UNIVERSITY of HOUSTON | ENGINEERING

TRANSPORT

Department of Chemical & Biomolecular Engineering • Fall 2013

NSF, DOE Award $1.2M for Diesel Research

A team of researchers led by associate professor Bill Epling has won a $1.2 million grant from the National Science Foundation and Department of Energy to develop a new emissions reduction technology for high-efficiency diesel engines.

According to Epling, there's one important fact about emissions reduction that's been neglected. Catalytic converters, which remove pollutants from exhaust gas or transform them into something less harmful, are uniform along their entire length. During operation, though, the properties of the exhaust gas and the converter itself change from one spot to the next. The temperature of the converter shifts, for example, while the exact mix of exhaust gas pollutants changes.

Epling will use this funding to develop catalysts that improve emissions reduction by factoring in these internal conditions.

"I want to tailor the design of this catalyst to take advantage of these gradients that always exist inside the catalytic converter. Why is the catalyst at the front of the reactor the same as at the back? Except for manufacturing purposes, there's no reason," Epling said.

This is especially important for high-efficiency diesel engines. Existing diesel catalytic converters are built to work between 200 and 300 degrees Celsius. The highly efficient diesel engines being developed now can put out exhaust at 150 degrees Celsius or lower. Emission controls for these new engines, then, must be re-worked in order treat this lower-temperature gas and meet environmental regulations.

In addition to Epling, the project's researchers are ChBE faculty members Vemuri Balakotaiah, Lars Grabow, Mike Harold and Dan Luss. Jim Parks, a researcher with Oak Ridge National Laboratories, is also on the team.

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Pictured Above: 1 and 2 (Conducting Research at the Texas Center for Clean Engines, Emissions & Fuels), 3 (Bill Epling)

Researcher Wins 2 Immunotherapy Grants

Assistant professor **Navin Varadarajan** has won two separate grants to develop new types of cancer therapies.

The first award, from the Melanoma Research Alliance, provides $225,000 to develop treatments for melanoma patients who aren't responding to any other treatment. It is being conducted in collaboration with Laszlo Radvanyi at the University of Texas MD Anderson Cancer Center. The second, from Alex's Lemonade Stand Foundation, gives Varadarjan and Laurence Cooper, also with MD Anderson, $250,000 to research treatments for diffuse intrinsic pontine glioma, the most deadly type of pediatric brain cancer.

Both awards focus on immunotherapy, an emerging field of medicine that involves engineering human immune cells to fight specific diseases. While Radvanyi and Cooper will actually alter these immune cells, Varadarjan's role is to help evaluate their effectiveness.

The key to this work is a special polymer slide Varadarajan has developed, dubbed the nanowell array. Instead of a flat surface, the slide has tens of thousands of individual chambers, each with a volume of about 50-100 pictoliters. At that size, the chambers are ideal for holding individual cells – an incredibly valuable characteristic, Varadarajan said.

"Standard slides are good for examining cell populations but they can't isolate specific cells. What the nanowell array does is shrink the container so that its dimensions are similar to those of a single cell. That lets us achieve single-cell resolution," he said.

Varadarajan will use the array to isolate individual altered cells and characterize their reactions to cancer. With this knowledge, researchers and physicians will be able to direct their work toward the most promising treatments.

"Immunotherapy is at the forefront of cancer treatment and research," Varadarajan said. "To help the most people, though, we've got to understand exactly what properties of infused cells are most effective at fighting cancer. This research will help us quickly identify those properties so they can be included in the future rounds of research and clinical trials."

Faculty Highlights

- **Michael Harold** was appointed chair of chemical engineering and received the Esther Farfel Award at UH.
- **Ramanan Krishnamoorti** was named the Chief Energy Officer of UH.
- **Dan Luss** was honored in the inaugural class of charter fellows of the National Academy of Inventors.
- **Gila Stein** received a UH Award for Excellence in Research and Scholarship.
- **Navin Varadarajan** received a Stewart Rahr-MRA Young Investigator Award.
- **Peter Vekilov** was named a John and Rebecca Moores Professor.
- **Richard Willson** was named the Huffington-Woestemeyer Professor.

Catalysis Research
Gets a Boost

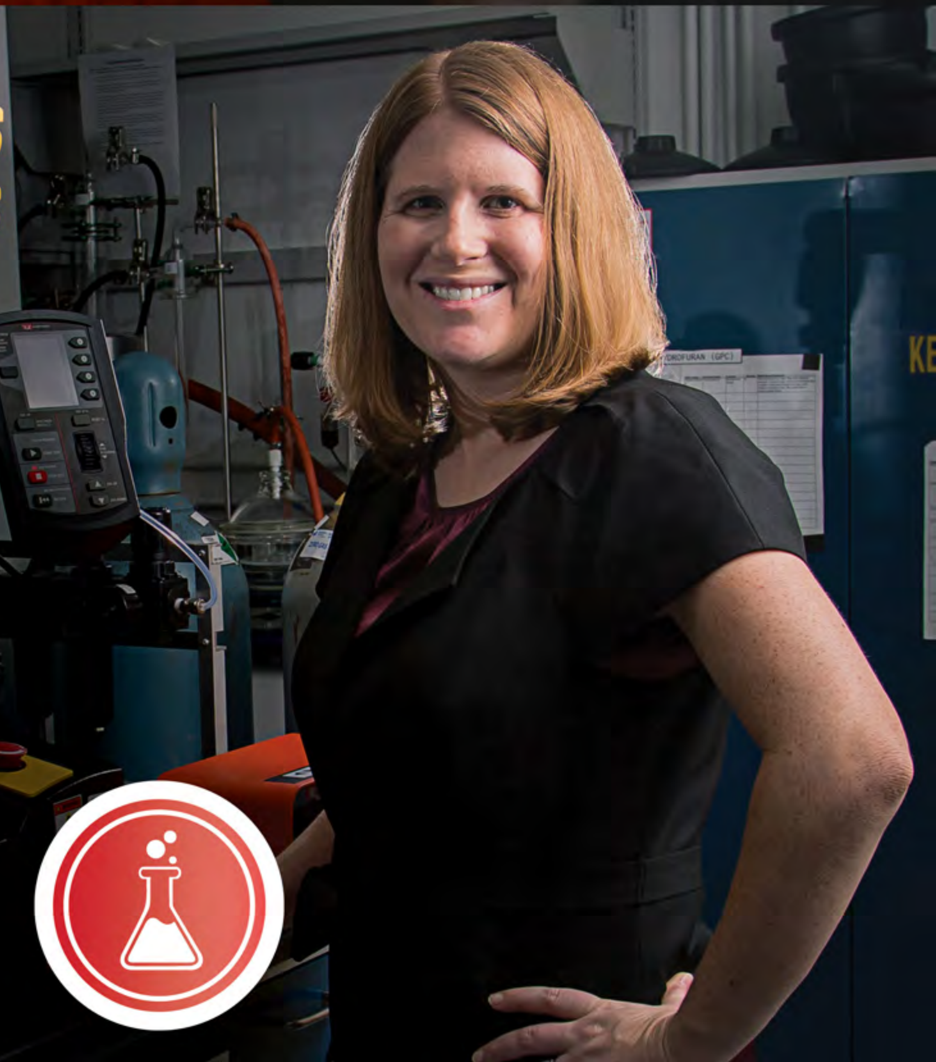
Assistant professor **Jeff Rimer** is an expert in the field of crystallization, which impacts everything from drug development to chemical synthesis to medical diseases such as kidney stones and malaria.

One of the primary efforts of Rimer's lab involves a class of crystals known as zeolites, which are widely used by industry as catalysts to speed up chemical reactions. A material will diffuse through pores in a zeolite crystal, react with specific sites in the crystal interior, and then exit, transformed into a more useful chemical. Rimer is attempting to control how zeolites grow in order to optimize their catalytic properties.

His grant for this work comes from the United States-Israel Binational Science Foundation, an independent body formed though an agreement between the two countries. He and his collaborator, Galia Maayan from the Technion - Israel Institute of Technology, received a two-year, $150,000 award to develop a class of molecules called peptoids that will attach to the zeolite crystals to change how they grow.

"This is something that could be integrated into an existing process very easily, without requiring equipment upgrades or dramatic changes in operating conditions," Rimer explained. "So from an economic perspective, this could be very attractive for industry."

Professors' NSF Grant To Develop
Advanced Adhesives for Composites



Wind turbines, aircrafts and automobiles could become more tough and durable thanks to research being conducted at the Cullen College of Engineering. All of these use composites, materials that contain two or more constituents with distinct properties. In these examples, the composites are made up of of a polymer resin and reinforcing fibers such as glass or carbon.

Typically, objects made of polymer composites contain multiple components held together with polymer-based adhesives. But these adhesives fall short, leading to failure at the connections between the components.

Creating better polymer-based adhesives is a challenge. Steps taken to increase the strength and stiffness of the polymer can result in decreased ductility and toughness.

Megan Robertson and Mina Dawood, assistant professors of chemical and biomolecular engineering and civil and environmental engineering, respectively, have received a $300,000 grant from the National Science Foundation to develop new polymers for adhesives that do not make such a tradeoff. Their approach is a simple one: mix two polymers together to get the best qualities of both.

Specifically, Robertson and Dawood will combine traditional epoxy resin polymers, which provide strength and stiffness, with a high-ductility polymer known as polydicyclopentadiene. "If you want to use these materials for more applications, you have to improve their properties or else they won't hold up. If they can absorb more energy before they break, they can survive in harsher environments," Robertson said.

JACS Article Outlines

DEVELOPMENT OF NEW BIOSENSOR

Making molecules is no easy task. An increasingly attractive approach: have bacteria make them for us.

Such efforts are part of the growing discipline of synthetic biology, where biological processes are altered to achieve specific goals. In this field, researchers can genetically modify bacteria so they'll produce a desired molecule – one that can be used to help make medicines or chemical products, for example.

This process is far from being perfected, though. A popular approach is to create millions or billions of different mutant bacteria in hopes of finding rare variants that produce more of the desired molecule than their "parents." This, in turn, presents a classic needle-in-a-haystack challenge. How do you identify the handful of bacteria you want among the huge number you don't?

Associate professor **Patrick Cirino** has recently published an article in the Journal of the American Chemical Society on the creation of a new biosensor that solves this problem, at least in one case, and shows an approach that can be applied to screening a variety of targeted molecules.

UH Announces Plans for NEW Multidisciplinary Research and Engineering BUILDING

The University of Houston Cullen College of Engineering has grown tremendously in recent years, with research expenditures and enrollment at or near all-time highs. To keep this momentum, UH and the college have announced plans to construct a new Multidisciplinary Research and Engineering Building (MREB).

The four-story, 120,000-gross-square-foot facility will serve as a catalyst for the Cullen College to rise among the top 50 engineering programs in the country. Furthermore, the MREB will allow the college to add 250 graduate students and attract leading faculty, including members of the prestigious National Academy of Engineering. The new facility will also increase the college's annual research expenditures to $36 million, which will in turn promote approximately $612 million worth of economic activity in the city of Houston alone.

The facility will support both academic and research programs, including lecture spaces, research labs, computational training facilities, a visualization lab, a high-performance computational server room, and a nuclear magnetic resonance spectrometer lab. Groundbreaking is scheduled for 2014, with occupancy beginning in 2016.

According to Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College of Engineering, the current focus for this project is fundraising. Though UH has committed to funding a large portion of the $51 million facility, the Cullen College community must do its share, he explained.

"The commitment from the University of Houston is strong, but we need the support of our alumni and friends to make this building a reality. We are tasked with raising $10 million for this much-needed facility. So far, we have secured $4,076,710 from our alumni and friends," Tedesco said. "I ask our alumni, friends and supporters to explore our plans for this building. See what we plan to do and what we can do, and then help the Cullen College of Engineering become an even greater resource for our university, our students and our community."

For more information, please visit:
www.egr.uh.edu/newbuilding

View the digital brochure!
www.egr.uh.edu/newbuilding/brochure

Ph.D. Candidate Katy Olafson

Awarded Keck Predoctoral Fellowship and Poster Award

Katy Olafson, a Ph.D. candidate in chemical and biomolecular engineering who is co-advised by Drs. Peter Vekilov and Jeffrey Rimer, has been awarded a one-year predoctoral fellowship in the Gulf Coast Consortia/W.M. Keck Center for Quantitative Biomedical Sciences Nanobiology Interdisciplinary Graduate Training Program (NIGTP). Olafson was also awarded second place at the Keck Center Annual Research Conference poster contest for the research conducted during her fellowship.

The competitive fellowship program provides high-level training in the exploration of nanoscience and biology interdisciplinary studies. Trainees will become experienced investigators using unconventional approaches in the development of diagnostics and therapeutics.

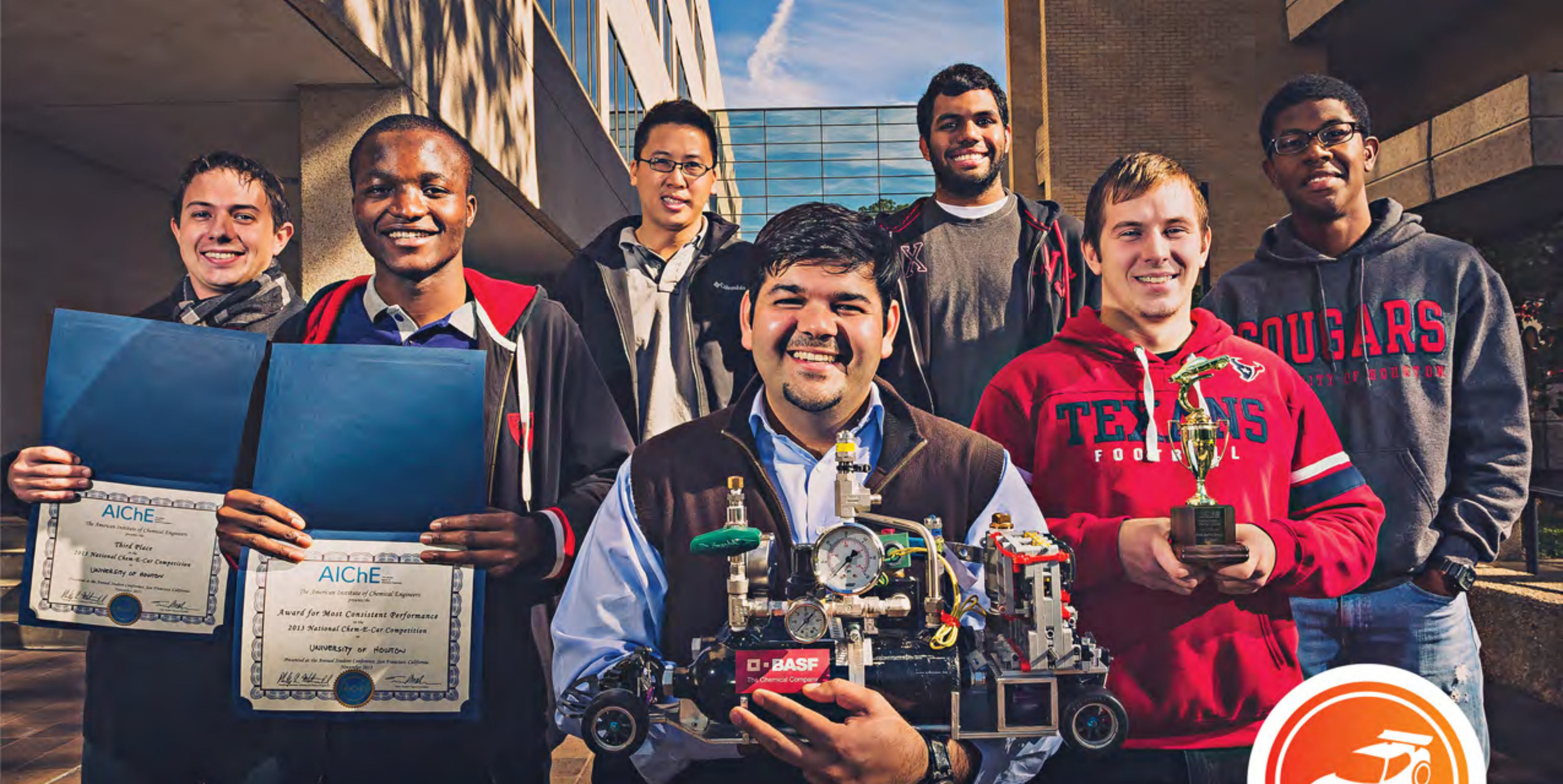
“Involvement with the Keck Fellowship provides me with the opportunity to collaborate with fellow graduate students and professionals within and outside my area of focus,” Olafson said. “Being surrounded by scientists in different fields offers novel perspectives on my research and exposes me to new techniques and rational approaches.”

Olafson investigates current antimalarial medications with the goal of understanding the drug inhibition mechanism to ultimately design novel antimalarial treatments. While malaria has largely been eradicated in the United States, it is endemic to areas in which approximately 40 percent of the global population resides, causing 515 million episodes annually and killing over 2,000 people each day.

Olafson is exploring the nanoscale dynamics of crystallization of beta-hematin (the synthetic form of hemozoin). She aims to identify active growth sites on the surface of beta-hematin crystals and propose inhibition pathways which will underline the design of novel malaria treatments.

Her award-winning poster, titled “Classical and Non-classical Growth Mechanism of beta-Hematin Crystals,” was one of 65 posters entered into the Keck Center’s poster competition. While Olafson couldn’t be happier about her second-place win, she says she took home a lot more than just an award from the Keck Center’s Annual Research Conference.

“The conference was absolutely wonderful. The Gulf Coast Conference invited numerous professionals from industry and academia to present their work and to collaborate on ideas with young researchers, such as myself,” Olafson explained. “Discussing ideas and being exposed to other unsolved problems demonstrates what drives us to be involved in the work we are.”



Engineering Students Claim Third Place in National

CHEM-E-CAR COMPETITION

It took more than a thousand hours and a few trips back to the drawing board, but the University of Houston Cullen College of Engineering's Chem-E-Car competition team's hard work paid off in November when they clinched third place overall at the annual national Chem-E-Car competition. This is the highest UH has ranked in the 15 years the competition has taken place. The team was also named Most Consistent by the judging panel.

The Chem-E-Car competition is sponsored annually by the American Institute of Chemical Engineers (AIChE). Teams must construct a car powered solely through chemical reactions that can haul a certain load several meters. However, the specific load and distance are not known until the competition day. Teams who qualify in the regional competition held in March advance to the national competition at the annual AIChE Student Conference, which was held in San Francisco this year. For this year's competition, cars hauled 250 milliliters of water over a distance of 17 meters. Teams were given two opportunities to come as close as possible to the finish line. The UH team's winning run landed 13 centimeters from the finish line.

The UH Chem-E-Car team is comprised of Team Lead Rishabh Mahajan and team members Abraham Aboiralor, Paul Abraham An Dinh, Ed McDowell and Yen Nhi Nguyen.

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