TRANSPORT

Research Milestones in Chemical & Biomolecular Engineering

UNIVERSITY of HOUSTON

CULLEN COLLEGE of ENGINEERING

Department of Chemical & Biomolecular Engineering

Letter from the Chair

I am proud to highlight the many exciting accomplishments of the UH ChBE community in this issue of Transport.

The UH ChBE Dept. is doing very well. We have record enrollments in our doctoral program — about 110 for a faculty of 19, and B.S. graduates — 80-90 per year during the past few years. Year after year, we continue to be ranked among the best chemical engineering programs in the nation: The doctoral program is ranked 17th by the National Research Council among U.S. programs while U.S. News and World Report ranked UH ChBE 22nd among public university chemical engineering departments. Our hiring success in the past 10 years has strengthened the traditional department core competency in reaction engineering & catalysis, as well as making significant gains in biomolecular engineering and materials engineering. During that period UH ChBE faculty have received eight early career awards, including six NSF CAREER Awards. This is in no small part due to the success of our faculty and students in tackling research with a real, direct impact in the city of Houston and beyond. Our faculty, together with their graduate students and postdocs, are conducting pioneering research while publishing their works in the top journals, and presenting their work at international conferences.

UH ChBE is a pioneering research leader. From catalysis and reaction engineering to the creation of a polymer center, there is no shortage of exciting, game-changing research within our department. Our faculty conducts innovative, interdisciplinary research to solve critical problems spanning energy to disease treatments. Discovering sustainable polymers, developing new catalysts to convert methane into valuable chemicals and remove harmful pollutants from engine exhaust, inventing new immunotherapy methods to fight cancer and inhibitors to stop malaria, and safely recovering offshore energy resources are just a few of the projects underway in our department.

Thank you for being a friend of UH ChBE. I look forward to hearing from you and seeing you at upcoming departmental, college and University events!

Sincere regards and “Go Coogs!”,

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

UH ChBE
BY THE NUMBERS

BEST ENGINEERING PROGRAM OF
2020

BEST GRAD SCHOOLS
U.S.News & WORLD REPORT
RANKINGS

#22
BEST CHEMICAL ENGINEERING PROGRAM AMONG STATE/ PUBLIC UNIVERSITY CHEMICAL ENGINEERING DEPARTMENTS (SOURCE: U.S. NEWS & WORLD REPORT)

590
TOTAL STUDENTS IN DEPARTMENT

462
UNDERGRADUATE STUDENTS

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

109
DOCTORAL STUDENTS

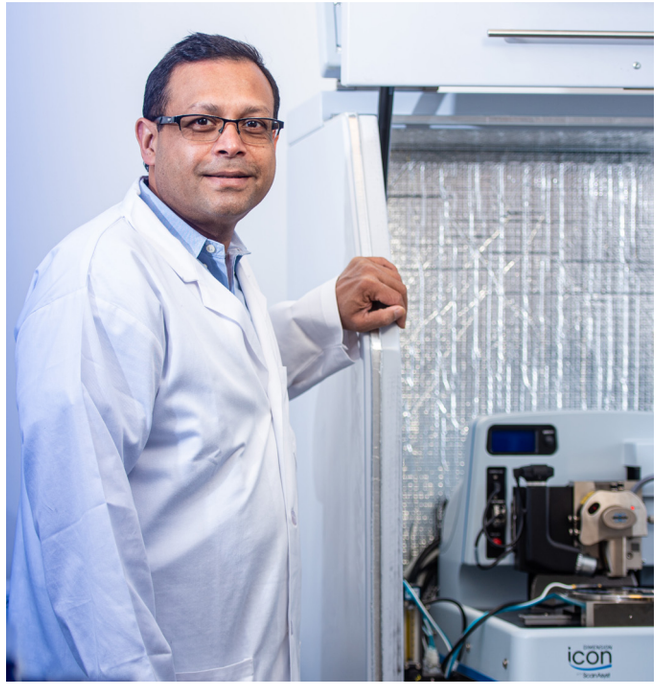
TOP 20
CHEMICAL DOCTORAL PROGRAM IN THE U.S. (SOURCE: NATIONAL RESEARCH COUNCIL)

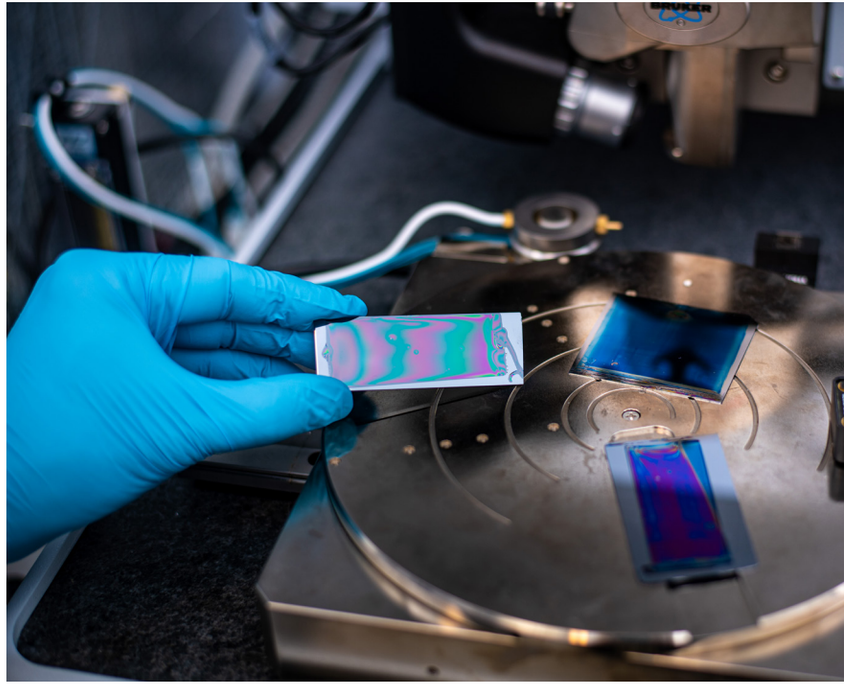
Alamgir Karim Leads Game-Changing Project to Advance

COPOLYMER PRODUCTION

The National Science Foundation (NSF) awarded a three-year grant to a UH Cullen College of Engineering research team led by **Alamgir Karim**, professor of chemical and biomolecular engineering. The team's project, titled "Ordering of Block Copolymer Systems with Enhanced Molecular Interactions and Diffusional Dynamics," received $399,718. Karim is developing a revolutionary method to use solvents, instead of heat, to bond individual single-layer polymers into a multi-layered copolymer in a new proposed system called direct immersion annealing (DIA).

In the marketplace, two benefits are expected with DIA technology, according to Karim and research assistant Ali Masud, a UH chemical engineering doctoral student. First, the energy saved with the new process would make manufacturing familiar products like soda bottles more cost effective. Second – and this is the game changer – engineers will be able to tweak either the recipe or the process (or both) to produce a material that has the highly specific qualities that its end use requires. Product packaging could become more biodegradable or astronauts' space suits more flexible. There may be infrared coatings that help keep buildings cool, car bumpers that are incredibly resilient, and food wrappings that defy more hot summer days than any food preservation system now in use. In some cases, the highly refined copolymer materials might inspire advances in other fields. For example, they could help make bendable cell phones commercially viable, or perhaps bring improved batteries to the next generation of nano-devices.





UH Chemical Engineering Chairman

WINS SWCS AWARD FOR APPLIED CATALYSIS

Mike Harold, M.D. Anderson Professor and chairman of the chemical and biomolecular engineering department at UH Cullen College of Engineering, recently won the 2019 Southwest Catalysis Society (SWCS) Award for Excellence in Applied Catalysis.

Harold, who is an expert in catalytic reaction engineering, has spent much of his 34-year-career working to improve air quality in Houston and beyond. As founding director and principal investigator of the Texas Center for Clean Engines, Emissions and Fuels (TxCEF), Harold has helped develop technologies to reduce harmful vehicle emissions, performed testing and verification on emission-reducing technologies developed by outside groups, and worked to improve fuel economy for medium- and heavy-duty vehicles. Most recently, he is leading a team of researchers chosen by the U.S. Department of Energy on a $2 million project to develop and optimize a lower-cost, more efficient catalyst for natural gas vehicles to eliminate unreacted methane.

His past accolades include being elected a fellow of the American Institute of Chemical Engineers (AIChE) on 2014 as well as the University's most prestigious faculty honor – the Esther Farfel Award in 2013 among numerous other research and teaching awards. He also serves as the Editor-in-Chief of *AIChE Journal*.

GETTING CLOSER:

Finding Out Why the Immune System Attacks Itself

Navin Varadarajan, M.D. Anderson Associate Professor of chemical and biomolecular Engineering, recently published in *Arthritis & Rheumatology* journal a first-of-its-kind study - a comprehensive profile of B cells in rheumatoid arthritis (RA). B cells are lymphocytes, or white blood cells, that make protein antibodies that attack a patient's healthy proteins in patients with RA. He anticipates that the findings will serve as a foundational data set for investigating multiple hypotheses on the roles of B cells in RA and other autoimmune disorders, and will enable drug discovery.

The team is the first to show that B cells make amphiregulin. Amphiregulin sits in a well-studied pathway, the epidermal growth factor receptor pathway (EGFR), and so the next step will be to determine if inhibiting the pathway impacts the B cells.

Varadarajan's team also published a list of FDA-approved drugs, such as Xeljanz (tofacitinib), that target various pathways of the B cells, though they aren't specifically approved for that purpose.

GROWING A NEW GENERATION
of Researchers

UH ChBE's **Jacinta Conrad**, Frank M. Tiller Associate Professor, is working hard to help foster a new generation of researchers. She is one of several professors at the Cullen College leading Research Experience for Undergraduates (REU) programs funded by the National Science Foundation. The NSF awarded Cullen College researchers $790,000 for three years to reach students early in their college careers with two REU programs. Conrad is leading the Materials for Sustainability in Energy and Manufacturing program, which is currently in its final year, alongside Haleh Ardebili, Bill D. Cook associate professor of mechanical engineering. The program introduced students to the realities of research work, which can often be long-drawn-out and laborious, and do not always turn out as expected. Dow Chair and Welch Foundation professor of chemical and biomolecular engineering, Alamgir Karim, also worked with REU students to pattern and observe the structure of thin films.

Conrad hopes that the exposure the students receive with cutting-edge research at UH will propel them to apply to graduate schools and pursue research as a career.

NSF CAREER Winner
Jeremy Palmer Seeks to

LEARN MORE ABOUT CRYSTAL FORMATION

Crystal formation is key to fields as disparate as drug design, biomedical diagnostics and petrochemical production, but significant questions remain about how that formation begins in the presence of soft materials. **Jeremy Palmer**, assistant professor of chemical and biomolecular engineering, received a $500,000 CAREER award from the National Science Foundation to increase understanding of crystal nucleation within polymers and other soft materials. A better understanding and the ability to control the crystallization process could prove helpful in all sorts of areas, including biological systems, water and wastewater treatment plants, and pharmaceutical formulations, to name a few.

HOUSTON, WE HAVE AN EXPERIMENT:

Cancer Research Goes to the International Space Station

Recently, **Peter Vekilov**, John and Rebecca Moores Professor of chemical and biomolecular engineering and chemistry, sent his latest experiment to the International Space Station. The cargo included 30 tubes of ice in which two miniscule proteins were suspended in various forms. One of the proteins, p53, protects cells from cancer. The other protein, hnRNPA, causes amyotrophic lateral sclerosis (ALS), known as Lou Gehrig's disease. The proteins were delivered via a Space X rocket on a resupply mission.

According to Vekilov, Normal p53 protects you from cancer. Mutated p53 causes cancer by destroying all cancer protection mechanisms. With no gravity in space, conditions are ideal to test Vekilov's theory about how mutated groups of p53 form into droplets. On board the ISS, astronauts thaw the tubes, then place them beneath the Light Microscopy Module, a high-powered light imaging microscope. Back on Earth, in Cleveland at the NASA Glenn Research Center, scientists remotely acquire and download terabytes of digital images and videos of Vekilov's proteins across many levels of magnification. Under Vekilov's watchful eye, his team is scouring the images for change, a process that may take up to two years given the amount of data. After the experiment's pictures are taken and the data is reviewed, Vekilov expects to find a potential treatment strategy for the two deadly diseases.

Vekilov also recently won the University of Houston's Awards for Excellence in Research, Scholarship and Creative Activity for the 2018-19 academic year in the "Professor" category. The honor comes from his discovery of he two-step nucleation mechanism – called the Vekilov mechanism – where crystal nuclei form inside pre-existing dense liquid droplets. The impact of this finding will allow biomedical researchers to gain a better understanding of how pathogenic crystals of proteins and small molecules form in the body.

CULLEN COLLEGE PROFESSORS EARN $765K WELCH AWARDS

to Continue Life-Altering Research, Investigate Chemical Conundrums

Three UH Cullen College chemical and biomolecular engineering professors received funding from the Welch Foundation for their contributions to basic chemical research that benefits humankind. These three-year grants extend from 2018 to 2021 and add up to $765,000 in research funding. **Jeffrey Rimer**, Abraham E. Dukler Professor, earned a $330,000 award to continue his search for more effective drugs to treat kidney stone disease. Assistant professor **Jeremy Palmer** earned a $240,000 grant to further expand his postdoctoral research on unusual phase behaviors exhibited by water molecules during supercooling. **Jacinta Conrad**, Ernest J. and Barbara M. Henley Associate Professor, won a $195,000 grant so she can continue exploring the structure and dynamics of attractive nanoparticle glasses. Located in Houston, the foundation is one of the largest private funding sources for chemistry research in the country.

A New Take on

FIGHTING MULTIDRUG RESISTANT BACTERIA

Michael Nikoloau, professor of chemical and biomolecular engineering, and College of Pharmacy professor Vincent Tam recently won a five-year, $3.5 million grant from the National Institute of Allergy and Infectious Diseases to develop technology that will quickly suggest the most promising combinations of antibiotics to kill certain resistant bacteria. The team is working with an external company, BacterioScan, to develop a rapid diagnostic device that will test bacterial responses to several drug combinations. Clinicians will place bacteria samples in the device, a box, which will monitor bacterial growth in the presence of different antibiotics and will automatically process collected data to spit out predictions of the best combinations in short order. Initial testing will include bacteria P. aeruginosa, which cause pneumonia; A. baumannii, which cause urinary tract infections and meningitis; and the superbug Klebsiella pneumoniae, which can cause all three illnesses and others. They will test different structural classes of antibiotics to hit the bugs at different sites.

The University of Houston
Cullen College of Engineering

The University of Houston Cullen College of Engineering addresses key challenges in energy, health care, infrastructure and the environment by conducting cutting-edge research and graduating hundreds of world-class engineers each year. With research expenditures topping $30 million and increasing each year, we continue to follow our tradition of excellence in spearheading research that has real, direct impact in the Houston region and beyond.

UNIVERSITY of HOUSTON | ENGINEERING

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