for UH. As the University's chief energy officer, he is responsible for leading the University's efforts to establish energy-centric partnerships to address the world's most pressing energy challenges.

AICHE ELECTS UH ENGINEER AS VICE CHAIR FOR CATALYSIS AND REACTION ENGINEERING DIVISION

By Natalie **Thayer**

Lars Grabow, assistant professor of chemical and biomolecular engineering at the UH Cullen College, was recently elected as second vice chair for the Catalysis and Reaction Engineering (CRE) division of the American Institute of Chemical Engineers (AIChE).

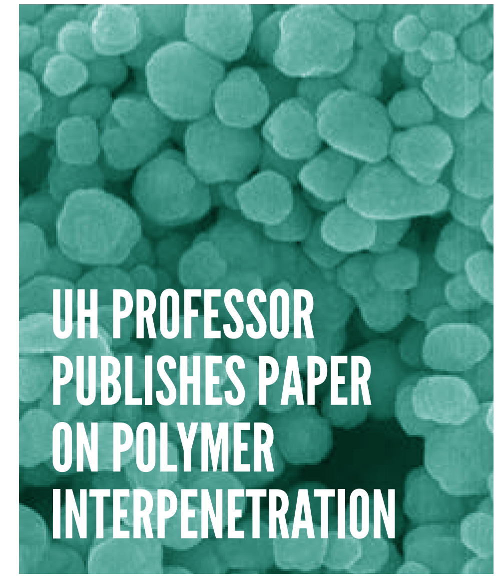
As a leading worldwide organization for chemical engineering professionals, AIChE's vision is to provide value to the field by promoting the professional and personal growth of chemical engineers and applying chemical expertise to meet global societal needs. AIChE boasts more than 50,000 members from over 100 countries. Members are connected with a vast network of renowned colleagues, provided with unique learning opportunities, and gain access to both established and groundbreaking chemical engineering processes and methods.

The CRE division, which focuses on catalysis, industrial and engineering chemistry, fuel chemistry and petroleum, is the largest division of AIChE.

In his role as second vice chair for the CRE division, Grabow will be responsible for the CRE Travel Awards, which provide graduate students with travel assistance to present their research at the annual AIChE meeting. He will select the judges to review applications, select the 20 strongest graduate students to receive the awards and present the awards to the winners at the 2016 CRE annual meeting in San Francisco, California.

Grabow will be committed to the AIChE leadership team for four years. After serving as second vice chair, he will move into the role of vice chair in 2017, chair in 2018 and past-chair in 2019.

TO LEARN MORE ABOUT AICHE'S CRE DIVISION,
please visit *www.aiche.org/community/divisions/catalysis-and-reaction-engineering-division-cre*



UH PROFESSOR PUBLISHES PAPER ON POLYMER INTERPENETRATION

Ramanan Krishnamoorti, professor of chemical and biomolecular engineering at the UH Cullen College of Engineering, coauthored a paper on tuning polymer interpenetration that published in the *Journal of the American Chemical Society*.

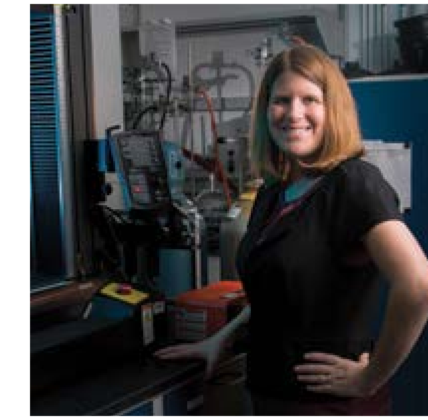
Researchers tailor properties of polymer nanocomposites for biomedical, pharmaceutical and automotive applications, among numerous other industry uses.

According to a University of Delaware article, researchers typically employ either wetting or dewetting for either dispersion or aggregation of nanoparticles, respectively, which they believed were synonymous and mutually exclusive processes. Depending on desired properties necessary for particular objectives, both transitions were useful.

Krishnamoorti and his collaborators found a sharp change from dispersion to aggregation of nanoparticles that did not correlate with the gradual change they found from wetting to dewetting, refuting an established scientific theory. Their discovery provides a finer tuning knob to tailor nanoparticles in polymore-nanoparticle composites for specific applications.

Tyler Marin, a graduate student working with engineering professor Arthi Jayaraman at the University of Delaware, was lead author on the paper. Other collaborators included researchers from the University of Colorado, the University of Maryland and the National Institute of Standards and Technology Center for Neutron Research.

FRONTIERS IN SCIENCE INVITES UH ENGINEER TO NATIONAL AND INTERNATIONAL SYMPOSIA



By Audrey **Grayson**

Since its inception in 1989, an invitation to the Kavli Frontiers in Science Symposia has symbolized a young scientist's vast accomplishments in his or her field. Each year, 80-to-100 of the world's most outstanding scientists under the age of 45 are invited to the symposia, which are sponsored by the Kavli Foundation and the U.S. National Academy of Sciences (NAS).

A chemical and biomolecular engineering professor at the UH Cullen College of Engineering was invited to participate in two Kavli Frontiers of Science Symposia in 2015.

Assistant professor **Megan Robertson** was among the 80 top young scientists invited to Indonesia in July of 2015 to participate in the Indonesian-America Kavli Symposium. Robertson was also among the 25 scientists invited to participate as a speaker at the 27th Annual U.S. Kavli Frontiers of Science Symposium held in Irvine, California in November of 2015.

The overarching purpose of the Kavli Frontiers in Science symposia is to bring together researchers from a broad range of scientific backgrounds to engage in one-on-one discussions and forge new, interdisciplinary collaborations.

"These symposia give participants the opportunity to think about new topics and develop collaborations with people who we wouldn't typically have the opportunity to meet," Robertson said.

The Indonesian-American Kavli Symposia began in 2010 following a visit to the country by former NAS president Bruce Alberts. Serving as one of the first U.S. science envoys appointed by President Obama to strengthen scientific and technical collaboration between the U.S. and Muslim-majority nations, Alberts established the Indonesian Kavli Symposia with support from the U.S. State Department and the Kavli Foundation. The symposium series is co-organized by the NAS and the Indonesian Academy of Sciences.

Symposia speakers covered topics including marine microbiology, astrophysics and exoplanets, infectious diseases, and nanomaterials found in nature. Robertson presented a general poster at the symposium relating to one of her laboratory's core research areas: developing polymers from renewable resources, such as biomass and plant sources.

"This topic is very relevant to Indonesia because there is an emphasis on using available resources to grow the local industry," Robertson said. "I am very hopeful that a collaboration between my lab group and researchers in Indonesia will result from this symposium."

Robertson traveled to the Beckman Center of the National Academies of Sciences & Engineering in Irvine last November for the U.S. Kavli Symposium, which covered topics including personalized medicine, cyber security, behavioral economics, space, reverse-engineering the brain, and feedstocks for new materials. As introductory speaker of one of the symposium's sessions, "Utilizing New Feedstocks to Access the Next-Generation of Materials," Robertson presented an overview focusing on the use of waste resources to develop polymers.

PROFESSOR HONORED WITH ISMR PIERCE AWARD IN AFFINITY TECHNOLOGY

Richard Willson, Huffington-Woestemeyer Professor of chemical and biomolecular engineering, is the recipient of the 2015 Pierce Award in Affinity Technology from the International Society for Molecular Recognition (ISMR). Willson traveled to Puerto Vallarta last year to collect the award and present a lecture at the biennial ISMR Affinity Conference.

The Affinity Conference is a long-standing tradition distinguished by its cross-cutting focus on the science and technology of biomolecular affinity interactions. Scientists and engineers from academia and industry meet to exchange knowledge on affinity technology and molecular recognition and their applications for health and disease as well as bioprocessing and biosensing.

Founded in 1985, ISMR fosters communication between researchers concerned with molecular recognition in chemistry, biology, biotechnology and medicine. In recent years, advances in numerous methodologies have provided researchers with tools to identify and characterize interacting molecules and to understand general rules of molecular recognition. This knowledge complements the field of affinity technology, making it possible to use both native and designed interacting molecules for such biotechnological applications as purification, diagnostics and therapeutics.

Willson, who serves as immediate past-president for the society, co-organized the 2015 Affinity Conference.

DISTINGUISHED FACULTY MEMBER AND FORMER DEAN RAY FLUMERFELT RETIRES

By Audrey **Grayson**

It's not every day that an institution has the opportunity to celebrate over three decades of achievements and contributions of one of their engineering professors and former deans. Last year, UH engineering faculty, staff, students and alumni did just that at a retirement celebration for **Ray Flumerfelt**, a trailblazer and champion for the UH Cullen College of Engineering.

Flumerfelt served as a faculty member in the chemical engineering department from 1967 to 1985, during which time he participated in the department's rise to a Top 10 nationally ranked program.

Flumerfelt returned to the Cullen College as its dean in 1998. During his nine-year tenure in that role, Flumerfelt led the college to unprecedented heights. After retiring as dean in 2007, he went on to lead the petroleum engineering program, playing an instrumental role in the relaunch of the college's petroleum engineering bachelor's degree program.

Flumerfelt's professional achievements and personal friendships at the Cullen College were celebrated at a luncheon held in his honor. The former dean was presented with a framed photo of the UH campus signed by the many friends he made during his three-decade-long career at the University of Houston.

DOCTORAL STUDENT WINS BEST PRESENTATION AT ANNUAL AICHE MEETING

By Natalie **Thayer**

Doctoral student **Megan Ketchum** received the Best Presentation Award of the “Chemical Engineers in Medicine” session at the 2015 American Institute of Chemical Engineers (AIChE) annual meeting held in Salt Lake City, Utah.

The AIChE annual meeting is the premier educational forum for chemical engineers interested in innovation and professional growth. Academic and industry experts convene to cover a wide range of topics relevant to cutting-edge research, new technologies and emerging growth areas in chemical engineering.

During the meeting’s “Chemical Engineers in Medicine” session, Ketchum presented her paper titled “High-Throughput Biomimetic Assay Designed to Quantify Antimalarial Efficacy.” The session focused on diagnostics, treatments and theranostics – a combination of therapy and diagnostics. The discussion drew leading pharmaceutical industry and academic experts to its audience.

Malaria is a parasite that attacks a host’s red blood cells and can lead to fever, nausea, coma and even death. When a human host in infected, the host’s hemoglobin breaks down into several highly unstable heme molecules, which in turn oxidize to hematin. Hematin is naturally toxic to the parasite; however, the parasite responds by sequestering the hematin into crystals, rendering the hematin benign. Current antimalarial drugs work by inhibiting hematin crystallization, so that the parasite is unable to survive and is thus eradicated from the body.

At the Cullen College, Ketchum worked with faculty advisers Peter Vekilov and Jeffrey Rimer and fellow chemical and biomolecular doctoral student Katy Olafson to study the environment for this crystallization process.

Within the digestive vacuole of the malaria parasite are two components, one aqueous and one lipid. Ketchum and Olafson studied the solubility of hematin in both of these environments, ultimately determining that the lipid environment is better suited for crystallization. While there is a high volume of published research exploring crystallization in the aqueous environment, there is relatively little research done in lipid-like environments.

Though current antimalarial drugs are effective, the parasite is becoming resistant to these drugs and it’s taking longer for the parasite to leave the human body in many new cases. Because of this, Ketchum said, there is a dire need to create new drugs.

“This is really the driving force behind what we’re doing,” she said. “We’re creating a platform for designing new drugs.”

Ketchum is on track to graduate in December of 2016. Until then, she said she plans to continue her research in Rimer’s lab, expanding her focus to cholesterol crystallization in gallstones and arteries.

Ketchum said she was drawn to chemical and biomolecular engineering because she always liked the idea of helping people.

“I often wonder about ways I can help make things better, especially ways to improve treatment options and the lives of patients,” she said.

CHEMICAL DOCTORAL STUDENT WINS AICHE RESEARCH AWARD

By Natalie **Thayer**

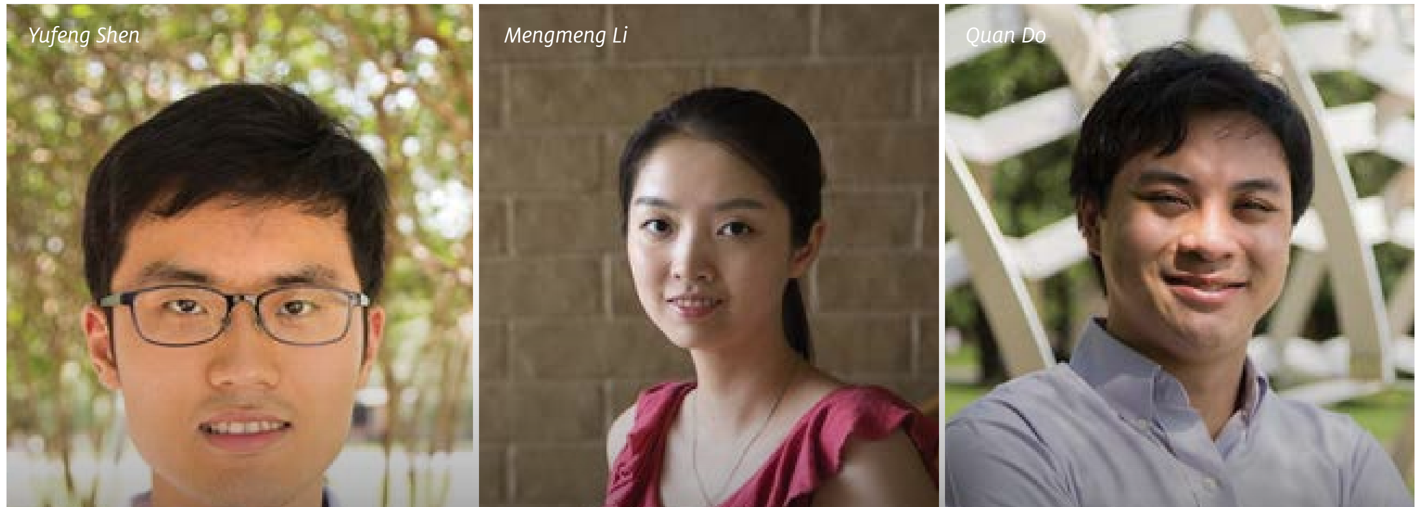
Katy Olafson, a chemical engineering doctoral student at the UH Cullen of Engineering, received a 2016 American Institute of Chemical Engineers (AIChE) Separations Division Graduate Student Research Award.

Working with her faculty adviser Jeffrey Rimer, Ernest J. and Barbara M. Henley Associate Professor, Olafson’s research focuses on malaria pathophysiology from the aspect of hematin crystallization. She said she studies how how anti-malarial drugs affect crystallization in an effort to contribute to the development of new drugs to treat the disease.

Rimer, a leading researcher in the field of crystallization, said Olafson’s dedication to the work makes her stand apart from the crowd.

“Katy is not only a promising researcher, but a rising star in her field,” said Rimer.

The award will be presented to Olafson at the 2016 AIChE Annual Meeting in San Francisco, California. In addition to attending the meeting as the Separations Division’s guest, she will receive a $200 cash prize and a plaque inscribed with her name.



Yufeng Shen Mengmeng Li Quan Do

THREE UH ENGINEERS EARN POSTER AWARDS AT SOUTHWEST CATALYSIS SOCIETY SYMPOSIUM

By Natalie **Thayer**

The UH Cullen College of Engineering hosted this year's Southwest Catalysis Society (SWCS) Symposium on April 22, 2016. The symposium provided an opportunity for engineering students from across the region to present their research to an esteemed crowd of international researchers and industry professionals.

This year, three Ph.D. candidates from the Cullen College's chemical and biomedical engineering department won poster awards for outstanding presentations. From reducing auto emissions to developing alternative fuels, the winners showcased an array of groundbreaking research taking place inside UH's chemical and biomolecular engineering laboratories.

Yufeng Shen, a third-year doctoral student and advisee of Ernest J. and Barbara M. Henley Associate Professor Jeffrey Rimer, researches catalysts that can convert methanol from natural gas to hydrocarbons, a compound essential to many everyday applications including plastics and gasoline.

Shen said he was interested in working in Rimer's laboratory at UH because of his focus on synthesizing catalysts.
"When I first joined [the group], I began building a reactor to test the performance of the catalysts we synthesized. That's the part I enjoy the most – running the experiments and testing," he said.

For the SWCS Symposium, Shen presented his work on the synthesized catalyst CSM-11 in his poster titled "The Effect of CSM-11 Crystal Size on Methanol to Hydrocarbon Reaction." Methanol, if efficiently converted to hydrocarbons through a catalyst such as CSM-11, could potentially be used as an alternative to crude oil for the production of various chemicals and fuel.

Shen said the symposium provided him an opportunity to gain new insights from leaders in the field and network with fellow graduate students.

"It's a good opportunity to broaden our horizons," Shen said. "Most of the time we're in the lab, we are so focused on our own research. But, at the symposium, we had a chance to learn what other people in the field are doing."

Under the guidance of Michael Harold, M.D. Anderson Professor and Chair of chemical and biomolecular engineering, fourth-year doctoral student **Mengmeng Li** investigates the catalytic reduction of nitrogen oxide, or NOx, related to lean-burn vehicles.

Due to regulations set forth by the Environmental Protection Agency (EPA), automobile manufacturers are currently exploring methods to increase fuel economy while reducing the harmful gases, such as NOx, that are emitted from vehicles.

With funding from an auto manufacturer, Li used a small-scale model catalyst to study the reaction mechanism – or the step-by-step sequence of reactions that lead to overall change – for NOx storage and reduction. The results of her research were presented in her poster titled "Reductant Effects During Fast NOx Storage and Reduction."

Li said that Harold played an invaluable role in her research by providing her guidance and sharing his expertise along the way.

"I enjoy working in Dr. Harold's lab because he is such an expert in the field of chemical reaction engineering," she said.

Recognition for this research is not new for Li. She has been published in several top research journals, including one publication in *Applied Catalysis B* and two publications in *Catalysis Today* just this year. Even though she has presented her work during many professional conferences, she said winning the SWCS poster award was a unique honor.

"At first, people might find it hard to understand your research when it's in a different area, but with the poster presentation, I had the chance to introduce and explain my research to the audience," she said.

Echoing Shen, Li said that the symposium provided her the chance to share and combine ideas with others beyond her own research area.

"Talking to other chemical engineers really enriched my knowledge and helped me think outside the box," she said.

Quan Do, a second-year doctoral student working with assistant professor Lars Grabow, said he was drawn to UH because of his interest in the oil and gas industry. At the Cullen College, he researches the potential for natural gas, or methane, to play a larger, more sustainable role in the energy landscape by forming chemical hydrocarbon derivatives, such as ethylene.

Do is looking for new ways to efficiently couple methane, which is a stable single-carbon molecule, to form ethane or ethylene, which are two-carbon molecules. Current methods rely on oxygen to facilitate the coupling process, but often result in undesirable byproducts, such as carbon monoxide and carbon dioxide.

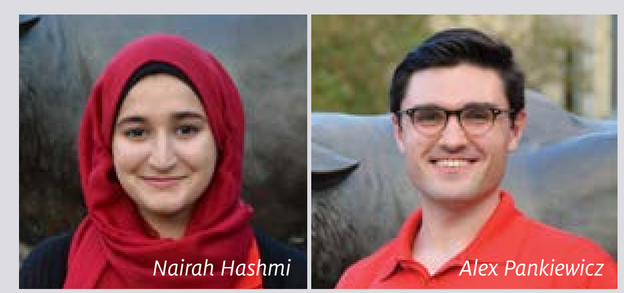
To avoid creating these byproducts, Do is researching a chemical looping process using transition metals to break the hydrogen-carbon bonds in methane. In this novel process, the transition metal serves as the catalyst, pulling the hydrogen from the methane molecule to form a metal hydride. The metal hydride is then either heated or treated with oxygen in a reactor, which regenerates the original metal so that it can be reused as a catalyst. Ideally, this process would break one hydrogen from the methane, allowing the molecules to bond and form ethylene.

So far, however, the five transition metals Do has explored – scandium, titanium, yttrium, zirconium and hafnium – break all four of the hydrogen bonds in methane instead of just a single one. He said his next step is to test the chemical looping process using combined transition metals to achieve the desired result.

His poster, titled "The Catalytic Dehydrogenation of Methane Using Transition Metals as Hydrogen Storage Materials," describes both his computational and experimental research in addition to elaborating the next steps he plans to take in this work.

Though his research indicates more work ahead of him, Do said he felt confident about his presentation at the symposium. "I think the judges appreciated my presentation, overall – my explanation and enthusiasm for the work," he said.

He also said that Grabow provides an important perspective as his faculty adviser, helping to keep him motivated and on track. "I think a lot of graduate students, especially engineering students, become so focused on their research that they can burn out," he said. "Dr. Grabow is very encouraging. He recognizes that students need to push themselves but also explore their interests outside of the lab to produce good work."



Nairah Hashmi Alex Pankiewicz

FORBES FEATURES OP-EDS BY UH ENERGY AMBASSADORS ON CLIMATE CHANGE, COAL EMISSIONS

By Natalie **Thayer**

Forbes.com recently featured two blog posts written by University of Houston Energy Ambassadors.

The first blog post, written by chemical engineering undergraduate **Nairah Hashmi**, was titled "Stepping Up to Step Down Climate Change." In it, Hashmi reflects on "climate change [as] a matter of personal consumption" and explores ways individuals can take small, responsible steps to reduce their own carbon footprint.

Alex Pankiewicz, who is double majoring in chemical engineering and chemistry with a minor in energy and sustainability, wrote the second blog post featured on *Forbes.com*. Pankiewicz spent the summer of 2015 teaching English in Wuhan, China. In his blog post "The Paradox Of China – Rising Standards Of Living, More Pollution," he shared his thoughts on the "tremendous amount of consumption and economic development in China," which he witnessed firsthand during his time working and traveling through the country.

The University of Houston's Energy Ambassador program is part of the UH Energy initiative. UH Energy is an interdisciplinary platform that integrates University-wide efforts related to energy and sustainability. Energy Ambassadors are selected and appointed to promote, plan, organize and run upcoming events.

Ricardo Sosa *Kyle Karinshak*

ONE CHEMICAL ENGINEERING STUDENT EARNS COVETED NSF RESEARCH FELLOWSHIP, ANOTHER RECEIVES HONORABLE MENTION

By Natalie **Thayer**

Chemical and biomolecular engineering graduate student **Ricardo Sosa** earned the coveted National Science Foundation (NSF) 2016 Graduate Research Fellowship.

The NSF Graduate Research Fellowship Program (GRFP) is a highly competitive and prestigious award open to undergraduate seniors and graduate students pursuing research-based master's and doctoral degrees in the STEM fields. It is the oldest graduate fellowship of its kind, and selected fellows receive an annual stipend for three years along with a tuition allowance and research and professional development opportunities.

Kyle Karinshak, a chemical engineering graduate student, received honorable mention for his application to the NSF GRFP. Honorable mention recipients are provided enhanced access to cyberinfrastructure resources, including supercomputing time, in support of their graduate student research. This year, the NSF received nearly 17,000 applications and made only 2,000 award offers to students from across the nation representing a diverse array of scientific disciplines.

Joan Ferrini-Mundy, assistant director for education and human resources at the NSF, said that the GRFP is a vital part of the NSF's efforts to foster and promote excellence in the STEM fields. "These awards are provided to individuals who have demonstrated their potential for significant research achievements, and they are investments that will help propel this country's future innovations and economic growth," she said.

Ricardo Sosa – NSF GRF Recipient

Sosa, a native Houstonian, was first introduced to chemical engineering during his senior year of high school when Jeffrey Rimer, Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering at the Cullen College, was invited to his AP research and design class. The presentation ignited Sosa's interest in engineering and helped shape his future academic pursuits.

Sosa contacted Rimer the summer after his senior year of high school, which led to a position as a research assistant in Rimer's lab during his first semester at the Cullen College. Since then, Sosa has worked with Rimer to explore surface science and intermolecular interactions in relation to kidney stone formation.

Sosa said he was drawn to the research in Rimer's lab because of the interdisciplinary approach to engineering. "This project interested me because we are applying chemical engineering principles to the biomedical field," he said.

Outside the lab, Sosa serves on the Outreach Committee for the UH American Institute of Chemical Engineers (AIChE) student chapter. As co-chair of the committee, Sosa has coordinated outreach events in local high schools to introduce students to STEM disciplines. He said he feels like he's come full circle by sharing his experiences in order to encourage high school students to pursue engineering.

"I think it's important to get high school students interested in the STEM fields," he said. "When I was in high school, I didn't fully understand what I was getting myself into [by studying engineering]. Now, I want to use my experiences to help make students aware and prepared."

Sosa began his chemical engineering graduate studies at the Cullen College this fall.

Kyle Karinshak – NSF GRF Honorable Mention

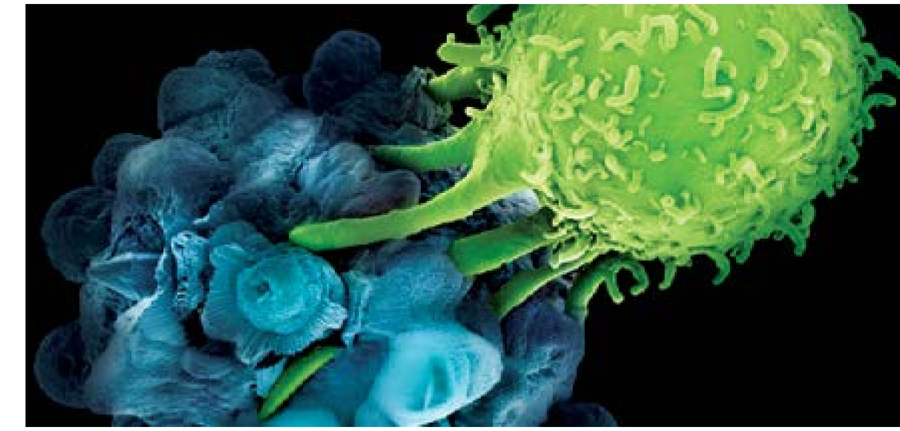
Before pursuing his doctoral studies at the UH Cullen College of Engineering, Karinshak attended a Research Experience for Undergraduates (REU) program at the University of Houston, which provides undergraduate students the opportunity to conduct hands-on research under direct supervision of a faculty member. Karinshak spent the summer working alongside William Epling, professor of chemical and biomolecular engineering at the Cullen College, to study nanoparticle catalysts and their reactivity.

Karinshak said that although the research he conducted during the REU program was quite challenging, he was impressed with the guidance and advice provided by Epling. Karinshak now works in Epling's lab exploring catalysis and reaction engineering, and is currently investigating the mechanism of sulfur poisoning in catalysis.

Karinshak also held a summer internship at NASA researching methods to improve the thermal propagation safety of space suit batteries. He said his REU experience was instrumental in securing his internship.

"I got the internship at NASA through contacts I made [at the Cullen College]," he said. "Being at the College has definitely opened up some interesting doors."

Karinshak received his bachelor's degree in chemical engineering from the University of Oklahoma and began his doctoral studies at UH in 2015.



POST-DOC EARNS TRAVEL GRANT FOR CANCER IMMUNOTHERAPY RESEARCH

The Society for Immunotherapy of Cancer (SITC) selected **Gabrielle Romain**, post-doctoral research fellow in the UH Cullen College of Engineering, to present her research on cancer immunotherapy at its 30^{th} anniversary annual meeting. She attended the conference in National Harbor, Maryland, last November with a travel grant of approximately $750.

Chemotherapy, radiation and surgery remain the most pervasive treatment options for cancer patients, but immunotherapy, which harnesses the immune system to fight cancer, is showing promise in small clinical trials. One such therapy is adoptive cell transfer, ACT, which involves genetic modification of T cells, a type of immune cell, to produce surface chimeric antigen receptors, or CARs, that recognize proteins on surfaces of antigens. Billions of these CAR T cells are grown in labs and infused into patients' bodies where they multiply and attack cancerous tumors.

CAR T cells have demonstrated clinical promise for combating even late-stage cancerous tumors resistant to all or most other types of treatments, but therapy outcomes remain somewhat unpredictable. Therefore, new approaches are necessary to assess potential for the treatment of cancers with immunotherapies, and Timelapse Imaging Microscopy In Nanowell Grids, or TIMING, which Romain and her colleagues developed, is showing promise.

Using their novel single-cell assay, Romain compared the efficacy of two different CD19-specific CAR constructs by tracking their interactions with tumor cells in vitro. CAR T cells rendered specifically for CD19 have demonstrated significant antitumor properties in patients with CD19 chronic lymphocytic leukemia, CLL, and acute lymphoblastic leukemia, ALL. Lymphomas have also responded positively to CD19 CAR T cells.

While discernible differences were not observed in populations of cells, Romain determined with TIMING that significantly more CAR T cells bearing CD8a receptor components participated in serial killing of NALM6 tumor cells than those with IgG4 components. A mouse model confirmed the superiority of CAR T cells containing CD8a in controlling the disease. **Navin Varadarajan**, assistant professor of chemical and biomolecular engineering at UH Cullen College, and Laurence Cooper, associate professor of pediatrics at the University of Texas MD Anderson Cancer Center, were lead investigators on the study.

"In aggregate, these results demonstrate the utility of TIMING single cell methodology in uncovering not only the dynamic profile of T cell behavior but in also uncovering the phenotypic biomarkers of CAR T cells with superior functional efficacy," Romain wrote in her abstract.

DOCTORAL STUDENT WINS YOUNG INVESTIGATOR AWARD AT AFFINITY 2015

Andrew Paterson, an alumnus of the chemical engineering doctoral program at the UH Cullen College of Engineering, won the Young Investigator Award at Affinity 2015, a conference of the International Society for Molecular Recognition. He presented his rapid medical diagnostic research at the conference in Puerto Vallarta, Mexico in September of 2015.

"I wasn't expecting anything, but the researchers found our work interesting and potentially useful," Paterson said. "Experts in different areas of biotechnology approached me after my presentation, and their excitement helps validate what we're doing and has really inspired us to push the technology to the next level."

Paterson has worked to improve the sensitivity of point-of-care and over-the-counter rapid medical diagnostic tests since 2012 when he joined the lab of **Richard Willson**, UH Huffington-Woestemeyer Professor of chemical and biomolecular engineering. The team also includes **Balakrishnan Raja**, who obtained his doctorate in chemical engineering under Willson in 2014.

"Our goal is to get this diagnostic technology out of the lab and into doctors' offices," Paterson said. "Ultimately, we plan to develop a consumer device sold in drugstores, so people can buy off-the-shelf diagnostic tests for a variety of diseases." Paterson spent the first couple of years establishing novel ways to use nanophosphors, light-emitting nanoparticles, to detect biomarkers such as molecules, viruses, proteins and bacteria. The last couple of years, he and the UH team developed a smartphone-based diagnostic platform that uses a lateral flow assay (LFA) reader and highly detectable nanophosphors for sensitive disease detection.

The LFA reader attaches to the top back half of the smartphone, similar to a protective case, and has a compartment that holds a rectangular disposable test cartridge. The cartridge contains the nanophosphors and a result window, which lines up with the phone's camera when the cartridge is inserted in the reader.

To perform the test, a liquid sample such as a drop of blood is added to the cartridge, and the nanophosphors bind to the targeted biomarkers in the result window. The camera flash activates the luminescent nanoparticles, the flash switches off and the camera immediately captures an image of the light emitted by the nanoparticles. The smartphone application then analyzes the image, determines a positive or a negative test result and displays the information on the smartphone screen. The diagnostic tool can also be used to quantify concentrations of the targeted biomarkers.

"The nanophosphors are similar to the material used to make glow-in-the-dark stars that children stick on their bedroom ceilings," Paterson said. "The stars charge while the light is on, and they glow with a very bright intensity just after the lights are turned off."

The light-based readout provides more sensitive, quantitative and reliable results than other rapid diagnostic tests that require subjective reading of faint-colored nanoparticles with the naked eye. Furthermore, existing tests are not quantitative enough and struggle to detect low levels of diagnostic targets for numerous diseases.

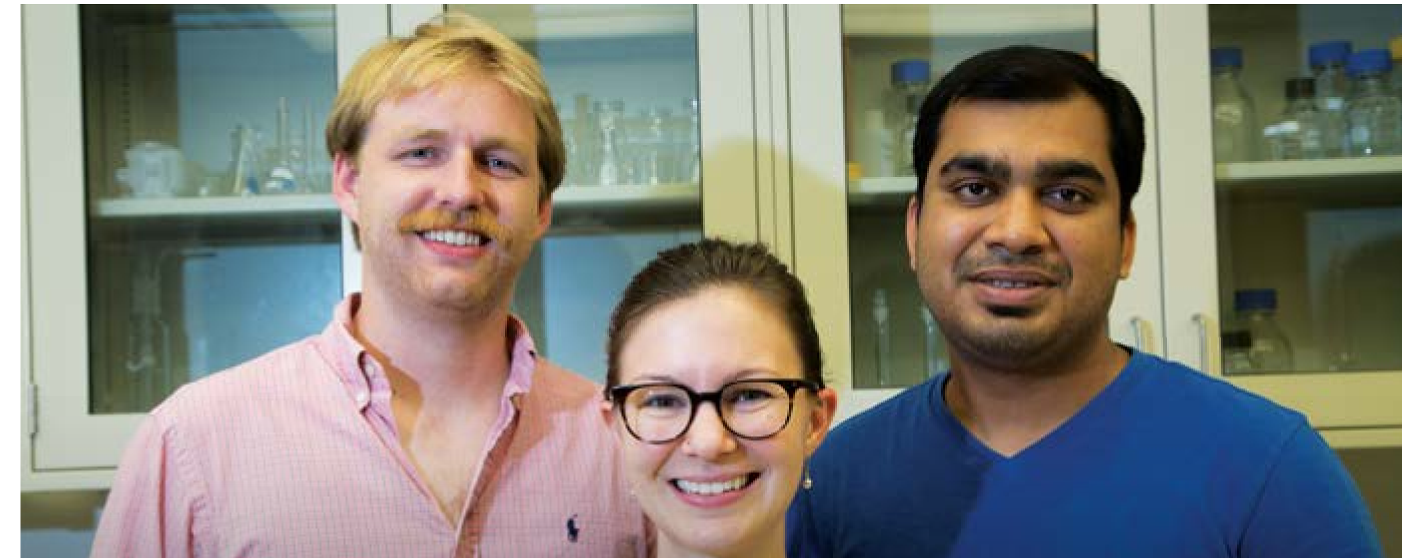
"The nanophosphors in our diagnostic tests currently provide tenfold better sensitivity than the most commonly used particles in rapid diagnostic tests, which opens up new opportunities in point-of-care testing," Paterson said. "We can achieve more on the fundamental materials side, and we can optimize the assay side to provide even better sensitivity for use in medical applications, where high sensitivity is critical."

Paterson used hCG, a pregnancy hormone, to develop the novel diagnostic technology, but he and Willson are focused mainly on detecting infectious diseases with their smartphone-based diagnostic platform. They are collaborating with Jakoah Brgoch, UH assistant professor of chemistry, to synthesize new nanophosphors with even better performance in the smartphone-based test.

Meanwhile, Paterson and Raja have formed a startup company, Luminostics, to commercialize the diagnostic technology and LFA reader.

"Earning awards from respected conferences helps establish our team's credibility – that we know what we're doing," Paterson said. "It can help with pitches to investors and could ultimately help us in getting this technology through the FDA-clearance process."

The nanophosphor research began with funding from the Western Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research (WRCE). A $50,000 National Science Foundation Innovation Corps (I-Corps) award in 2014 with Raja as entrepreneurial lead helped the team evaluate business aspects of the technology and the startup's first product, as well as partially fund the development of the smartphone reader platform. The Centers for Disease Control and Prevention Dengue Branch in Puerto Rico recently funded a pilot project for the UH team to develop a diagnostic test using the nanophosphors and smartphone platform for dengue fever, a mosquito-borne infectious disease. Additionally, Luminostics was recently awarded a $50,000 grant from Johns Hopkins University to develop a point-of-care test for chlamydia using the smartphone reader platform.



THREE DOCTORAL STUDENTS GIVE ORAL PRESENTATIONS AT GORDON RESEARCH CONFERENCES

By Natalie **Thayer**

From left: Matt Oleksiak, Katy Olafson and Manjesh Kumar

Cullen College of Engineering doctoral students **Manjesh Kumar, Matt Oleksiak** and **Katy Olafson** were invited to give oral presentations at two of the prestigious Gordon Research Conferences (GRC) last summer.

The conferences, founded in the late 1920s by Dr. Neil E. Gordon, promote discussions and the exchange of ideas by focusing on new, innovative research in the fields of biological, chemical and physical sciences.

Under the guidance of faculty adviser and Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering Jeffrey Rimer, Kumar, Oleksiak and Olafson presented their respective exploratory research on zeolites, which are crystals made up of aluminum, silicon and oxygen often used in the energy industry, and malaria pathophysiology.

Manjesh Kumar was invited to give an oral talk titled "Mechanism of SSZ-13 Crystallization and Methods to Tailor Material Properties" at the GRC on Nanoporous Materials and Their Applications in Holderness, New Hampshire. He was selected based on the strength of his poster and the overall quality of his research.

Kumar is a fifth-year Ph.D. student in chemical engineering. He was drawn to the Cullen College's doctoral program because he wanted to further investigate chemical engineering fundamentals. His project provides an interface between fundamental research of catalyst design and potential applications for industrial use.

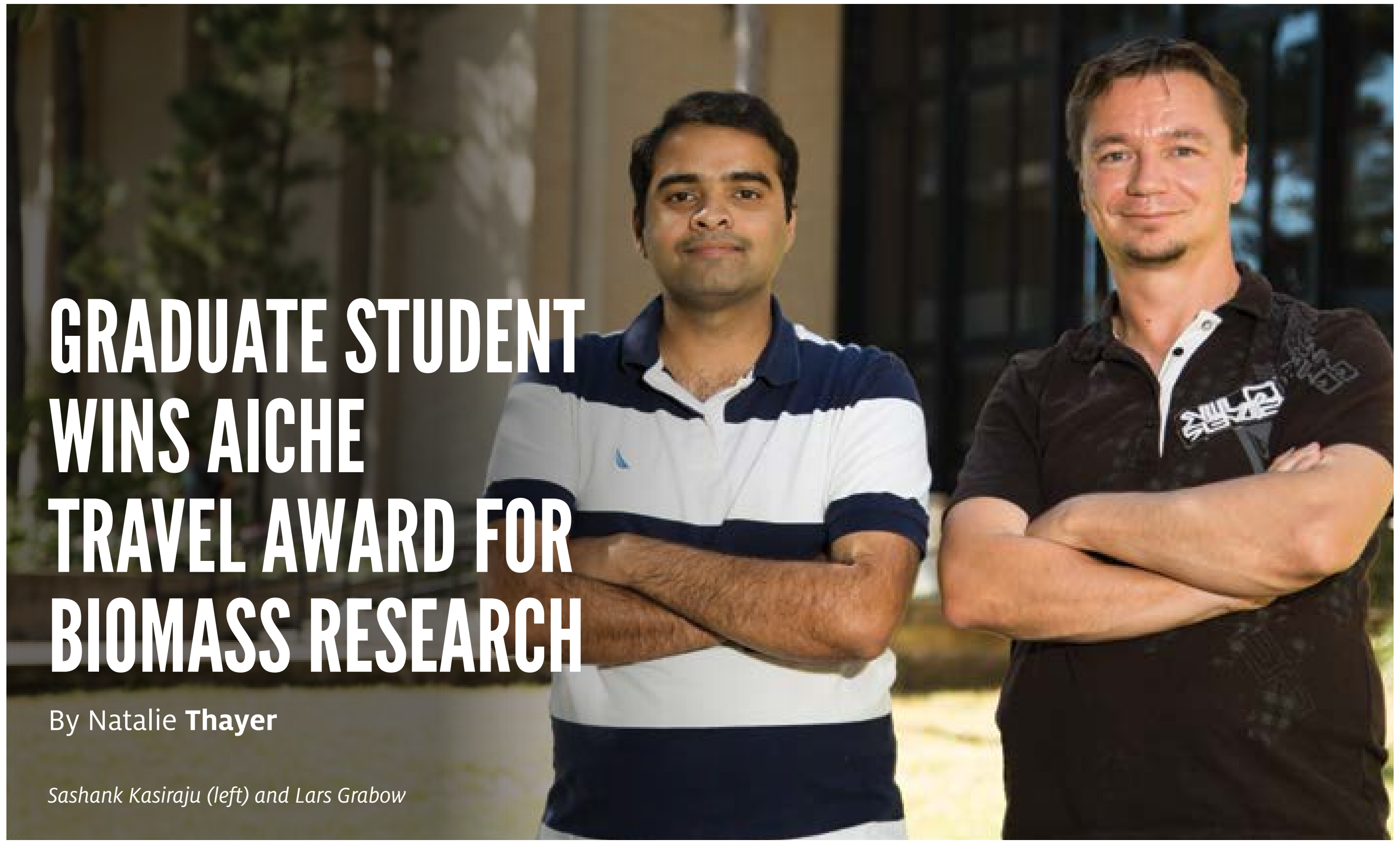
Kumar said that working with Rimer has helped him to both identify and focus on research projects. "Jeff is very open to ideas. Constant interactions help to generate new ideas for research and at the same time build on qualities like writing and presentation, and he helps you find the balance between work and life," he said.

Matt Oleksiak was also invited to give an oral presentation at the GRC on Nanoporous Materials in New Hampshire. Much like Kumar, Oleksiak was selected based on the strength and quality of his poster presentation. Oleksiak presented research on zeolite synthesis and its application in the energy industry. His research explored cost-conscious methods to create zeolites, map particular structures and tune the properties of the crystals.

Originally from New York, Oleksiak studied chemical engineering at the University of Delaware before moving to Texas to pursue his doctoral degree. He said Rimer has been an excellent mentor along the way because, "he is very open to discussion about ideas. We are able to have honest back-and-forth conversations because he values my insight."

Katy Olafson was invited to speak about her research on malaria pathophysiology from the aspect of hematin crystallization at the conference on Crystal Growth and Assembly in Biddeford, Maine. She studied how antimalarial drugs affect crystallization with the hopes of discovering new drugs to treat the disease. Rather than being invited to speak based on her poster presentation, Olafson submitted her abstract before the conference and was pre-selected through a new pre-screening process implemented only at select GRCs.

Olafson studied chemical engineering in her native state of Kentucky before moving to Houston to pursue her doctoral degree at UH – a decision that she said turned out to be ideal for her. "I really like combining [engineering] with science because, even if things repeatedly fail or don't initially work, you have the skill set to succeed eventually if you are tenacious – and that's the most rewarding feeling ever," she said.



GRADUATE STUDENT WINS AICHE TRAVEL AWARD FOR BIOMASS RESEARCH

By Natalie **Thayer**

Sashank Kasiraju (left) and Lars Grabow

Each year, the American Institute of Chemical Engineers (AIChE) presents travel awards to outstanding students from across the nation to present their research at the annual AIChE meeting. **Sashank Kasiraju**, a chemical and biomolecular engineering graduate student at the UH Cullen College of Engineering, was one of just 20 students to receive this honor from AIChE's Catalysis and Reaction Engineering (CRE) Division in 2015.

AIChE is the world's leading organization for chemical engineering professionals, boasting more than 45,000 members from over 100 countries. The organization is dedicated to promoting excellence in the chemical engineering profession through advancing education, career development and professional standards within the field.

Kasiraju's research focuses on hydrotreating bio-oil obtained from biomass to lower its oxygen content and convert it to renewable and sustainable biofuels. Hydrotreating refers to a process using high-pressure hydrogen gas to remove unwanted contaminants, such as oxygen, sulfur and nitrogen from fuel products.

The petroleum industry currently uses a method of hydrotreating that removes sulfur from fossil feedstock to produce clean diesel and gasoline. This hydrodesulfurization technology is well established and practiced daily in every refinery worldwide. Under the guidance of his faculty adviser Lars Grabow, Kasiraju is attempting to translate this existing knowledge to explore efficient catalysts for the related hydrodeoxygenation process of bio-oil. By building on existing industry technologies to improve the hydrotreating process, Grabow and Kasiraju hope to accelerate the discovery of hydrodeoxygenation catalysts and, ultimately, to contribute to the development of renewable biofuels.

Kasiraju has been fascinated by science for as long as he can remember.

"As a kid, I was always building gadgets and breaking things apart to put them back together afterwards," he said.

As a teenager, Kasiraju's father took him to visit the cement manufacturing plant where he worked. Kasiraju said that the moment he saw the advanced technology in the process control room and the high temperature coal-fired reactors in action, he was hooked on chemical engineering.

Before moving to Houston to attend the Cullen College, Kasiraju earned a bachelor's and master's degree in chemical engineering in India.

"Starting off [at the University of Houston] was a very interesting experience because everything in this country, even the way of teaching, is different," he said.

But Kasiraju said he learned to adapt and found that he enjoyed the unique challenges and opportunities that his academic career presented to him.

"I did research before, but it wasn't at this level," he said, adding that the opportunities for travel are a highlight of his experience at UH.

Kasiraju traveled to Salt Lake City, Utah to attend his first annual AIChE meeting last November. At the meeting, he gave an oral presentation on the results of his research and was officially recognized for his award at the formal CRE Division Dinner.

HARVARD-AMGEN SUMMER PROGRAM FOR BIOTECHNOLOGY ADMITS UH ENGINEERING UNDERGRAD

By Natalie **Thayer**

Last summer, **Rawan Almallahi**, a chemical and biomolecular engineering undergraduate student from the Cullen College, attended the 2016 Harvard-Amgen Scholars Program in Cambridge, Massachusetts.

The Harvard-Amgen Scholars Program is an immersive 10-week residential program for students pursuing research in biotechnology. Students admitted to the highly selective program are paired with world-renowned faculty mentors and postdoctoral scholars or graduate students who serve as supervisors in the laboratory. Students participating in the program also have the opportunity to attend the 2016 National Amgen Symposium at the University of California, Los Angeles.

Almallahi was chosen to attend the Harvard-based program from a pool of top-notch students from across the nation. She was selected due to demonstrated academic success, an interest in biotechnology research and a commitment to the pursuit of a scientific career.

Under the guidance of her faculty adviser Megan Robertson, Almallahi researches the biodegradation of epoxy resins, a class of reactive prepolymers and polymers. Epoxy resins have a wide range of applications, including electronics, coatings, automobiles, and renewable and non-renewable energy sources. In particular, epoxy resins play an integral role in wind turbines used to generate energy.

Despite the widespread use of epoxy resins in the renewable energy sector, they often contain harmful chemicals and are not biodegradable. Almallahi is investigating ways to incorporate vegetable oil into these polymers to reduce their harmful effects on both human health and the environment. She began this research in Robertson's lab last fall and received a Provost Undergraduate Research Scholarship (PURS) to continue the research in the spring of 2016.

Almallahi is also active on the UH campus outside the laboratory. She holds an officer position with the Cullen College's Engineering Honor Society, Tau Beta Pi, and is actively involved with the organization's STEM educational outreach efforts.

Almallahi worked on a project exploring graphene oxides for water treatment through the Harvard-Amgen Scholars Program. She said she was excited to be part of a new research community and learn about different aspects of the biotechnology field.

"I was really interested in meeting new people, new faculty members, and seeing what projects others [in this research area] are working on," she said.

HONORS COLLEGE AWARDS CHEMICAL ENGINEERING STUDENT FOR OUTSTANDING THESIS

By Natalie **Thayer**

Recent University of Houston graduate **Sheli Mauck's** passion for problem solving and all things STEM (science, technology, engineering and math) began as early as elementary school. As a child, she lived near a refinery and was fascinated by the inner workings of the nearby "metal city." As she approached college, this passion manifested in her pursuit of a bachelor's degree in chemical and biomolecular engineering from the UH Cullen College of Engineering. During her final semester, Mauck was awarded the 2015 Outstanding Senior Thesis Award by the UH Honors College.

Mauck's senior thesis, titled "Toughening Polylactide with Vegetable Oils," explored methods to strengthen polylactide, which is a commercially-manufactured, biodegradable and renewable polymer. Polylactide has the potential to be a valuable alternative material for common applications that have traditionally relied on other synthetic, petroleum-derived plastics, such as food packaging and water bottles. However, its current applications are limited because the material is relatively brittle and lacks durability. The goal of Mauck's thesis was to make a more durable, sustainable, biodegradable and renewable plastic by blending polylactide with vegetable oils and their derivatives.

The most exciting moment of discovery occurred during the final test of the novel polymer, Mauck said. As she ran the final blend through the testing process, she saw that the material actually exceeded her expectations in terms of strength and durability. Mauck said it felt like her entire year's worth of research led to that moment of success.

"I shouted, cheered and danced a little in my lab coat! It was a moment of such gratification," Mauck said.

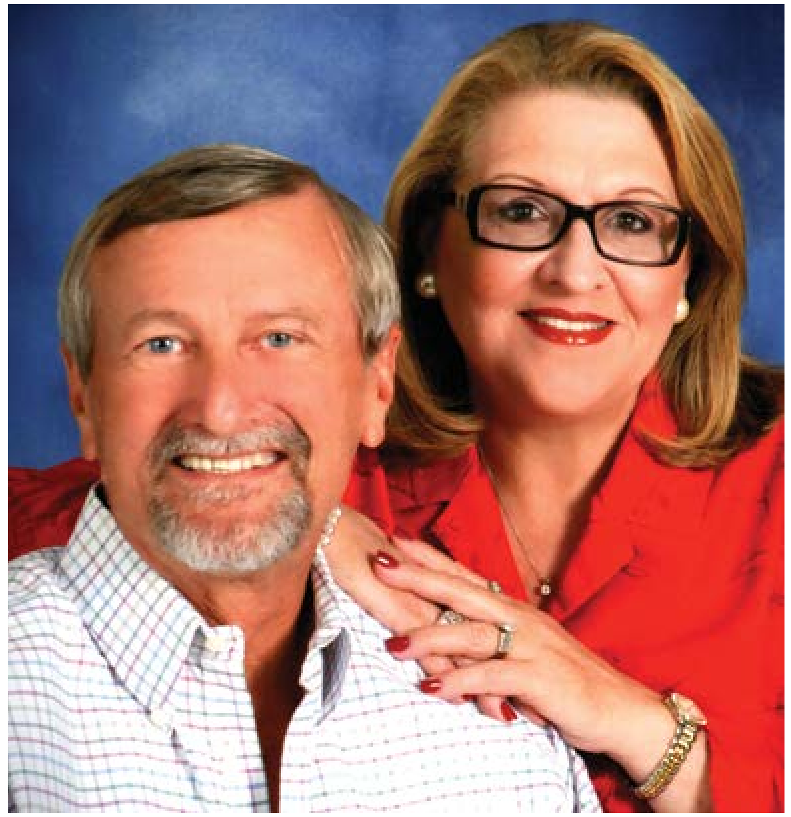
Mauck worked alongside her faculty adviser, assistant professor of chemical and biomolecular engineering Megan Robertson, to conduct this research. She credited Robertson and her other Cullen College professors for their guidance and support throughout her academic career.

"I wouldn't have made it without those who cared and gave me tough love when I needed it," she said.

As she prepares to enter the professional world to pursue a career in engineering, Mauck said she's happy that she can look back on this award and "remember what's important."

"This award represents my passion for engineering and it's an accomplishment I can take with me. It was the perfect conclusion to my undergraduate life," she said.

ALUMNUS ESTABLISHES $50K ENDOWED SCHOLARSHIP FOR UH CHEMICAL ENGINEERING STUDENTS



By Natalie **Thayer**

Chemical engineering alumnus **Mike Piwetz** and his wife **Mary Jo Piwetz** will establish a $50,000 endowed scholarship for chemical engineering students at the UH Cullen College of Engineering in 2017. This endowment follows a similar one established this year for the College of Technology's construction management program.

The Piwetz's ties to the University of Houston run deep. Mike's father, Florian W. Piwetz, graduated from the UH Cullen College of Engineering in 1950 with a bachelor's degree in industrial engineering. Florian married his wife, Effie, during his undergraduate education at UH, and was the first in his family to earn a college degree.

Mike and Mary Jo met at the University in 1969, when Mike was pursuing his undergraduate degree in chemical engineering from the Cullen College and Mary Jo was pursuing her undergraduate studies in special education. Three years later, the couple married on campus at the University Chapel.

Much like his father before him, Mike said that he and Mary Jo pursued their college courses with very limited funds, and were inspired to establish their endowed scholarship to help ease the financial burden of current UH Engineering students. The couple said they were moved to support the University to honor the family legacy at UH started by Florian.

"My engineering education led to a very satisfying career, and I want to help give other people that opportunity," Mike said.

Mary Jo added that the University has played a big part in their lives and contributed greatly to their success.

"We feel blessed to be able to contribute in this way," she said.

Upon graduation from the Cullen College, Mike began an extensive career with the global engineering construction company Fluor. He remained actively involved with UH throughout his career, playing a major role in the development of academic programs at both the Cullen College of Engineering and the College of Technology.

Over the years, Mike has served on the chemical engineering Industry Advisory Board (IAB) and the Engineering Leadership Board at the Cullen College, as well as on the IAB for the College of Technology. He also served as Fluor's executive sponsor to UH, responsible for the administration of grants to the University, and was the chairman of the committee responsible for raising over $10 million for UH's Sugar Land expansion.

Mike retired from Fluor in 2009 as the vice president of process engineering, but remains dedicated to the future of engineering and construction careers through education. He said he recognizes that many UH students face challenges pursuing their education, especially students who work full-time and attend classes simultaneously.

"It can be a struggle to work and go to college at the same time," he said. "We want to help ensure these students' success."

To be eligible for the Piwetz Family Engineering Scholarship, students must major in chemical engineering, have a minimum GPA of 3.25 and be enrolled full-time in either junior or senior level courses. Leadership qualities will also be considered for this scholarship.

Dean Tedesco (left) honors TIRR Foundation

Dean Tedesco (right) honors Crawfish Boil Committee

DEAN HONORS TWO ORGANIZATIONS WITH INDUCTION INTO THE BRIDGEBUILDER SOCIETY

By Natalie **Thayer**

At the 2015 Engineering Leadership Board (ELB) dinner last November, two organizations were honored with inductions into the UH Cullen College of Engineering Bridgebuilder Society.

Established in 2000, the Bridgebuilder Society recognizes and honors those who have made transformational gifts to the Cullen College of Engineering. Induction into the society is the highest honor the Cullen College bestows upon a donor.

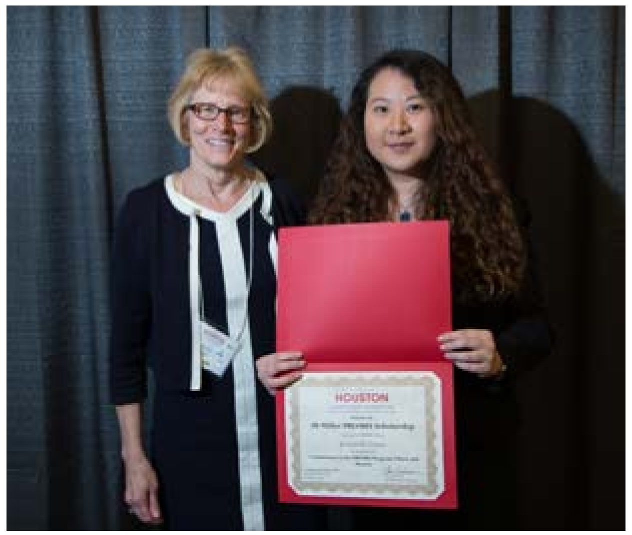
Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College, recognized **The Institute for Rehabilitation and Research Foundation**, also known as TIRR Foundation, and the **Offshore Industry Crawfish Boil Committee** for their significant financial contributions and commitment to the future of the college.

The TIRR Foundation is a nonprofit 501(c)(3) organization that seeks to improve the lives of people who have sustained central nervous system damage through injury or disease. The TIRR Foundation created, directs and funds Mission Connect, a collaborative neurotrauma research project. Mission Connect is focused on supporting the discovery of preventions, treatments and cures for central nervous system damage caused by brain injuries, spinal cord injuries and neurodegenerative diseases.

Led by executive director Cynthia Adkins, the TIRR Foundation has provided significant support to Jose Luis "Pepe" Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering, and his Non-Invasive Brain Machine Interface Systems Laboratory at the UH Cullen College.

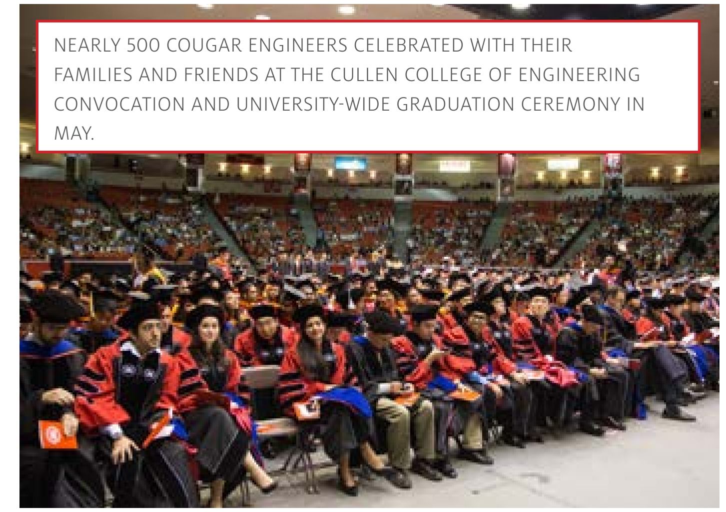
The Offshore Industry Crawfish Boil Committee has organized, managed and led efforts to host the annual offshore industry, pre-OTC crawfish boil for 27 years. The popular on-campus event draws several thousand individuals to the University each year, including industry partners, alumni and community members. The tireless efforts of the committee members have resulted in more than $1 million in financial support for programs and student scholarships in the Cullen College of Engineering.

2016 PROMES BANQUET

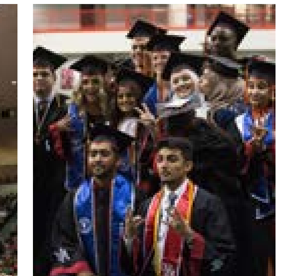



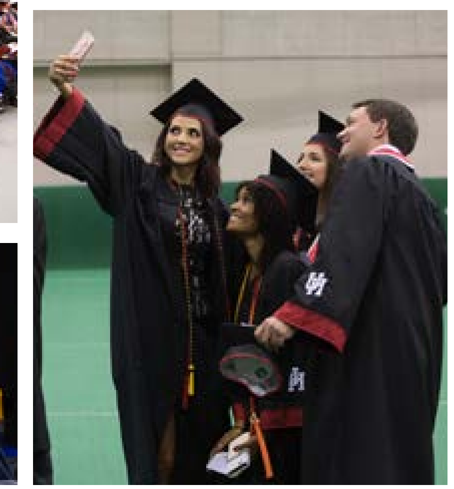
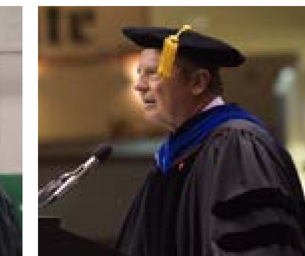

THE PROGRAM FOR MASTERY IN ENGINEERING STUDIES (PROMES) HELD ITS ANNUAL HONORS AND AWARDS BANQUET AT THE UH STUDENT CENTER BALLROOM IN APRIL.

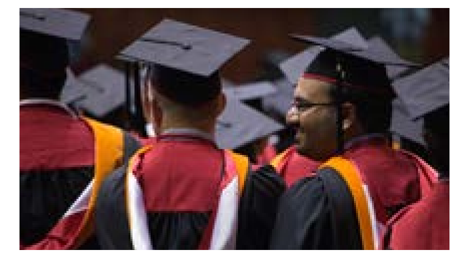
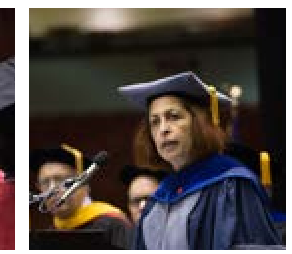

2016 CONVOCATION & COMMENCEMENT



NEARLY 500 COUGAR ENGINEERS CELEBRATED WITH THEIR FAMILIES AND FRIENDS AT THE CULLEN COLLEGE OF ENGINEERING CONVOCATION AND UNIVERSITY-WIDE GRADUATION CEREMONY IN MAY.

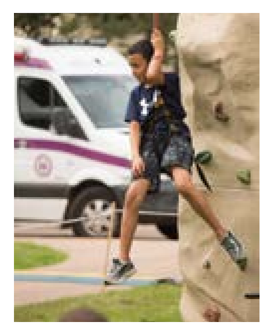


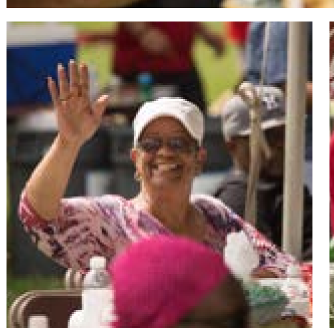



28TH ANNUAL OFFSHORE INDUSTRY CRAWFISH BOIL

STUDENTS, ALUMNI, FACULTY, STAFF AND FRIENDS OF THE CULLEN COLLEGE KICKED OFF THE OFFSHORE TECHNOLOGY CONFERENCE WEEK AT THE 28TH ANNUAL OFFSHORE INDUSTRY CRAWFISH BOIL IN MAY.

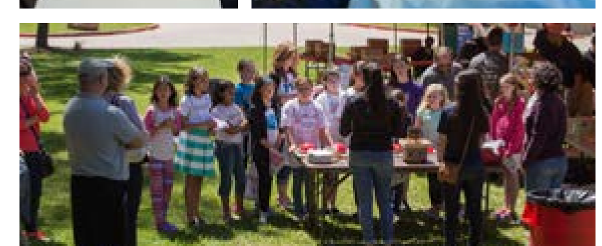



2016 "GIRLS ENGINEERING THE FUTURE!" DAY



THE INAUGURAL "GIRLS ENGINEERING THE FUTURE!" EVENT, SPONSORED BY CHEVRON AND HOSTED BY THE CULLEN COLLEGE LAST APRIL, INTRODUCED OVER 300 GIRLS IN GRADES 4TH THROUGH 8TH TO ENGINEERING PRINCIPLES THROUGH FUN, HANDS-ON ACTIVITIES ON CAMPUS.





UNIVERSITY of HOUSTON | CBE

UH Cullen College of Engineering
Department of Chemical & Biomolecular Engineering
Engineering Building 1
4726 Calhoun Road, Suite S222
Houston TX 77204-4004