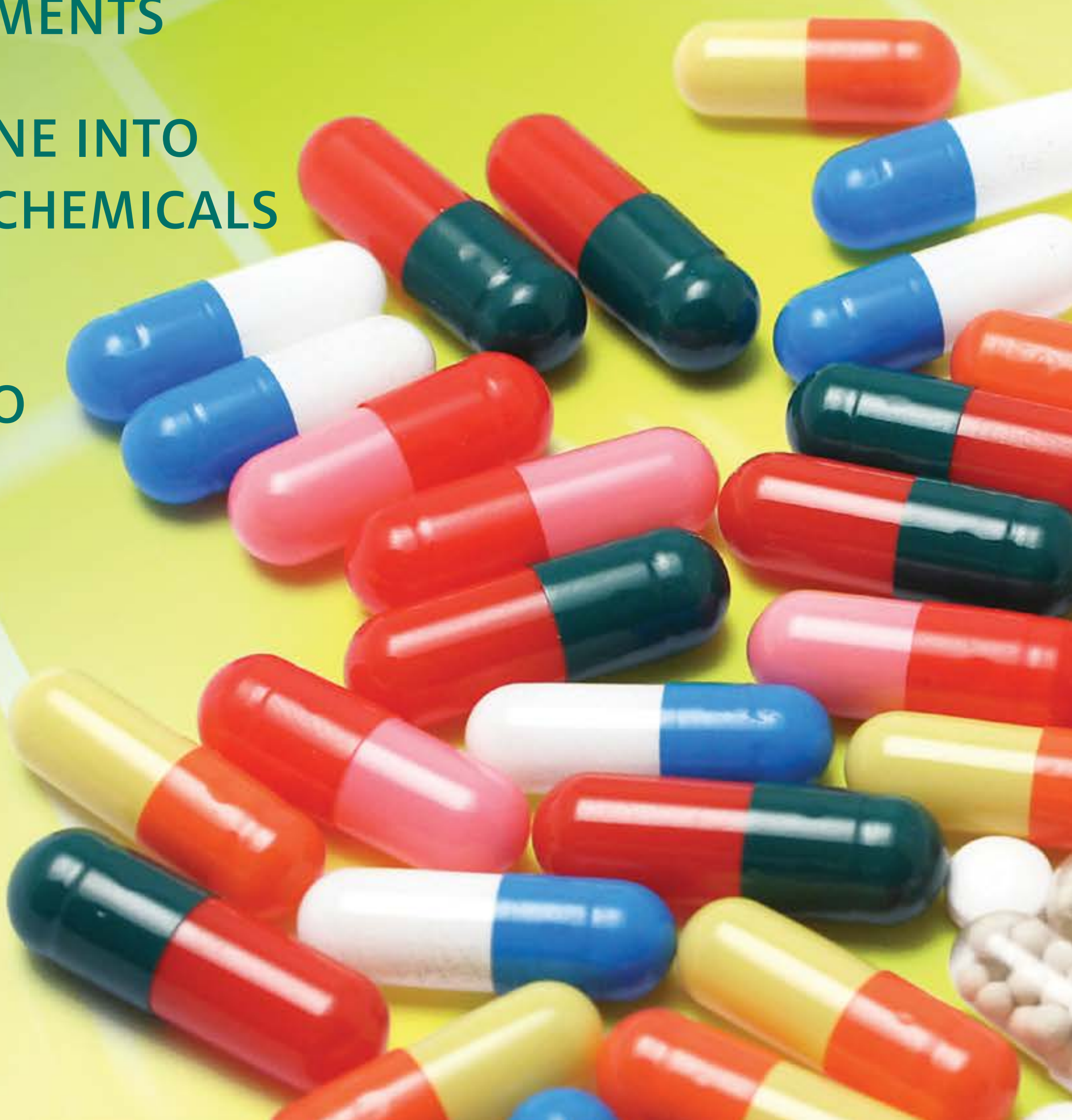
TRANSPORT

Cullen College Department
of Chemical & Biomolecular Engineering Magazine | Fall 2015

DISCOVERING NOVEL LEUKEMIA TREATMENTS

TURNING METHANE INTO MORE VALUABLE CHEMICALS

BRINGING NEW TECHNOLOGIES TO MARKET



COLLEGE ANNOUNCES PH.D. PROGRAM IN PETROLEUM ENGINEERING

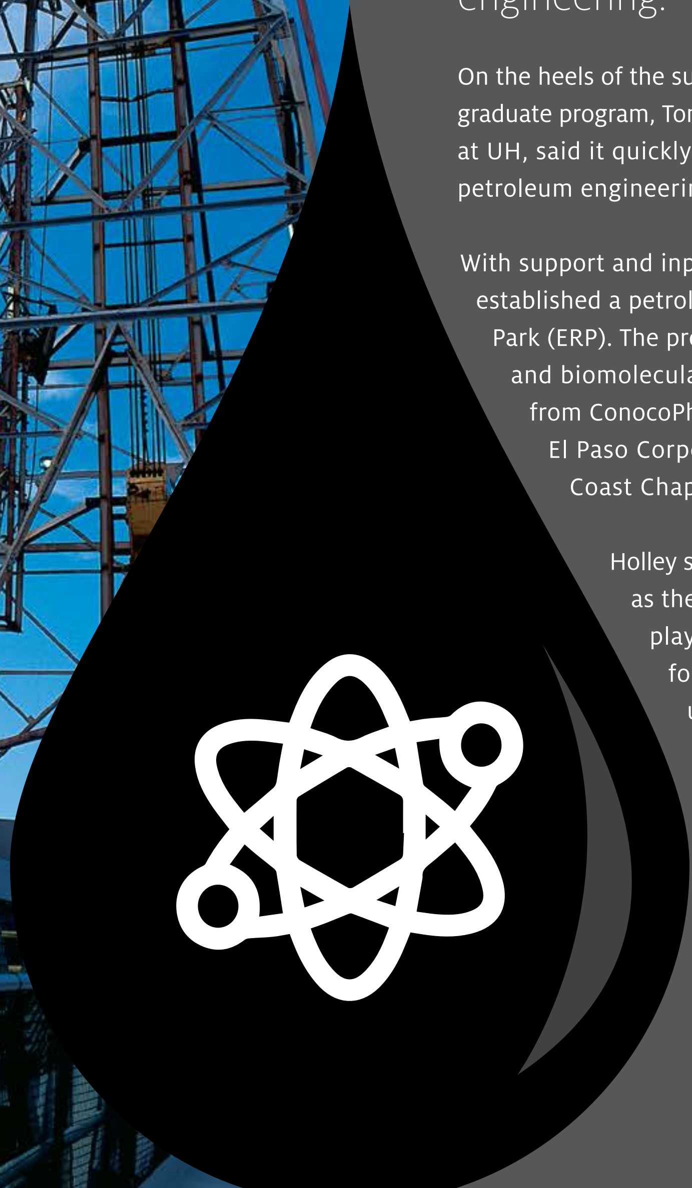
The UH Cullen College of Engineering continues its tradition of providing innovative and industry-relevant academic programs by officially announcing the approval of a new Ph.D. program in petroleum engineering.

On the heels of the success of the re-launched petroleum engineering undergraduate program, Tom Holley, director of the petroleum engineering program at UH, said it quickly became clear that "there was an essential need for a petroleum engineering doctoral program in the city of Houston."

With support and input from Houston's energy industry, the Cullen College established a petroleum engineering doctoral program at Energy Research Park (ERP). The program is administered by the Cullen College's chemical and biomolecular engineering department and has received support from ConocoPhillips, Devon Energy, Marathon Oil, Southwest Energy, El Paso Corporation, the Society of Professional Engineers Gulf Coast Chapter and major private donors.

Holley said that because of the program's location at ERP as well as the university's proximity to the energy industry's largest players, doctoral students will have unique opportunities for research and employment that students at any other university would not have. This was certainly the case for the revived bachelor's degree program in petroleum engineering, which was lauded by the Business-Higher Education Forum as a model partnership between industry and academia.

To learn more about the Ph.D. program in petroleum engineering, please visit: http://www.petro.uh.edu/graduate/degree-programs/phd.



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CHAIR'S MESSAGE

Dear Alumni and Friends of UH ChBE,

These are interesting and dynamic times for our department. I think that you will see that as you peruse the latest news in this issue of *Transport*.

A few years ago the National Research Council (NRC) ranking placed the UH ChBE department at 15th nationally out of over 100 departments. Recent indicators and accomplishments show continued growth and excellence in research and scholarship. The ChBE department now numbers about 20 full-time faculty and over 100 doctoral students, covering a diversity of research areas. As we wind down the 2014-2015 academic year, we will graduate about 20 Ph.D. students, an all-time high. 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 graduate students are doing top-tier research and are very active and visible at international conferences. Our undergraduates continue to have a very good reputation in the industry.

Faculty hiring is a critical activity as we position the department for the future. Last year, Jeremy Palmer joined the department as Assistant Professor, coming to us from Princeton where he worked as a postdoc with Professor Pablo Debenedetti. Jeremy's expertise is in molecular-scale simulations and theory with applications in adsorption, binding and transport. Jeremy joins a group of outstanding junior faculty members who are doing great things. Our hiring success has strengthened the traditional department core competency in reaction engineering and catalysis, as well as making significant gains in biomolecular engineering and materials science and engineering.

The petroleum engineering (PETR) program is a vibrant part of the ChBE department, under the capable leadership of Tom Holley. The program now has about 900 students! During the past year we hired two new faculty members: Christine Ehlig-Economides and Konstantinos Kostarelos. Ehlig-Economides returns to UH as the Miller Chair of Petroleum Engineering. She is a member of the National Academy of Engineering (NAE), and joins NAE colleagues John Lee and Dan Luss, both Professors in the ChBE department. Kostarelos (Associate Professor) comes to UH from the University of Cyprus. We expect to add several faculty members to the PETR program in the coming years to meet the incredible demand and to confront the many exciting challenges of the natural gas revolution in the United States.

For our alumni: If you are a member of Linkedin, you can join the UH Chemical Engineering alumni group (http://www.linkedin.com/groups?gid=1872800). This can enable you to connect with friends and colleagues from the past. And please consider supporting your alma mater.

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

Sincere regards,
Dr. Michael P. Harold
Chair of Chemical and Biomolecular Engineering;
M.D. Anderson Professor of
Chemical and Biomolecular Engineering
Cullen College of Engineering
University of Houston

BRAGGING POINTS

UH engineering students ranked **15th in the U.S. for salary earning potential** (Source: PayScale.com)

Listed as one of the world's top universities **for grads who go on to become CEOs** (Source: The Times Higher Education of London)

Ranked #4 in the nation for **"top colleges where students get the best bang for their buck"** (Source: PolicyMic, 2013)

ChBE BY THE NUMBERS

#15
BEST CHEMICAL AND BIOMOLECULAR ENGINEERING PROGRAM IN THE U.S.
(SOURCE: NATIONAL RESEARCH COUNCIL)

$67,814
AVERAGE STARTING SALARY FOR B.S. IN CHEMICAL ENGINEERING
(NATIONAL ASSOCIATION OF COLLEGES AND EMPLOYERS 2015 SALARY SURVEY)

22:1
UNIVERSITY-WIDE STUDENT TO FACULTY RATIO

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

CULLEN COLLEGE OF ENGINEERING BY THE NUMBERS

TOP 100
ENGINEERING SCHOOLS IN THE U.S.

$25.8M
IN RESEARCH EXPENDITURES

11 NATIONAL ACADEMY OF ENGINEERING FACULTY MEMBERS

UH SELECTED TO LEAD OFFSHORE ENERGY RESEARCH CENTER

The University of Houston will lead a national research center for subsea engineering and development of safe and sustainable offshore energy resources. The work will focus on reducing risks of offshore accidents, oil spills and other deepwater disasters in the Gulf of Mexico.

The Subsea Systems Institute is funded by the federal Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States (RESTORE) Act with penalties paid by British Petroleum (BP) for the devastation caused by the 2010 Deepwater Horizon oil spill.

Outgoing Texas Gov. Rick Perry earmarked $4 million already paid to Texas by BP for the UH-led center and another center led by Texas A&M University-Corpus Christi. Total funding is pending determination of penalties levied in civil court. UH President Renu Khator called the Subsea Systems Institute a "defining moment" in the University's growth in her annual address last fall.

"We are grateful for this grant, which is the culmination of years of work to establish the University of Houston as 'The Energy University' and a vibrant and comprehensive partner with the energy industry," Khator said. "We envision our Subsea Systems Institute as serving to ensure that technologies, policies, regulations and standards needed for safe and environmentally responsible operations in the energy industry are developed and shared."

The RESTORE Act requires that the five states along the Gulf Coast affected by the Deepwater Horizon oil spill create centers to conduct research. The Houston-area Congressional delegation offered strong bipartisan support for UH as the lead institution for the center focused on offshore energy.

UH will lead the collaboration with Rice University, the NASA Johnson Space Center, Texas Southern University, Houston Community College and Lone Star College to serve as a resource for industry and government regulators.

"A center focused on prevention is the right thing to do," said Ramanan Krishnamoorti, professor of chemical and biomolecular engineering and chief energy officer at UH. "A center in Houston is the right place to do it, and UH, Rice and NASA is the right team."

Krishnamoorti said Houston's thriving energy industry makes the University's location ideal for the institute, which is also expected to explore the continued push by energy companies to move into deeper waters.

Researchers will test and validate equipment to establish neutral, third-party knowledge, standard policies and best practices. The institute will develop new materials and oversee workforce training, especially at depths and temperatures previously unexplored.

"As the home of the nation's only subsea engineering program, the University of Houston is uniquely positioned to lead not just the United States but the world in developing educational programs to ensure future leaders are able to safely and efficiently discover and develop future sources of energy in the Gulf of Mexico and other deepwater regions," said Paula Myrick Short, vice president for academic affairs and provost at UH.

UH HOSTS ROBERT LANGER AT NEAL R. AMUNDSON LECTURE

From left: Mike Harold, Robert Langer

Robert Langer, the Koch Institute Professor at MIT, was the featured speaker at the annual Neal R. Amundson Lecture sponsored by the UH Cullen College of Engineering's Chemical and Biomolecular Engineering Department. The event was held at the UH Hilton last February.

Langer is a world-renowned expert in chemical engineering who is credited as the first person to engineer polymers to deliver large molecular weight drugs for the treatment of diseases such as cancer and mental illness. He was recently named the winner of the Queen Elizabeth Prize for Engineering. The organization cites his "revolutionary advances and leadership in engineering at the interface of chemistry and medicine," and the award credits Langer for improving over 2 billion lives worldwide because of disease treatments that were developed in his lab.

This year's Amundson Lecture attracted more than 150 audience members. Langer's talk focused on the trials and tribulations he encountered as a researcher as well as the inevitable roadblocks he had to overcome in order to successfully file for patents and gain F.D.A. approval for the treatments discovered inside his laboratory.

The Amundson Lectures are held annually in recognition of the late Neal R. Amundson, former Cullen Professor of Chemical and Biomolecular Engineering and Mathematics at UH. He is widely regarded as the most prominent chemical engineering educator in the United States. His pioneering research has impacted the areas of modeling and analysis of chemical reactors, separation systems, polymerization and coal combustion. He has had a profound, pioneering impact on the education of chemical engineers, changing the teaching of the field from a qualitative, descriptive approach to precise scientific methodologies. He has long been an intellectual leader of the Chemical Engineering community, and he chaired the NRC committee that wrote the report on "Frontiers in Chemical Engineering."

UH ENGINEERING MAJORS RANKED 15TH IN U.S. FOR EARNING POTENTIAL

The University of Houston's Cullen College of Engineering was ranked among the top 20 schools in the country for graduating students with the highest salary potential by PayScale.com.

The 2013-2014 PayScale Potential Salary Report features the rankings of colleges by salary potential for graduates with degrees in nine specific major groupings, including humanities, engineering, social sciences and computer sciences. The University of Houston was ranked 15th for salary potential of engineering graduates. Other top 20 schools included Columbia University (#13) and MIT (#11).

PayScale.com is an online salary, benefits and compensation information company that provides surveys to estimate compensation for professions based on education levels, academic institutions, job titles, experience, companies and location, among other factors.

According to the PayScale report, UH engineering graduates earn an average of $69,800 annually early in their careers and an average of $123,500 annually by their mid-careers.

Read the full report at www.payscale.com/college-salary-report/best-schools-by-majors/engineering.

RESEARCHERS RECEIVE BOOST FROM WELCH AWARDS

Three UH Cullen College assistant professors of chemical and biomolecular engineering received Welch Awards in Chemistry from the Welch Foundation for their contributions to fundamental chemical research that benefits humankind. Located in Houston, the foundation is one of the largest private funding sources for chemistry research in the country.

Jeffrey Rimer earned a three-year, $330,000 award to continue his search for more effective drugs to treat kidney stone disease. The foundation awarded **Jacinta Conrad** with a three-year, $195,000 grant to explore the structure and dynamics of attractive nanoparticle glasses. **Jeremy Palmer** also earned $195,000 to expand his postdoctoral research on unusual phase behaviors exhibited by water molecules during supercooling.

JEFFREY RIMER

Occasional and chronic kidney stones, which are crystal aggregates that form in the kidney, affect approximately 10 percent of the U.S. population. Each year, more than half a million people visit emergency rooms with the painful mineral and acid salt deposits.

Jeffrey Rimer earned his first Welch Award in 2012 to study mechanisms of naturally occurring biological growth inhibitors on kidney stones. The foundation renewed Rimer's award this year to explore small, organic molecules as potential drugs to treat the kidney disease. The award funds more than three full-time graduate students to help conduct the research.

"In the past 30 years there have been no advancements in therapies for kidney stone disease," Rimer said. "We started a program with our first Welch award to design peptides as potential drugs to mimic natural proteins that inhibit the growth of crystals implicated in stone disease."

The current treatment for kidney stones is an organic molecule called citrate, which is an over-the-counter supplement. Citrate acts as a mild inhibitor of the crystals but is incapable of significantly reducing stone incidence rates among patients with chronic disease.

"There is so much we still do not understand about this system at a molecular level," Rimer said. "The premise is that understanding the factors governing the specific recognition and interactions between drug molecules and crystal surfaces will help us design more effective crystal growth inhibitors."

Rimer has patented a promising new drug for the treatment of kidney stones that serves as the basis for the next phase of their research. He is collaborating with a nephrologist at Litholink Corporation to perform human trials and a chemical engineering professor at the University of Pittsburgh to perform computational simulations of drug-crystal interactions.

Rimer intends to leverage Welch funding for future phases of his research. For example, he and his collaborators are recruiting other researchers to conduct animal testing to determine drug efficacy in vivo, which he is looking to the National Institutes of Health (NIH) to fund.

"The focus of this Welch project is on kidney stone research, but understanding and controlling molecule-crystal interaction is a general theme that connects much of my work," Rimer said. "The foundation has been integral in supporting my research in crystal engineering, and helped launch new research projects in my group."

JACINTA CONRAD

Jacinta Conrad earned her Welch Award to explore one of the most puzzling fundamental problems in physical chemistry, the origins of the glass transition. Glasses lack long-range order and look structurally like liquids but behave mechanically like solids. In contrast, many solids are ordered crystals, in which the molecules or atoms are arranged in a regular lattice. Ordered crystals and disordered glasses can be composed of the same molecules, but their structures and how they form are very different. Despite years of research, the reasons for these differences are poorly understood among scientists.

"While we have a basic understanding of crystal formation, we don't understand what drives the formation of glass," Conrad said. "There is not one unifying theory that explains the phenomenon."

For certain applications, glasses have mechanical advantages over crystals because their disordered structures are void of weak spots associated with ordered crystal structures. Conrad's research group uses a novel colloidal model system to study the structure and dynamics of colloidal particles across the phase transition from dense liquid to glass. Their objective is to test existing theories for the glass transition, which will increase fundamental understanding and help engineers tailor mechanical properties of glasses for practical applications.

Ordinary phase transitions often involve abrupt structural changes between ordered and disordered states, such as disordered liquid water freezing to form ordered crystalline ice. By contrast, the molecules in a liquid remain disordered as the material solidifies into a glass. Likewise, there is no structural change when solid glasses melt into liquids.

In her lab, Conrad uses confocal microscopy to image colloidal particles suspended in liquids and tracks them over time with computer software. In these dense colloidal solutions, particles move when jostled or bumped by solvent molecules or by other particles, much like crowds determine motions of people pushing through them. With the microscope, researchers can observe hard, spherical particles colliding with other particles and bouncing away like billiard balls. As the number of particles increases, these dynamics become slower and slower, and the suspension behaves more and more like a solid.

Colloidal systems are popular for studying fundamental questions about phase transitions and flow behavior because they allow researchers to track every particle on the micron scale and ask detailed questions on both the structure and dynamics of every particle.

"We can watch every single colloid as it transitions from a disordered liquid to an ordered solid, such as crystal," Conrad said. "But none of the theories work for glasses."

Conrad hypothesizes that differences between the predictions of existing theories and the measurements on experimental glasses are caused by attractive interactions between the colloids, which she and her team will control in this study. In her model system, she can make the particles attractive, or sticky, by adding small polymers to her solutions. The polymers crowd the colloids, and this crowding pushes the colloids together to create an effective attraction. She plans to study the effects of these attractions in controlled settings to better reconcile the gaps between theories and experiments.

"This novel modeling system is convenient and simple, yet we can control the particle size, the distance between particles at which attractions occur and the strength of attraction," Conrad said. "We have a few knobs to tune with this system, which allows us to ask detailed questions about existing theories."

Over the course of this three-year grant, Conrad hopes to establish the usefulness of her novel colloidal modeling system for testing existing theories and to study the glass transition in thin films and small drops, which is relevant for applications in coatings and 3-D printing.

JEREMY PALMER

Jeremy Palmer earned his Welch Award to expand on his postdoctoral research on the phase behavior of liquid water at low temperatures that published in *Nature* last year.

"We're trying to fill a knowledge gap about the unusual behavior exhibited by some liquids when they're cooled near or below their normal freezing point," Palmer said.

Water's density anomaly is one well-known example of this unusual behavior. As liquid water cools at ambient pressure, its density increases, like most simple liquids. However, at 4 degrees Celsius, water does something strange – it starts to expand and to become less dense as it cools. Although liquid water normally freezes into ice at zero C, it can be stabilized in experiments to about 42 C below zero, at which point freezing occurs too rapidly for measurements on liquid water to be performed. Remarkably, experiments on liquid water performed slightly above this temperature reveal that it continues to defy normal liquid behavior and expand upon cooling. Many other peculiar behaviors, such as its increased compressibility upon cooling, are also observed in water at low temperatures.

Although water is the most studied substance in the world, the physical origin of its unusual behavior upon cooling continues to elude scientists. And it is not the only substance that behaves strangely – evidence suggests that liquid forms of silicon and possibly carbon exhibit similar trends.

"These are some of the most ubiquitous and important substances on Earth," Palmer said. "They shape almost every aspect of our natural world and life as we know it, and yet we still don't understand why they behave the way that they do."

With Welch Foundation support, Palmer and his research team will use state-of-the-art computer simulation techniques to study molecular models of these substances to better understand their odd behaviors. Their investigation will focus on examining one particularly intriguing and controversial hypothesis that suggests these substances behave like a mixture of two liquids.

According to this theory, at cold temperatures far below the freezing point (colder than 42 C below zero), two different liquids can exist and undergo a phase transition, in which one liquid converts into the other. Although this hypothesis is consistent with the majority of experimental measurements, at least for water, phase transition of co-existing liquids is also thought to occur at very low temperatures under different conditions where crystallization occurs rapidly. As a result, definitive evidence to experimentally falsify this hypothesis has not yet been obtained.

"One advantage of computer simulations is that we can directly study the behavior of model substances under conditions where two liquids may exist," Palmer said. "Although models can't resolve this controversy for any real material, they can provide us with understanding of the physical mechanism responsible for this behavior and help in interpreting the vast amount of experimental data already published on this topic."

While such behavior is in principle easier to study in model systems, the possibility of it occurring in models of water had been the subject of vigorous debate for more than two decades until recently. In their 2014 *Nature* paper, Palmer and collaborators resolved this long-standing controversy by using computer simulation to provide the first unambiguous evidence demonstrating that at least one water model separates into two liquids at sufficiently low temperatures.

"We know for sure that two liquid phases coexist in at least one water model, but we don't know whether or not this happens in models of other important substances such as silicon and carbon," Palmer said. "We aim to answer this over the next few years."

Palmer also plans to explore how and why this behavior occurs. Answering these interesting scientific questions would help to establish an understanding of the broader role that this phenomenon could play in nature's design – if it occurs in real substances.

PROFESSOR WINS NSF CAREER AWARD TO TRANSFORM METHANE INTO MORE VALUABLE CHEMICALS

Methane, which is the abundant and inexpensive majority component of natural gas, would make an ideal feedstock for the fabrication of more valuable chemicals. However, engineers have not found a way to break the chemical compound's strong carbon-hydrogen bond without burning the methane. Despite decades of research, they have not realized the potential for one of the most stable molecules known in chemistry.

"Methane is essentially spherical, like a ball with no point of attack, so it requires a lot of energy to break that C-H bond," said **Lars Grabow,** assistant professor of chemical and biomolecular engineering at the UH Cullen College of Engineering. "It's a very happy molecule."

Grabow earned a prestigious National Science Foundation (NSF) CAREER Award to explore a novel chemical looping process for methane coupling to transform natural gas into more valuable commodity chemicals such as ethylene. The award totals $500,000 distributed over five years.

The foundation awards 600 grants each year to support the development of academic careers that are dedicated to the stimulation of the discovery process through inspired teaching and enthusiastic learning, according to the NSF website.

Exothermic reactions between methane's hydrogen atoms and oxygen deliver the energy necessary to break the carbon–hydrogen bond at high temperatures, but they also form carbon dioxide, and the methane burns in the process.

"You can burn it, and that's all the technology currently allows us to do with natural gas," Grabow said. "That's great if you want to use methane to generate heat to drive turbines and make electricity in a natural gas-fired power plant, but that's not our objective."

Grabow's goal is to abstract hydrogen from methane to form new carbon-carbon bonds rather than to burn it. Engineers could use the resulting hydrocarbons, which would contain commodity chemicals like ethylene and ethane, to manufacture plastics, lubricants, cosmetics and pharmaceuticals.

"It can have a huge impact on the petrochemical industry," Grabow said. "We could also make propane or polypropylene, and those are other big commodity chemicals primarily derived from petroleum right now."

Grabow plans to isolate hydrogen with carbon in one reactor and hydrogen with oxygen in another, which physically separates the carbon from the oxygen to prevent them from forming the bond that produces carbon dioxide. The key to his strategy is a hydrogen storage material, which engineers have used in numerous applications including hydrogen-powered fuel cells for electric vehicles. Such reversible hydrogen storage requires weak hydrogen binding to allow release of the gas at later times, but many discovered compounds bind hydrogen too strongly.

Grabow's idea for hydrogen abstraction from methane requires strong hydrogen binding, which could revive prior failed material discoveries. As the C-H bonds break in the first reactor, the hydrogen storage material absorbs the hydrogen like a sponge. The saturated material is moved to the regeneration reactor where the hydrogen is removed, and the material is ready to repeat the process.

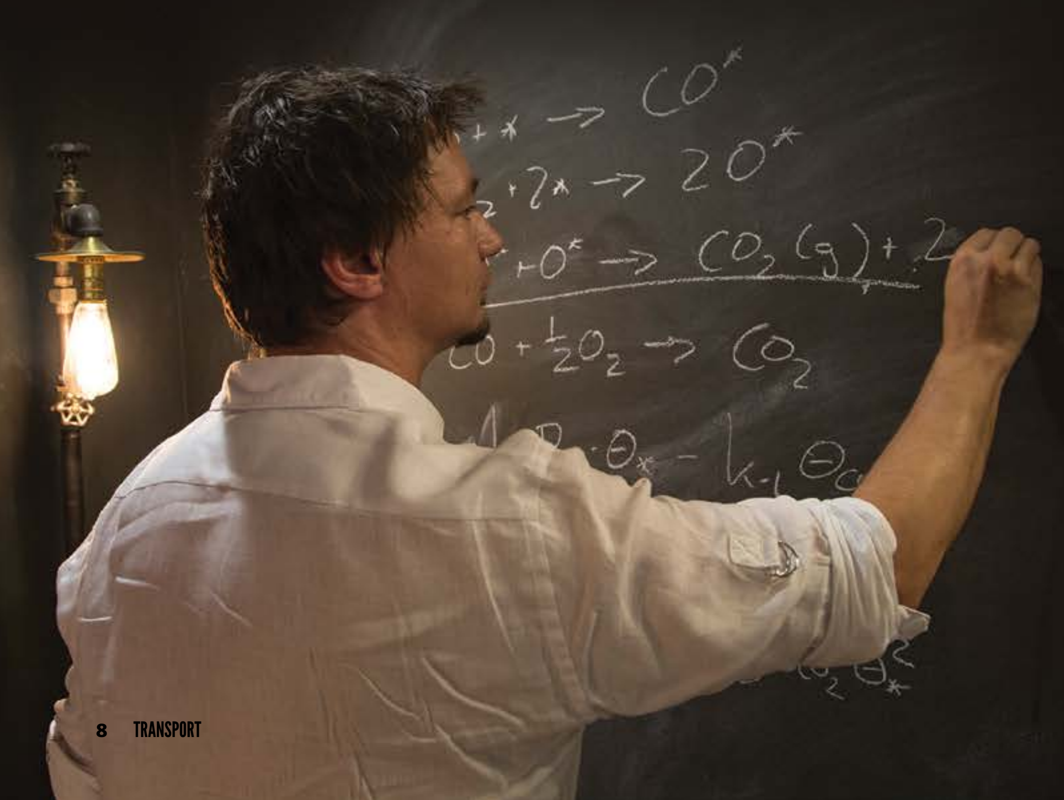
"The preliminary data we gathered from literature as well as the hydrogen storage material database provided by the Department of Energy points to the fact that this concept can be realized," Grabow said. "We just need to make sure that we design the right sponge, and we have several ideas about how to do this."

Bill Epling, UH associate professor of chemical and biomolecular engineering, is lending his laboratory and experimental expertise to the project. Together, he and Grabow are in the process of designing a laboratory-scale reactor setup and training a graduate student to help test their ideas.

The overall reaction, which is two methane molecules coupled with the help of oxygen to make ethane, is called oxidative coupling of methane. Kinetics, transport phenomena and thermodynamics make the process possible. Kinetics refers to the rate of the C-H bond activation. Mass transport is required for the diffusion of hydrogen atoms through the metal's outer layer to the center where the hydride phase forms. And thermodynamics provides the driving force for metal hydride formation and methane coupling.

The project's simple methane reaction performed on different materials is conducive to individual and group projects, so Grabow intends to introduce the research to students in his undergraduate and graduate classes as well as a high school summer student. Ideally, Grabow wants his students to publish a paper from the classroom setting.

"The cool thing is that kinetics, transport and thermodynamics are the core disciplines of chemical engineering, so this project combines the course material that we teach all of our UH students in a fairly simple system," Grabow said. "It provides an interesting framework for class projects that are relevant to our local oil and gas industry, and it allows me to bring my research interests to the classroom to enrich the students' overall learning experiences."



PROFESSOR AND POST-DOC PUBLISH PAPER ON NOVEL LEUKEMIA TREATMENT

Navin Varadarajan

Almost 19,000 new cases of acute myeloid leukemia and 10,500 deaths from the blood and bone marrow cancer could strike Americans this year, according to the American Cancer Society. Chemotherapy, when used as primary treatment, is successful in about 65 percent of patients with the cancer, and remission rates vary depending on patients' individual characteristics, according to the organization.

A few years ago, a second-line immunotherapy treatment approved by the Food and Drug Administration was withdrawn from the market after a decade of use because of safety concerns. Now, a team of chemical and biomolecular engineers at the University of Houston is exploring a different approach to immunotherapy treatment for acute myeloid leukemia.

Gabrielle Romain, post-doctoral research fellow in the UH Cullen College of Engineering, recently published a paper in the journal, *Blood*, which is a publication of the American Society of Hematology. Her research, conducted with principal investigator, **Navin Varadarajan**, assistant professor of chemical and biomolecular engineering at the Cullen College, is a preliminary study of an innovative immunotherapy that targets acute myeloid leukemia tumor cells with engineered monoclonal antibodies to improve the quality and quantity of killing by natural killer immune cells.

"The disease does not have enough treatment options, so there is a need for alternative therapies," Romain said. "So with a new mutation inserted in an existing antibody, we hope to revive interest in this strategy to treat leukemia."

The UH chemical engineering team is collaborating with the teams of Badri Roysam, chair of the Cullen College's electrical engineering department, George Georgiou, professor of chemical and biomedical engineering at the University of Texas at Austin, and Dean Lee, professor of biomedical engineering in the pediatrics division of UT M.D. Anderson Cancer Center. In addition to standard bulk testing, the University of Houston is contributing its single-cell assay to the project.

"It's a good collaboration merging the expertise of engineers and clinicians, and the result is that we can focus on immunotherapeutic treatment for leukemia," Romain said.

Prior to this study, Romain and her colleagues developed the single-cell assay, Timelapse Imaging Microscopy in Nanowell Grids, or TIMING, which is a soft, biocompatible polymer grid that creates 20,000 nanowells when placed atop a glass slide. Each nanowell, which is about the size of a speck of dust, captures approximately one to three cells, and the objective is to capture and observe the interaction between an immune cell and one or more tumor cells.

"With TIMING, we are not only imaging but also measuring characteristics of the immune cells," Romain said.

The researchers can quantify singular dynamics of natural killer cell-mediated killing of tumor cells with the single-cell assay. This innovative technology complements bulk testing, which is limited to observation of end results, such as total amounts of targeted tumor cells killed when engineered antibodies are mixed with tumor and immune cells.

The previous antibody, which the FDA eventually removed from the market, was bound to a toxin that targeted the acute myeloid leukemia cells. Romain and the other researchers used a slightly different strategy. They targeted the same antigen, but their antibody was engineered to improve recruitment and efficiency of immune cells rather than to deliver toxins to tumor cells.

Surfaces of different types of tumor cells express unique molecular patterns, and researchers work to identify the tumor-associated antigens so they can engineer particular antibodies to target them. In this study, the mutation involved interchanging three amino acids in the constant region of the antibody, which conferred an affinity for natural killer immune cells. Romain coated the CD33 tumor cells with the engineered antibodies during an incubation process before she loaded them with the immune cells onto the biocompatible grid of nanowells. The coating facilitated recognition of the tumor cells by natural killer immune cells.

"We observed under the microscope that the interactions between the immune and tumor cells were better with the help of engineered antibodies," Romain said. "The natural killer immune cells killed faster and increased their serial killing ability."

The addition of the engineered antibodies as intermediates allowed immune cells to triple the overall amplitude and to double the speed of their targeted killing in preliminary studies. The next step is to translate those results in animal models.

"Antibody immunotherapy is now an established treatment modality," Romain said. "And these engineered antibodies can reinvigorate interest in antibody immunotherapy for acute myeloid leukemia."

RESEARCHERS IDENTIFY GROUNDBREAKING TECHNIQUE FOR MALARIA DRUG DEVELOPMENT

Jeffrey Rimer

Peter Vekilov

More than three billion people – almost half of the world's population – are at risk of contracting malaria, which is spread by infected mosquitos. In 2013, an estimated 200 million malaria cases worldwide resulted in approximately 585,000 deaths of mostly African children under the age of 5, according to the World Health Organization.

Last month, the *Proceedings of the National Academy of Sciences of the United States of America*, a scientific journal established in 1914, published results of a groundbreaking malaria study conducted by professors and graduate students in the Cullen College of Engineering at the University of Houston.

Jeffrey Rimer, Ernest J. and Barbara M. Henley assistant professor of chemical and biomolecular engineering, and **Peter Vekilov,** professor of chemical and biomolecular engineering and chemistry, developed a technique that can help facilitate development of new antimalarial drugs. The UH engineers discovered the fundamental mechanisms for hematin crystal growth and drug-induced crystal inhibition in malarial parasites. Their research also yielded potential for accelerating high-throughput combinatorial drug screening, a shot-in-the-dark approach to drug development.

The project began three years ago with seed funding from the Alliance for NanoHealth at the Methodist Hospital Research Institute in the Texas Medical Center. Rimer and Vekilov enlisted the help of two graduate students, Katy Olafson and Megan Ketchum.

The malaria parasite, which is transmitted by mosquitoes, goes through several stages in its life cycle after it enters the human body. During the asexual stage, the parasite infects red blood cells and breaks down hemoglobin, releasing heme. Heme is then oxidized to toxic hematin, which crystallizes within the digestive vacuole, thereby removing the toxin from the parasite.

While the quinoline class of antimalarials has proven effective, fundamental knowledge of hematin crystallization and the mechanism by which antimalarial drugs potentially inhibit crystallization were not well understood until Rimer and Vekilov conducted their study. This lack of understanding among scientists was attributable to their inability to conduct in situ studies of crystal growth at the microscopic level.

Consequently, the first objective of the UH study was to develop a biomimetic platform for assessing hematin crystallization. Rimer, Vekilov and their students used time-resolved atomic force microscopy, AFM, to render three-dimensional topographical images of crystal surfaces at near-molecular resolution. They discovered a method of growing hematin crystals that is similar to those formed in vivo, and published their breakthrough last year in *Crystal Growth and Design*, a journal of the American Chemical Society.

This biomimetic growth solution enabled Rimer and Vekilov to conduct the first-ever in situ AFM study of hematin crystallization in the absence and presence of a common antimalarial drug, chloroquine.

Using AFM, the UH team observed that hematin grows by a classical pathway involving the generation and spreading of layers via the incorporation of hematin molecules. They identified four types of crystal surface sites for hematin to incorporate into the crystal. They also quantified the rate of layer generation and the velocity of layer advancement as a function of growth conditions, such as hematin concentration.

In situ AFM revealed that a two-micromolar concentration of chloroquine – an amount almost 100 times less than the solubility of hematin – suppresses the growth of layers on crystal surfaces. The drug concentration disproves a popular hypothesis that complexation, which involves the binding of an antimalarial drug molecule to free hematin in solution, is the primary mode by which the drug arrests hematin crystallization. While drug-hematin complexes do exist, this mode of action would require a significantly higher and toxic concentration of drugs to achieve the same effect they observed for crystal growth inhibition, Rimer said.

The research validates another hypothesis that antimalarial drugs bind to crystal surfaces and block the attachment of hematin. This leads to the accumulation of toxic hematin in the digestive vacuole that ultimately kills the parasite.

Elucidating the effects of molecules on hematin crystal growth could help pharmaceutical companies better streamline efforts to design and screen new antimalarial drugs. The UH team's findings could also potentially accelerate high throughput combinatorial drug screening, which is effective but time consuming. Researchers could prescreen the effects of numerous molecules on crystal growth to narrow the pool of potential drugs from thousands to hundreds before conducting more intensive parasite assays. Rimer and Vekilov have filed a provisional patent application for this technique.

NSF AWARD BOOSTS COMMERCIALIZATION OF SMARTPHONE-BASED RAPID DIAGNOSTIC TESTS

A professor and doctoral student in the chemical and biomolecular engineering department at the UH Cullen College of Engineering won the National Science Foundation's (NSF) Innovation Corps (I-Corps) award. The UH I-Corps team will use the $50,000 award to develop highly sensitive rapid medical diagnostic tests that use "glow-in-the-dark" nanoparticles to signal the presence of a disease target.

The NSF I-Corps program aims to prepare scientists and engineers to extend their focus beyond the laboratory and bring select, NSF-funded projects to the commercial market. Balakrishnan Raja, a chemical engineering Ph.D. student, is serving as the Entrepreneurial Lead on the I-Corps grant. **Richard Willson,** Huffington-Woestemeyer Professor of chemical and biomolecular engineering, is the grant's principal investigator. Raja and Willson have recruited Tim McGrath, who has over 20 years of experience as an executive in the biotech industry and has served as president or CEO of three life sciences companies, as the I-Corps business mentor.

Willson, an expert on improving medical diagnostic tools and technologies, has had several NSF-funded research projects that many of his graduate students participate in. Raja has been conducting research alongside Willson throughout his career as a Ph.D. student. During this time, Willson's lab group developed the core of the technology that won them the I-Corps award.

Their idea involves the use of nanophosphors, or light-emitting nanoparticles, to replace the traditional colored nanoparticles found in most rapid diagnostic tests, such as over-the-counter pregnancy tests or rapid HIV tests.

"One of the issues with colored nanoparticles is you have to look by eye, and sometimes the results can be very faint," Raja said. "This format of rapid diagnostic test is used for a variety of diseases right now, but it has several limitations."

Among the limitations of current diagnostic tests, Raja said, is their inability to detect low levels of diagnostic targets for several diseases or to provide quantitative information, such as the stage of disease.

Using phosphorescent nanoparticles and a light-based readout will allow for much more sensitive, quantitative and reliable test results. Moreover, Raja said an inexpensive smartphone attachment that is designed like a phone case could be manufactured, allowing the test results to be read with the phone's built-in camera and flash.

"A user would have to add the sample, such as a fingerprick quantity of blood, to a disposable test cartridge containing our nanoparticles, and then insert it into the smartphone attachment after 15 minutes. The flash from the camera will excite the luminescent particles, and the camera will capture the light emitted by them," Raja said.

The researchers will also develop a smartphone app to analyze the picture captured by the camera and provide an immediate, quantitative readout of the results.

While Willson and Raja are currently exploring many different disease targets for their rapid diagnostic test, one of their initial interests is developing a rapid test for chlamydia, the most commonly reported sexually transmitted disease in the U.S., according to the Centers for Disease Control and Prevention. If left untreated, chlamydia can lead to cervical cancer, infertility and many other complications.

Raja and Willson are also exploring rapid tests for dengue fever, flu and strep throat. Their vision, Raja said, is to one day sell a variety of these rapid diagnostic tests over-the-counter at very affordable prices.

The group's idea will be put to the test during the intensive 6-month I-Corps program, which requires them to attend entrepreneurship workshops, engage with future customers and competitors, and ultimately develop a fully-functioning prototype of their proposed diagnostic system.

And the timing of the rigorous entrepreneurial I-Corps training couldn't have been better for Raja and a small group of Willson's Ph.D. students; long before the opportunity to apply for the NSF I-Corps program arose, Raja said that he and two other students working in Willson's lab were planning to commercialize their glowing diagnostic tests. "The I-Corps award will be a huge boost to these efforts," he said.

Doctoral students Andrew Paterson (a co-inventor of the nanophosphor technology) and Gavin Garvey, along with Gabe Hodges, a physician specializing in internal medicine and pediatrics, have been working with Raja for over six months on their startup company, Luminostics. The company is dedicated to bringing these rapid diagnostic tests into hospitals and clinics as quickly as possible. Willson will continue to serve as an advisor to Luminostics even after Raja's academic career comes to a close.

"Dr. Willson has been very supportive of us in doing this. It's not typical of Ph.D. advisors to let their students pursue these commercial interests," Raja said. "I truly appreciate that. It's really cool."

From left: Vincent Tam, professor of pharmacy, and Mike Nikolau, professor of chemical and biomolecular engineering. Photo by John Shapley.

FIGHTING ANTIBIOTIC-RESISTANT BACTERIA WITH NIH GRANT

A professor in the UH Cullen College of Engineering and his collaborator in the College of Pharmacy remain players in the relentless cat-and-mouse game played between bacteria and antibiotics with a $519,000 grant from the National Institutes of Health.

Chemical and biomolecular engineering professor **Mike Nikolaou** and pharmacy professor Vincent Tam earned their initial $400,000 grant from the National Science Foundation (NSF) a few years ago. Their work to combat drug-resistant bacteria has produced a patented equation that universally assesses the effects of combinations of antibiotics on bacteria found in preliminary lab data. By the end of 2015, the researchers anticipate the development of the first working prototype of a methodology and associated software to improve the process of determining effective antibiotic cocktails for patients in clinical settings and to expedite the development and approval of new antibiotics.

"This is a race of humans developing antibiotics against nature's evolving bacteria ..."

"So this is a race of humans developing antibiotics against nature's evolving bacteria, and it's very difficult to win that race because bacteria evolve fairly rapidly," Nikolaou said.

The process of antibiotic development and approval is painstaking. From the moment a company discovers a molecule that kills bacteria to the time it determines a safe and effective dosing regimen for patients, the process can easily last a decade, Nikolaou said. Nikolaou and Tam's work can more efficiently analyze data to find dosing regimens at particular concentrations that are both effective against bacteria and safe for patients.

Different antibiotics kill the multitudes of bacterial varieties in many ways, but the common thread is that all antibiotics remove elements vital to the survival and proliferation of bacterial cells. Through trial and error, physicians determine the least toxic antibiotic concentrations that are still potent enough to cure serious clinical infections, such as cancer in patients with weakened immune systems. At microbiology labs in hospitals, they add progressively more potent antibiotic concentrations to bacteria-infected blood in test tubes. After a certain period of time, usually 24 hours, they examine the results. Blood that remains cloudy is still infected with bacteria, while blood that appears clear is free of the microorganisms. The lowest antibiotic concentration that clears the blood is given to patients.

The problem is that bacteria are increasingly resistant, so physicians test concentrations of antibiotics that are so high that they become toxic for patients, and they still do not kill the bacteria.

Bacteria develop mechanisms of resistance that counter the actions of the antibiotics. For example, the bacteria might develop efflux pumps that push antibiotics out of cells, or they might secrete substances that neutralize the antibiotics. In such cases, other substances are used to augment the same antibiotics to battle the countermeasures of bacteria.

"Single antibiotics are becoming less and less effective against bacteria, so very frequently you have to use combinations of antibiotics," Nikolaou said. "In recent years, we've been using more combinations of antibiotics so that we can have a combined effect that can make the antibiotics more potent and perhaps kill bacteria that would otherwise be resistant."

Numerous possibilities for interactions between antibiotics exist. An example of an interaction might involve one antibiotic opening pores in bacterial cell walls so another antibiotic might easily enter to do the killing, Nikolaou said.

Physicians are presented with the challenge of considering overwhelming varieties of antibiotic combinations, or cocktails, and their dosing regimens for patients. Time restrictions necessitate that they eyeball results and make best guesses about treatments based on their expertise and intuition.

"Unfortunately, no one has the time," Nikolaou said. "Doctors' and patients' time is extremely precious."

Nikolaou and Tam are working to optimize the process by reducing the amount of time and guesswork needed to assess the most effective drug combinations for killing bacteria.

"Our approach is empirical, so it relies on experimental data rather than detailed prior knowledge," Nikolaou said. "So you don't need to know the type of bacteria, the type of killing mechanism or the mechanism of resistance."

Nikolaou and his team of students composed their basic mathematical model based on Tam's observations of the effects of antibiotics and combinations of antibiotics on bacteria populations in blood over time. Through better use of collected data, their equations predict the course of bacteria populations in realistic situations reasonably well.

"The equations do not define logic, they augment logic and intuition more accurately," Nikolaou said.

The researchers plan to use existing image analysis technology to automatically record the effects of various antibiotic cocktails on bacteria in blood samples. A photometer modified for their purposes can feed the data to computer software, which the team is in the process of developing, that runs the patented mathematical model.

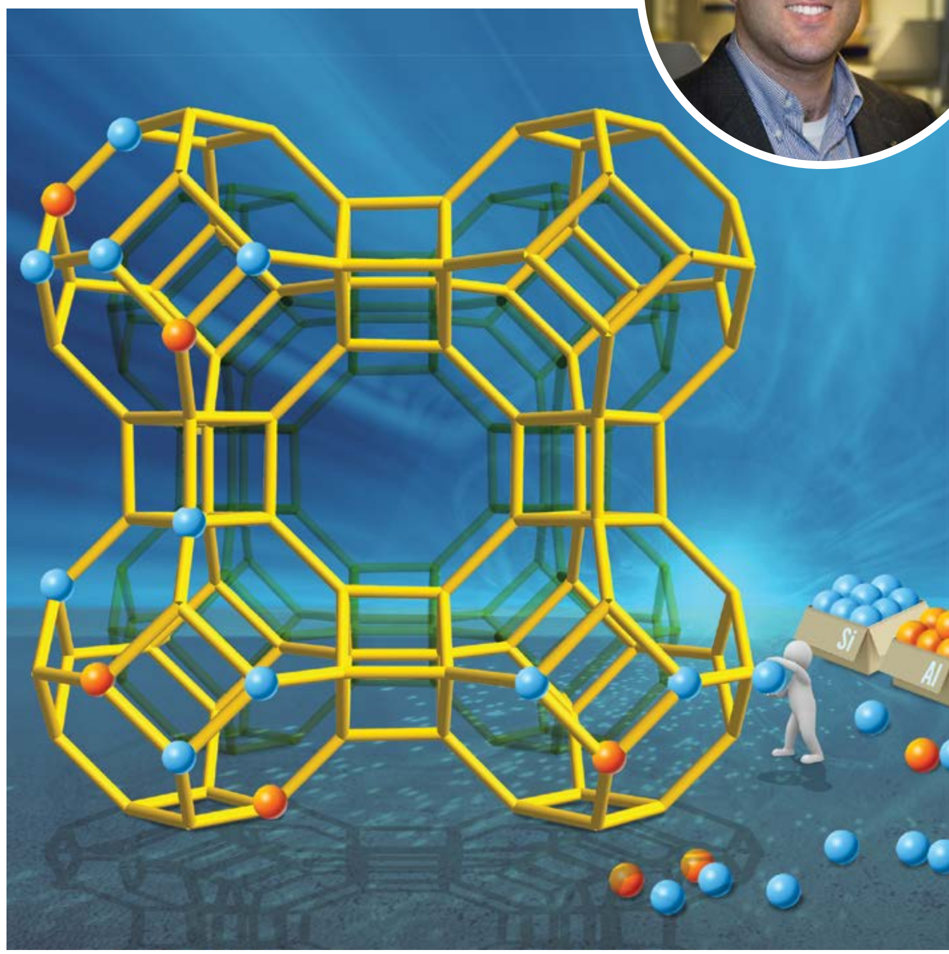
"The user will simply have to push the button, and the software will do the calculations that tell the doctor what antibiotic or combination of antibiotics to use at what concentration," Nikolaou said.

Automation provides opportunities to collect additional data that is more accurate at more frequent intervals. The photometer can record data every hour, for example, rather than once at the end of a 24-hour time period. Instead of plotting two points on a graph, the software can plot 24 or more points and create an entire curve that helps to more accurately extrapolate outcomes beyond 24 hours. Furthermore, photo analysis can provide more precise information such as the extent of the blood's cloudiness or clearness and the rate of decline of bacteria populations.

The software can also account for differences between patients and test tubes. Concentrations of antibiotics degrade over time in patients while they remain fixed in test tubes. In the field of antibiotics development, test tube research is often followed by tests conducted with elaborate systems that attempt to mimic the ways antibiotics work in the human body.

"So you're gaining efficiency ... plus you don't have to do a bunch of tests afterwards," Nikolaou said.

JOURNAL FEATURES IMPROVED METHOD FOR ZEOLITE SYNTHESIS ON COVER



A professor at the UH Cullen College of Engineering has discovered an improved method for synthesizing a zeolite structure that is more hydrothermally stable than its counterpart currently used in industrial processes.

Jeff Rimer, Ernest J. and Barbara M. Henley Assistant Professor of chemical and biomolecular engineering, published his findings in the journal, *Chemical Communications*. His article and corresponding artwork were featured as the cover story for the journal's January issue. Rimer conducted the research alongside his postdoc, Marlon Conato, and his graduate student, Matthew Oleksiak.

Zeolites are crystalline materials that are used as adsorbents and catalysts in a variety of chemical processes, spanning applications from gasoline production to additives for laundry detergent – not to mention thousands of other commercial and consumer products.

But despite the importance of these materials in many chemical and industrial processes, the ways in which these crystals are synthesized are not well understood. Rimer's primary research focus is finding better ways to rationally design zeolites in order to improve the materials' performance and reduce the costs and trial-and-error associated with their synthesis.

The typical synthesis of certain zeolite structures yields crystals made up of silicon and aluminum atoms in a one-to-one ratio. Such zeolites are particularly good adsorbents – for example, these crystals could be used to remove greenhouse gases, such as CO_2, from the atmosphere.

The zeolite structure being studied in Rimer's group, known as zeolite A (LTA type), performs very poorly as a catalyst due to its high aluminum content. In order to use this zeolite as a catalyst, researchers must improve its hydrothermal stability by increasing the silicon content in the crystal.

One way of doing this is by adding organic structure-directing agents to the growth solutions used to prepare the zeolites. However, these additives are generally expensive and the process of synthesizing zeolite structures by this route is economically infeasible, Rimer said.

Rimer's team, then, is investigating new methods of growing these zeolite structures without the use of these organic additives.

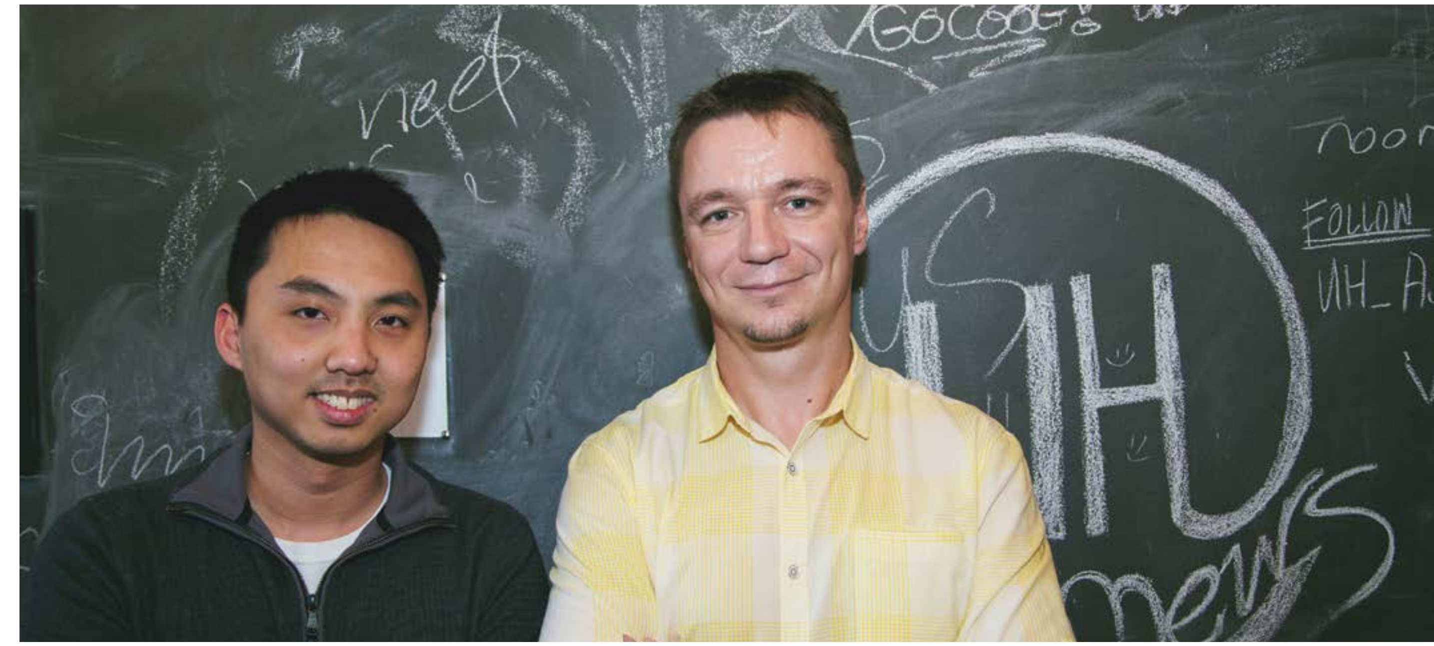
So far, Rimer's group has established a basic platform for conducting organic-free synthesis of many types of zeolite structures. These findings were published in the *Journal of the American Chemical Society* last year. While developing these models, Rimer said that his team noticed one particular "sweet spot" in their diagram where a zeolite structure with very commercially-appealing characteristics was formed.

This zeolite structure, named HOU-2, exhibits nearly twice as many silicon atoms as its more aluminous analogue zeolite A, making it a potentially far more effective catalyst. Moreover, Rimer's team found that this zeolite structure was very stable when synthesized under certain conditions and yielded twice as many crystals as zeolite A.

Rimer's group collaborated with Radha Motkuri, a researcher at the Pacific Northwest National Laboratory, to further investigate the gas absorption qualities of HOU-2. So far, the researchers have found that the zeolite works effectively at selectively separating CO_2 from other gases. Researchers at the Pacific Northwest National Laboratory are particularly interested in the zeolite's performance as an adsorbent for CO_2 sequestration.

"We have improved the stability of these materials in a way that's economically viable to industry and we're using standard conditions that are very similar to what industry uses when they manufacture zeolites," Rimer said. "This is something that could be integrated into current commercial processes very rapidly."

PROFESSOR AND STUDENT REVEAL SECRETS BEHIND GOLD'S UNEXPECTED OXIDATION



From left: Ph.D. student Hieu Doan and chemical and biomolecular engineering professor Lars Grabow

Perhaps one of the most desirable qualities of gold – especially to those wearing it as jewelry – is its ability to hold onto its bright, shining glow. Gold can resist rusting and tarnishing when exposed to air or water because it's inert, meaning it's one of the least reactive of all metals.

But gold has some unexpected properties, too. For instance, gold nanoparticles can be used as a catalyst to oxidize carbon monoxide (CO) into carbon dioxide (CO_2) – a puzzling quality for a metal that isn't supposed to be reactive.

For the past 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. Until now, no single model has completely explained what takes place during a reaction wherein gold is used to help transform CO into CO_2.

A professor and Ph.D. student at the UH Cullen College of Engineering have created the first-ever model to fully explain what happens during the catalytic oxidation of carbon monoxide. Assistant professor **Lars Grabow** conducted this research alongside doctoral student Hieu Doan. Their collaborators on this project were Bert Chandler, Johnny Saavedra and Christopher Pursell at Trinity University in San Antonio. Their findings were published last year in the journal *Science*.

The catalytic oxidation that transforms CO into CO_2 has always relied on one basic, elementary notion: carbon monoxide reacts with oxygen to form CO_2. However, Saavedra, Pursell and Chandler observed through their research that something else might be playing a hidden role in this reaction.

"So at that point, Hieu stepped in and said he wanted to explain why this happened and started doing some basic calculations," Grabow said. "It all started with that – just some basic calculations – then it led to this paper."

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, pinpointing exactly how gold is able to act as a catalyst.

"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.

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 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 and they just swim in that water layer like fish and they jump out to facilitate the reaction then they jump back into the water layer," Grabow said.

Although people have been experimenting with CO oxidation using gold catalysts for nearly 30 years and many researchers have reported that water can change the reaction kinetics quite drastically, Grabow noted that until now no research has ever reported the exact mechanism that his group identified in their *Science* article.

PROFESSOR CELEBRATES 30TH ANNIVERSARY AS MEMBER OF NATIONAL ACADEMY OF ENGINEERING

Dan Luss, Cullen Professor of Engineering, recently celebrated his 30th anniversary as a member of the prestigious National Academy of Engineering (NAE). Luss was named a member of the NAE in 1984.

The NAE is a private, independent, non-profit institution founded in 1964 with the mission of promoting the engineering profession in order to advance the well-being of the nation.

Membership in the NAE is one of the highest professional honors that an engineer can achieve. There are currently over 2,000 peer-elected members of the NAE, described by the NAE website as "professionals in business, academia and government who are among the world's most accomplished engineers."

Luss represents one of the 11 NAE members who currently serve as faculty in the University of Houston Cullen College of Engineering. According to the NAE website, these faculty members "have distinguished themselves in business and academic management, in technical positions, as university faculty, and as leaders in government and private engineering organizations."

Luss has spent more than four decades with the Cullen College, including more than 20 years as chairman of the chemical and biomolecular engineering department. He has published more than 300 journal articles. He was honored last year as a member of the inaugural class of charter fellows of the National Academy of Inventors.

His research contributions have been recognized by several American Institute of Chemical Engineers awards, including the Founders Award, the Wilhelm Award, the Professional Progress Award, the Allan P. Colburn Award and eight Best Paper Awards, as well as the Amundson Award from ISCRE and the ASEE Curtis McGraw Award and the Chemical Engineering Division lectureship Award.

Luss' research group develops policies that prevent chemical reactors from "runaways," or rapid, uncontrollable temperature excursions that may lead to explosions. His recent research is concerned with the reduction of particulate particles (soot) and nitrogen oxide emissions by diesel engines. The main thrust of his research has been to increase the efficiency of chemical processes. His studies of the large-scale synthesis of advanced ceramics, such as superconducting materials, led to a patent for production of high-temperature superconducting powders. Another patent was awarded for the development of a method of carbon combustion synthesis of oxides, which enables a more economic production of these products.

WILLSON NAMED TO NATIONAL ACADEMY OF INVENTORS

Richard Willson, Huffington-Woestemeyer Professor of chemical and biomolecular engineering, has been named a fellow of the National Academy of Inventors for his contributions to scientific and technological innovation.

Willson was among 170 people elected as National Academy of Inventors (NAI) Fellows, representing 114 universities and governmental and nonprofit research institutes. With the new fellows, membership in the NAI has grown to 414, including 21 Nobel Laureates. The new fellows were inducted last year during the annual conference of the National Academy of Inventors at the California Institute of Technology.

Those elected to the rank of NAI Fellow are inventors on U.S. patents, nominated by their peers for outstanding contributions to innovation in areas such as patents and licensing, innovative discovery and technology, significant impact on society and the support and enhancement of innovation.

Willson, who also has an appointment as a professor of biochemical and biophysical sciences in the UH College of Natural Sciences and Mathematics, studies nanotechnology and biomolecular technologies in medical diagnostics in an effort to recognize diseases at earlier stages, when treatments are more effective.

He has been issued 16 U.S. patents since joining the UH faculty with another 13 patents pending, according to the University. He said his total number of patents, including pending foreign patents, is about 80.

Willson's NAI recognition was based on his body of work. One innovation highlighted was his co-invention of the first technology for single-molecule DNA sequencing, which led to a UH spinoff company, VisiGen Biotechnologies, headed by Susan Hardin. Several other UH faculty members were also involved in the company, which was acquired by Life Technologies in 2008. Willson was chief technology officer.

In all, he has been involved with five startup companies, either directly or as an adviser.

While much of Willson's work has focused on biotech, he also is well known as the sole inventor of a catalyst testing process that allows for the rapid testing of multiple chemical reactions at once. Although that work was done in the 1990s, the technology continues to be used by most major chemical companies. The core patent has been referenced by 105 other U.S. patents and has led to at least 10 active U.S. patents and a large number of foreign counterparts.

Willson is a fellow of several other prestigious professional societies, including the American Association for the Advancement of Science, the American Chemical Society and the American Institute of Medical and Biological Engineering, but he said election to the National Academy of Inventors is a special honor, in part because both his father and his son are patent attorneys. The NAI also remains a fairly small group, he added.

"Some people in the academy are my personal heroes," he said.

Previously inducted fellows from the UH Cullen College of Engineering include: Benton Baugh, adjunct professor of mechanical engineering; Paul Chu, chief scientist of the Texas Center for Superconductivity at UH; Dan Luss, Cullen Professor of chemical and biomolecular engineering; Dmitri Litvinov, dean of the Graduate School and John and Rebecca Moores Professor of electrical and computer engineering; Zhifeng Ren, principal investigator at the Texas Center for Superconductivity; and Venkat Selvamanickam, M.D. Anderson Chair Professor of mechanical engineering and director of the Texas Center for Superconductivity's Applied Research Hub.

PETROLEUM ENGINEERING PROFESSOR WINS SPE INNOVATIVE TEACHING AWARD

Christine Ehlig-Economides, William C. Miller Endowed Chair Professor of petroleum engineering, was a winner of the 2014 Society of Petroleum Engineers (SPE) Faculty Innovative Teaching Award. The award recognizes petroleum engineering faculty members who have demonstrated innovative teaching techniques in order to encourage and equip others in academia to use similar teaching methods.

Ehlig-Economides began her second stint at the University of Houston Cullen College of Engineering after serving as a petroleum engineering professor at Texas A&M University for over a decade. Prior to that, she spent 20 years traveling the world as an engineer for Schlumberger. Ehlig-Economides said the decades of industry experience under her belt helped to prepare her for the next chapter of her career as a petroleum engineering educator.

The course that won Ehlig-Economides the SPE award was titled "Energy Resources, Their Utilization and Importance to Society," and was available as an elective course during her tenure at Texas A&M. The class was open to all students at the university – not just engineers or other STEM majors.

"Good citizens should understand energy," Ehlig-Economides said. "So that's how it got started."

The overarching goal of the class was to enable non-engineers to understand the basic fundamentals about energy resources, how they are produced, how to use them with minimal adverse impact to the environment, and their local and global importance to society, Ehlig-Economides said.

Content included in the course was strongly influenced by the university's proximity to the city of Houston, the energy capital of the world, she added.

"Look at the benefit to society," she said. "If we're teaching lawyers, teachers, doctors, and other future Aggies that are not necessarily engineers – individuals who may be making laws and influencing our communities – then we are providing a beneficial service to our city."

The course consisted of a standard lecture-driven class and a discussion-oriented recitation laboratory led by undergraduate peer instructors who had previously completed the course. This method of employing undergraduate students to help engage their peers in discussions proved to be particularly effective, Ehlig-Economides said.

"That is definitely something I want to carry over to my courses here at the University of Houston."

Another innovative and effective tool for engaging students in the learning process was implementing student-generated quizzes in the course, she said.

"If the students were thinking about a good question to ask while I was teaching, then that means they're actually engaged," she said. "This is a teaching method that I'm currently using in my classes at UH."

She also asked students to form a team on the first recitation day and come up with a preliminary plan for developing and marketing an energy-related product or service. The student teams were required to deliver elevator speeches to market their project ideas to experienced project managers.

"I felt really good when they did their projects at the end and presented them to their peers," Ehlig-Economides said. "When their peers started questioning them and they were answering their questions, it was clear they had knowledge and background on the topic and were standing their ground and defending what they've done using energy and engineering language – then I'm thinking, 'Yep, that's what I'm trying to accomplish.'" Ehlig-Economides also involved the students in the development of an electronic textbook about energy that was funded by the National Science Foundation (NSF), working with collaborators at Pennsylvania State University, Stanford University, the University of Massachusetts Lowell and the University of California at Long Beach.

Ehlig-Economides designed the iBook specifically for her innovative energy course.

The iBook, titled "LiveEnergy," was also inspired by the notion that high-level energy concepts aren't just for engineers or STEM workers. Rather, all citizens can benefit from understanding energy resources, their utilization and their impact on society. Moreover, by involving individuals from a variety of different disciplines and backgrounds in energy discussions, the entire energy community can benefit.

"Traditionally, very few engineering courses are offered to non-engineers, but this was an exception," Ehlig-Economides said. "This course was inspired by the conviction that sustainable energy solutions must involve all disciplines, not just engineering."

To access and learn more about "Live Energy," please visit: http://live-energy-project.com/.

FACULTY ACCOLADES

- **William Epling** was promoted to full Professor, effective Fall 2015
- **Jeffrey Rimer** was promoted to Associate Professor with tenure, effective Fall 2015
- **Gila Stein** was promoted to Associate Professor with tenure, effective Fall 2015
- **Jeffrey Rimer** received a UH Teaching Excellence Award
- **Jacinta Conrad** received a UH Advance 2015 Women and Gender Resource Center (WGRC) Distinguished Faculty Scholar Award in the pre-tenure faculty category
- **Ray Flumerfelt** retired as a full-time faculty member to become an Emeritus Professor

STUDENTS, FACULTY TEAM UP TO BRING NEW TECHNOLOGIES TO MARKET

As an undergraduate, **Christopher Holly** and his teammates have more experience writing papers and waiting tables than wooing investors, but they caught on quickly.

They won $15,000 at the Baylor New Venture Competition last spring, the result of being willing to adapt, pulling an all-nighter as they rewrote their pitch to address early questions. The prize money paid to incorporate their fledgling business, Zeolytic Technologies Inc., with money left over.

The energy startup offers a zeolite created by **Jeffrey Rimer**, Ernest J. and Barbara M. Henley Assistant Professor of chemical and biomolecular engineering, which can maximize catalyst performance as refiners turn crude oil into transportation fuels.

Holly and his partners, **Jared Beale**, **Nick Brannon** and **Torri Olanski**, are part of an innovative program at the University of Houston's Wolff Center for Entrepreneurship, pairing business students with University researchers. The students develop plans to turn a faculty-created technology into a viable business.

The program, a partnership between the Wolff Center and the UH Division of Research, serves several purposes: Instead of textbook case studies, students work with real technologies, devising business plans and competing for start-up funding. Faculty inventors receive help commercializing their research.

"The (Wolff Center) program at UH provides an excellent opportunity to transform ideas and inventions developed in the laboratory into commercial technologies," Rimer said. "This cannot be accomplished unless you have a team of highly motivated and innovative students pushing their business plan forward, which we do."

There are six major business plan competitions – the Zeolytic Technologies team went to California for Chapman University's California Dreamin' competition in late April – and their popularity is growing.

"They're catching fire as startups see them as a source of funding," says Ken Jones, director of undergraduate programs at the Wolff Center, part of the Bauer College of Business.

Most of the competitors are graduate students, but UH sends undergraduates, Jones said. This is the third year UH has paired students with researchers; students launched a business, REEcycle, after last year's competition tour, during which they won more than $100,000 and the three top awards at the National Clean Energy Business Plan Competition, sponsored by the U.S. Department of Energy.

REEcycle now operates out of the new Innovation Center incubation space at UH's Energy Research Park, using a method developed by Allan Jacobson, Robert A. Welch Chair of Science and director of the Texas Center for Superconductivity at UH, to recycle rare earth elements critical for powering cell phones, wind turbines and other clean energy technologies.

REEcycle CEO Casey McNeil was named to Forbes magazine's "30 under 30" list of movers in the energy world, and he and his teammates competed again in business plan competitions last spring.

Jacobson also created the technologies used by two additional Wolff Center teams – Carla and Purus – competing this spring: Carla is pitching a process to reclaim lanthanum, another rare earth element, from used catalysts, and Purus is working with Jacobson's technology to remove hydrogen sulfide and carbon dioxide from natural gas and biogas streams.

Jones said all entrepreneurship students are placed in teams and paired with a technology developed by a UH faculty member, although not all the teams go on to compete. Sometimes, for example, students determine that commercial prospects for a technology aren't good, or that it needs more work.

The real entrepreneurship work begins once they determine the commercial potential. "Whether it's zeolites or whatever, technology is pointless unless someone is willing to pay for it," Jones said.

Holly, who will graduate in May, said he and his teammates are convinced Rimer's zeolite technology can go the course.

The technology provides a means of selectively tailoring the properties of zeolite materials to improve their performance in applications such as catalysis. "Its key advantages are its versatility – it can be applied to any zeolite structure – and its ability to tune catalyst properties in a way that cannot be matched by conventional zeolite synthesis," Rimer said, noting that it already has drawn attention from petroleum and petrochemical companies that use zeolites as commercial catalysts.

Holly said the students have formed a corporation and will work out of the Energy Research Park's Innovation Center.

PH.D. STUDENT WINS POSTER AWARD AT GRAVITATIONAL AND SPACE RESEARCH MEETING

A chemical and biomolecular engineering Ph.D. student was awarded best poster at the 2014 annual meeting of the American Society for Gravitational and Space Research in Pasadena, Calif.

Maria Vorontsova's poster was titled "Coulomb-independent aggregation in protein solutions." Her poster demonstrated that the electrostatics are not the principal force in clustering mechanisms and that to control cluster populations, the water structuring and hydrophobic interactions need to be tuned.

"Presenting at the annual meeting was a great opportunity for me to meet professors and students from diverse research areas and share our experience towards solving major scientific questions," Vorontsova said.

Vorontsova is a member of Peter Vekilov's research group. Vekilov, a professor of chemical and biomolecular engineering, researches the nucleation precursors of protein crystals, protein-rich liquid clusters.

CHEMICAL ENGINEERING STUDENT WINS OVERSEAS POSTER CONTEST

One of the Cullen College of Engineering's chemical and biomolecular engineering students took the college's tradition of excellence overseas last summer, winning the Best Poster Award at the International Summer School in Denmark.

Graduate student **Sashank Kasiraju's** poster was entitled "Hydrodeoxygenation of furan vs. hydrodesulfurization of thiophene: A first principles investigation."

According to Lars Grabow, professor of chemical and biomolecular engineering and Kasiraju's advisor, the summer school is attended by students and postdoctoral researchers from "the best theoretical groups in the world," and the award is quite prestigious, particularly for early graduate students.

STUDENT'S POSTER RECEIVES HONORS AT GORDON RESEARCH CONFERENCE

Last year, a professor and student in the Cullen College's chemical engineering department published an article in the journal *Science* that revealed the secrets behind gold's unexpected oxidation activity.

Hieu Doan, the chemical engineering Ph.D. student who was a co-author on the *Science* paper, recently gave an oral presentation about this research at the prestigious Gordon Research Conference (GRC). Out of the over 100 research posters accepted into the conference, Doan's poster was one of only five that was selected by the GRC organizers to be presented to the conference attendees.

"I felt very honored that my poster was chosen and I was able to present our research at the conference," said Doan.

The Gordon Research Conferences take place every two years, bringing together scientists from around the world to exchange ideas and present research on the biological, chemical and physical sciences. This year's conference on the topic of "Chemical Reactions at Surfaces" was held in Ventura, Calif.

"The Gordon Research Conference is a bit more selective than many other research conferences, in that you must submit your research and an application to be considered to attend the conference," said Lars Grabow, assistant professor of chemical engineering at the Cullen College. Grabow is Doan's faculty advisor and was a co-author on the *Science* article on which Doan's award-winning GRC poster was based.

"I was so proud to see his poster get chosen for this honor and to witness Hieu do such an excellent job at explaining the research to an expert audience," Grabow added. "Hieu's poster even beat the one that I entered into the conference!"

Doan's poster outlined research he conducted alongside Grabow, which was focused on determining why gold, one of the least reactive of all metals, performs so well as a catalyst when oxidizing carbon monoxide (CO) into carbon dioxide (CO_2). The collaborators on this project were Bert Chandler, Johnny Saavedra, and Christopher Pursell at Trinity University in San Antonio.

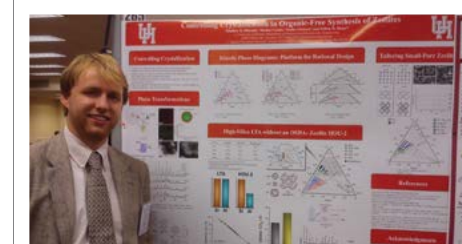
Together, the team discovered that the reason for gold's unexpected oxidation is water.

Although people have been experimenting with CO oxidation using gold catalysts for nearly 30 years and many researchers have reported that water can change the reaction kinetics quite drastically, Grabow noted that until now no research has ever reported the exact mechanism that his group identified in their *Science* article.

"I did notice that several other researchers at the GRC were presenting work on the role of water in other chemical reactions, so it seems that our research has laid out the groundwork for other groups to build upon," Grabow said.

Doan is currently in his final year as a chemical engineering doctoral student at the University of Houston. After graduation, Doan plans on pursuing a career in the oil and gas industry. "I think I will miss doing research with Dr. Grabow," Doan said. "But I am looking forward to my future experience in the industry."

AICHE AWARDS BEST POSTER TO CHEMICAL ENGINEERING PH.D.



Matt Oleksiak is a talented Ph.D. student in the Cullen College of Engineering's chemical engineering department, performing highly technical research on zeolite catalysis. But he has another skill that's gaining attention: explaining his research through posters.

Oleksiak recently received the best poster award at the American Institute of Chemical Engineers (AIChE) Meeting in the category of Catalysis and Reaction Engineering. His poster was entitled "Synthesis of Zeolite Catalysts in the Absence of Organic Structure Directing Agents."

"It was exciting to have the opportunity to present my work to experts on what I do and being chosen to receive the poster award was exhilarating," he said.

"I was exposed to many intellectually stimulating concepts and was able to exchange ideas with some of the brightest minds in our field," he added.

More impressive, it's not Oleksiak's first poster award. Just last year, he received top honors at the Southwest Catalysis Society's meeting for his poster, "Controlling Crystal Polymorphism in Organice-Free Synthesis of Zeolites."

FOUR GRADUATE STUDENTS WIN KOKES TRAVEL AWARDS

4 graduate students from the Department of Chemical and Biomolecular Engineering at the UH Cullen College of Engineering received prestigious Kokes Awards to attend the 24th North American Catalysis Society (NACS) meeting held in Pittsburgh, Penn. last June.

The winning students were Hieu Doan, Manjesh Kumar, Yang Zheng and MengMeng Li. Out of 200 student abstracts submitted, only 110 received Kokes Awards.

The Kokes Travel Award program of NACS aims to encourage undergraduate and graduate students to attend and participate in the biennial NACS conference. This award allowed Doan, Kumar, Zheng and Li to travel to the conference free of charge and covered the costs of their student conference registration fee and hotel accommodations, as well as providing a travel allowance.

The North American Meeting (NAM) of the Catalysis Society is widely recognized as the premier research conference for heterogeneous catalysis, homogeneous catalysis, electro-catalysis and photo-catalysis. Held every other year, NAM draws crowds of more than 1,100 attendees and features plenary lectures, keynote addresses by leaders in the catalysis field, awards and hundreds of oral and poster presentations.

Hieu Doan

Doan, who is advised by chemical engineering professor Lars Grabow, was a co-author on a paper published in the journal *Science* that revealed the secrets behind gold's unexpected oxidation activity. In addition to the prestige of publishing this research in a major journal, Doan was one of only five researchers selected to present his poster as Hot Topic Talk at the Gordon Research Conference held in Ventura, Calif.

Doan's research poster on gold's oxidation activity was also presented at the NAM24. "I'm very excited," Doan said. "It's an honor to be chosen for this award and I'm really enjoyed meeting with some of my peers and collaborators as well."

Doan's poster outlined his research determining why gold, one of the least reactive of all metals, performs so well as a catalyst when oxidizing carbon monoxide (CO) into carbon dioxide (CO_2). The collaborators on this project were Bert Chandler, Johnny Saavedra, and Christopher Pursell at Trinity University in San Antonio.

Together, the team discovered that the reason for gold's unexpected oxidation is water.

Doan is currently in his final year as a doctoral student at the University of Houston. After graduation, Doan plans on pursuing a career in the oil and gas industry.

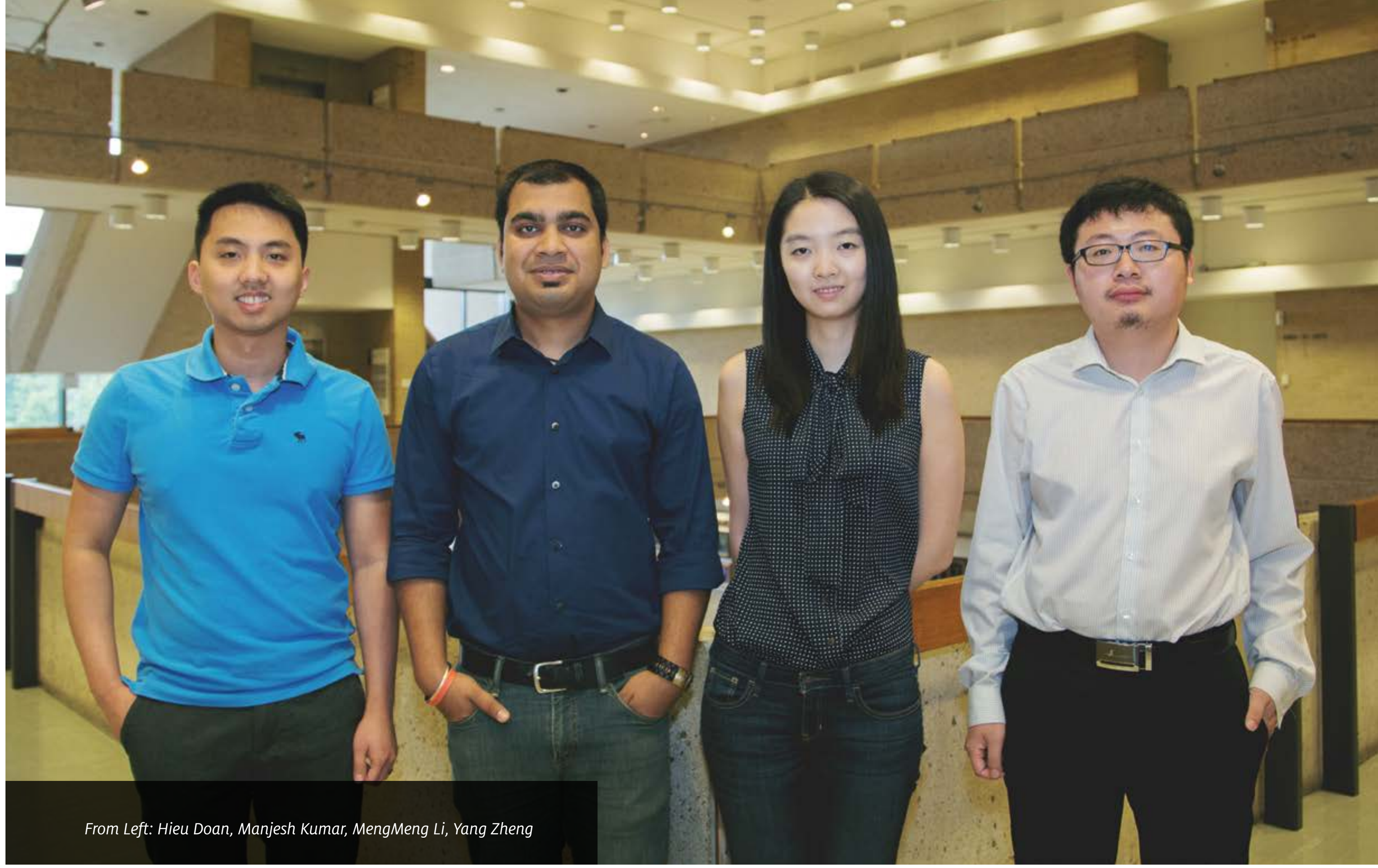
Manjesh Kumar

Kumar has been working closely with advisor Jeff Rimer for over three years to find better methods for growing zeolites, which are crystalline materials that are used as adsorbents and catalysts in a variety of chemical processes. Zeolites span applications from gasoline production to additives for laundry detergent – not to mention thousands of other commercial and consumer products.

But despite the importance of these materials in many chemical and industrial processes, the ways in which these crystals are synthesized are not well understood. Kumar's research focuses on finding better ways to rationally design zeolites in order to improve the materials' performance and reduce the costs and trial-and-error associated with their synthesis.

Kumar was selected to give an oral presentation on his research at the NAM24 meeting. His research group published a paper titled, "A Facile Strategy to Design Zeolite L Crystals with Tunable Morphology and Surface Architecture," in the prestigious *Journal of the American Chemical Society* in 2013. He presented some of his recent research work on effective morphology control of commercially relevant zeolites like Mordenite and SSZ-13 and its potential growth mechanism.

Kumar, who is about one year away from graduation, plans to look for a research position in the oil and gas industry after earning his Ph.D. "I would really like to continue on the research path I started here at UH," Kumar said.



From Left: Hieu Doan, Manjesh Kumar, MengMeng Li, Yang Zheng

Yang Zheng

Zheng has spent most of his career as a doctoral student working side-by-side with Mike Harold, chair of the chemical and biomolecular engineering department, and Dan Luss, Cullen Professor of Engineering. Harold and Luss are both renowned experts in the field of chemical reaction engineering, one application area being the emissions treatment of engine exhaust – a fact not at all lost on Zheng.

"I am so proud to work with them," Zheng said. "I receive great guidance from them as a Ph.D. student."

So far, Yang has three peer-reviewed publications with co-authors Harold and Luss based on his doctoral research in respected catalysis and chemical engineering journals like *Applied Catalysis B: Environmental* and the *Chemical Engineering Journal*. One of the benefits of working closely with Harold and Luss is access to the University of Houston's Center for Clean Engines, Emissions and Fuels, or TxCEF, one of the world's leading research centers for advancing the discovery and adoption of new engines, fuels and emission reduction technologies.

Zheng's research focuses on the discovery of novel automotive emission control systems for reducing nitrogen oxide, or NOx, from diesel engine exhaust. Specifically, Zheng is looking into combining two existing NOx reduction technologies to achieve better control of harmful emissions for diesel engines.

So far, results from Zheng's research shows that using dual layer catalysts consisting of an LNT catalyst (or lean NOx trap) and an SCR catalyst (or selective catalytic reduction) with rapid hydrocarbon pulsing effectively reduces NOx in diesel engine emissions with less ammonia slip.

Zheng plans to graduate this year and hopes to continue his current research on automotive emission control systems.

MengMeng Li

Li also works closely with faculty advisor Mike Harold to research NOx reduction systems for diesel engines. However, Li's work focuses more closely on using sequential catalysts to selectively reduce NOx in diesel engine emissions. The first catalyst enables the generation of ammonia, which is used by the second catalyst to eliminate the NOx.

"The idea is to reduce NOx by 50 percent with the lean NOx trap, then to produce as much ammonia as possible for downstream selective catalytic reduction to achieve complete NOx removal," Li said. This method of reducing NOx emissions in diesel engines could potentially be much more cost effective than current emission reduction systems.

Although Li's research results have been promising so far, the system she's studying is still very new and widely debated. "It's a new technique," she said.

Li has spent the last three years conducting research sponsored by private industry, including Honda Inc., with Harold at TxCEF. "I had the opportunity to work closely with industry throughout this research," Li said. "It was very helpful for me to interact with industry and learn what their needs are and what their standards are. I think having that experience helped me with the poster presentation."

Li, who is currently in her third year as a Ph.D. student, said she was pleasantly surprised to receive the Kokes Award so early in her career as a doctoral student. "I really didn't expect to get it," she said. "I am honored and very excited."

EAA PAST PRESIDENT ELECTED TO UHAA BOARD OF DIRECTORS

A distinguished member of the Cullen College community has been granted the opportunity to make her mark on a new alumni board – this time, at the university-wide level.

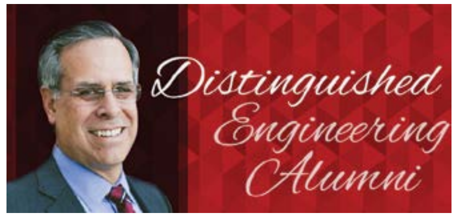
Cynthia Oliver Coleman received her bachelor's degree in chemical engineering from the Cullen College of Engineering in 1971. Now, she's been elected to the University of Houston Alumni Association (UHAA) Board of Directors for a three-year term; she'll also be eligible for two term extensions during her service to the UHAA.

Coleman is a past president of the UH Engineering Alumni Association (EAA), and she is the founder and chair emeritus of EAA Engineers Week. She is a retired chemical engineer for ExxonMobil, and also serves as counselor to the UH Society of Women Engineers as well as a board member on the UH Petroleum Engineering Advisory Board. She is an advocate and donor for the UH Women in Engineering Program.

EAA HONORS TWO CHEMICAL ENGINEERING ALUMNI AT *Annual Gala*

The 2015 Cullen College of Engineering Alumni Awards Gala was held at the Petroleum Club of Houston on Thursday, June 11. The annual event, hosted by the Engineering Alumni Association (EAA), recognizes the professional achievements and contributions of college alumni and faculty. At this year's gala, two alumni from the chemical and biomolecular engineering department at the UH Cullen College of Engineering were honored for their professional achievements and years of service to the UH community.

Distinguished Engineering Alumni – Frederic Wasden



An alumnus of the chemical and biomolecular engineering department at UH, Frederic Wasden (Ph.D. ChE '89), was honored at the gala with the Distinguished Engineering Alumni Award. Wasden, who earned his Ph.D. in chemical engineering from the Cullen College in 1989, currently serves as the general manager for Shell's Carmon Creek heavy oil development in Alberta, Canada.

Wasden joined Shell the same year he earned his doctoral degree, taking on research and development assignments supporting nearly all of Shell's early deepwater host and subsea fields, followed by management assignments in oil shale and materials technology, corporate health and safety, and deepwater operations. He then moved into general management roles supporting Shell's global deepwater field developments prior to assuming his current role.

Wasden's early career followed on from his UH doctoral research with professor Abraham Dukler, and led to a wide range of technical publications in the field of multiphase fluid mechanics and flow assurance. He co-founded the Institute for MultiFluid Science and Technology in 1994 along with several industrial and academic colleagues to provide a focused collaboration setting for the growing discipline.

After graduation, Wasden stayed active in the UH community, teaching graduate and undergraduate chemical engineering courses. In 1993 the UH student AIChE chapter recognized him for his excellence in instruction. Wasden currently serves as a member of the Chemical Engineering Industrial Advisory Board.

Wasden served as technical editor for the ASME *Journal of Fluids Engineering* and has chaired many technical conferences and served on the International Steering Committee for the 2001 International Conference on Multiphase Flows. Leveraging his deepwater field development experience, he represented Shell in deepwater national outreach conferences in Norway and Mexico. His recent publications focus on balancing heavy oil development with sustainability and profitability challenges.

Wasden and his wife, Kay, currently reside in Calgary, Alberta with their two children. He coaches little league baseball, judges speech and debate tournaments and remains a member of St. Mark's Episcopal Church in Houston.

Roger Eichhorn Service Award – Anthony "Tony" Catalano

Anthony B. "Tony" Catalano, P.E. (MSChE '79) received his master's degree in chemical engineering from the UH Cullen College of Engineering, working under the direction of professor Raymond Flumerfelt. He earned his bachelor's degree in chemical engineering from Cooper Union in 1977.

Catalano began his career at Chevron, holding a variety of positions during his 17-year tenure with the company, including production research, gas processing plant operations and management. He spent one year with NGC Corporation as a natural gas trader before co-founding Sago Energy, a mid-stream energy company with natural gas pipelines in West Texas and Louisiana, as well as a West Texas natural gas processing plant. Upon the successful sale of Sago, he co-founded Tristream Energy, another mid-stream energy company with natural gas pipelines and a natural gas processing plant in East Texas. He retired from Tristream as COO in 2014, and his next objective is to commercialize technology from his U.S. patent.

Catalano has supported the Cullen College of Engineering in several ways: he served as a board member of the Engineering Alumni Association for six years, served on the UH Alumni Council for two years, and served on the Cullen College's Engineering Leadership Board (ELB) for 10 years, spending one year as the ELB chair. Catalano was also a member of the EWeek Committee for eight years, serving as host of a game show featuring Cullen College students. He delivered the spring 2007 commencement address for the college. Catalano was a volunteer instructor in the college's Engineering Leadership and Entrepreneurship Program (ELEP) for five years and mentored two groups of ELEP students attempting business startups after graduation.

SHELL OIL COMPANY COMMITS $3.5 MILLION TO UH

Shell Oil Company is contributing $3.5 million to the University of Houston in support of the new Multidisciplinary Research and Engineering Building (MREB) and other educational initiatives.

The collaboration between Shell and the University will ensure the continuation of research programs over the next three years, and through its social investment efforts, Shell will continue to support programs that develop talent for a future workforce.

"Energy is one of our main priorities at UH," said University of Houston President Renu Khator, "and this latest example of Shell's unrivaled generosity will allow us to considerably expand our efforts to become the Energy University. We deeply appreciate Shell's enlightened commitment to community improvement, social responsibility and innovative research."

"The University's programs increase energy education and engineering advancement for students, right here in our backyard, and that's something we value," said Marvin Odum, President of Shell Oil Company. "Energy leadership and innovation each have a long history in Houston, and it is imperative that we continue to provide support to the bright young minds of tomorrow."

When UH established its Energy Research Park (ERP) in 2009, Khator announced her vision for the facility as a collaborative endeavor, with the world's leading energy companies represented throughout the park's 75 acre campus.

Groundbreaking on the $51 million, four-story research and engineering building was Oct. 6, with occupancy set for 2016. The Shell contribution will ensure adequate teaching and physical resources are available to meet the industry demands for quality personnel.

UH CREATES MEHTA FAMILY ENGINEERING RESEARCH CENTER

The Mehta family has provided support to establish the Mehta Family Engineering Research Center on the ground floor of the University of Houston's new Multidisciplinary Research and Engineering Building (MREB).

The Mehta Family Engineering Research Center will house the University's new High Performance Computational Center, five state-of-the-art wet labs, the new Mass Spectrometry Lab, a large multipurpose room, conference room and student lounge.

The High Performance Computational Center will promote research and teaching on campus through integrating leading-edge high performance computing and visualization for UH faculty, staff and students.

The new wet labs are designed to allow researchers to work with chemicals, drugs or biological matter. The labs will handle liquid solutions or volatile phases requiring direct ventilation. The wet labs will be fitted with specialized piped utilities supplying water and various gases used during research.

The new Mass Spectrometry Lab will allow researchers access to the most current equipment designed for analytical chemistry.

Dean Joseph Tedesco said the Mehta family contribution is an example of the community support that allowed the Cullen College of Engineering and the University to move forward with the new building.

"This building will allow us to expand both our educational offerings and our research facilities," Tedesco said. "It will allow more students to participate in research opportunities. We appreciate the Mehta family for this generous gift."

The four Mehta siblings all attended the University of Houston.

"We have all benefited from the outstanding faculty and opportunities the engineering school provided us," said Rahul Mehta. "We are grateful for the dedication and excellence of the faculty."

Supporting the MREB is their way of showing appreciation for the opportunities afforded to them from the University, as well as to show their support for the faculty and other members of the UH community, the family said.

"It is educational investments like this that will keep the University of Houston at the forefront of research and education, and continue the tradition of excellence we all experienced during our time here," Jainesh Mehta said.

The MREB is scheduled to open in 2016.

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UNIVERSITY of HOUSTON | ENGINEERING

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CULLEN COLLEGE CELEBRATES FEMALE ENGINEERS WITH 2015 WOMEN IN ENGINEERING DAY

STUDENTS KICK OFF SEMESTER AT BOS PARTY

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