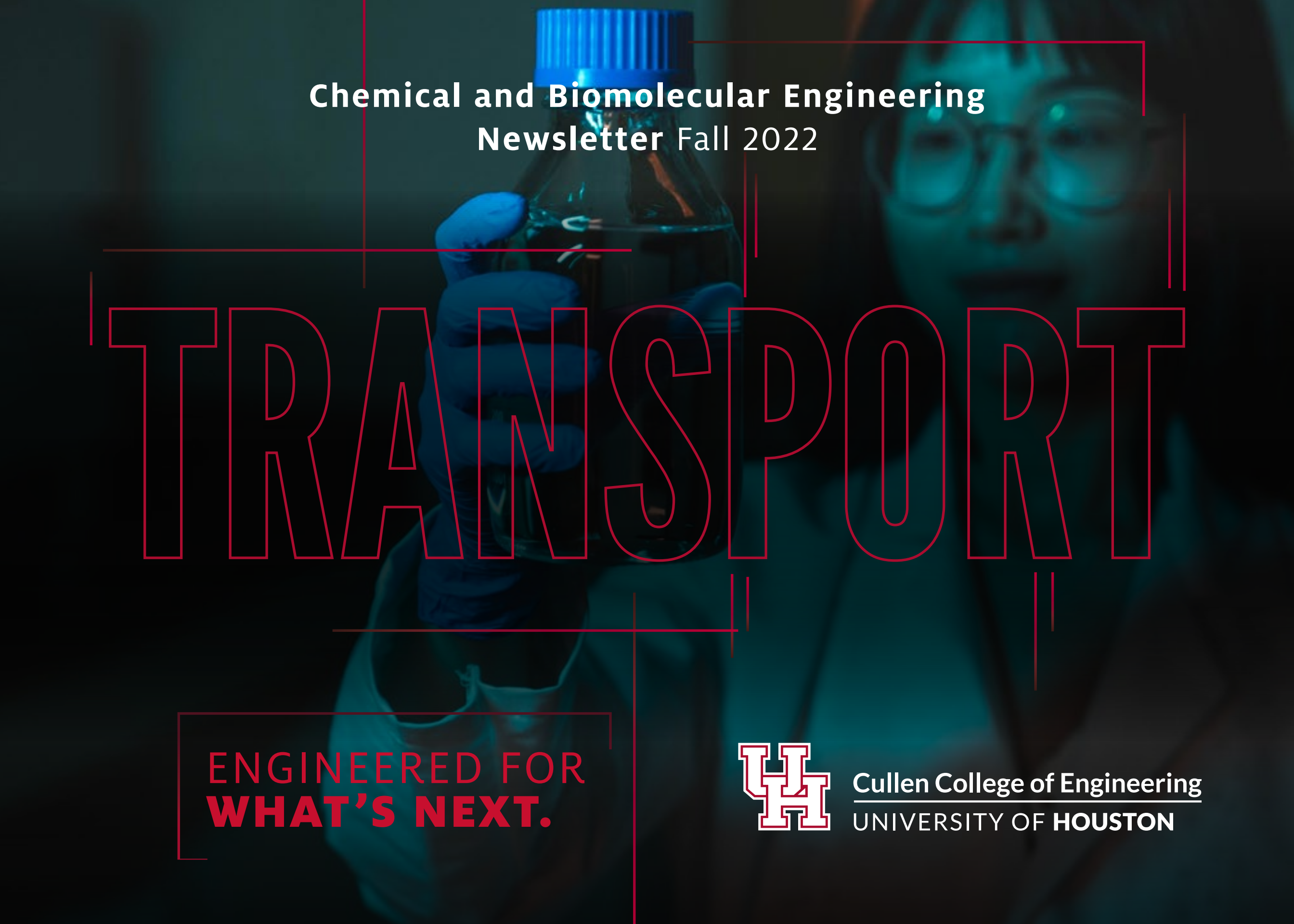


Chemical and Biomolecular Engineering
Newsletter Fall 2022

# TRANSPORT

ENGINEERED FOR
**WHAT'S NEXT.**

Cullen College of Engineering
UNIVERSITY OF **HOUSTON**

# Letter from the Chair

**Dear Colleagues,**

Greetings from Houston!

I am delighted to share some of the recent research highlights and accomplishments of our faculty and students. From research on enhancing underrepresented student engagement in STEM to developing advanced lymphoma treatments, discovering novel zeolite structures, and pioneering the electro-rheology of coacervate droplets, there is no shortage of exciting research projects in the William A. Brookshire Department of Chemical and Biomolecular Engineering. I invite you to take a moment and look through the following items, and if any strike your interest, do not hesitate to reach out to me personally.

Warm Regards,

**Triantafillos J. (Lakis) Mountziaris**
William A. Brookshire Department Chair and Professor
William A. Brookshire Dept. of Chemical & Biomolecular Engineering
University of Houston

# UH ChBE **BY THE NUMBERS**

## FACULTY *(SPRING 2022)*

**1** NATIONAL ACADEMY OF ENGINEERING MEMBER

**2** NATIONAL ACADEMY OF INVENTORS FELLOWS

**2** NATIONAL ACADEMY OF INVENTORS SENIOR MEMBERS

## ENROLLMENT *(SPRING 2022)*

**502** UNDERGRADUATE STUDENTS

**136** GRADUATE STUDENTS

***LEARN MORE ABOUT ChBE PROGRAMS:***
*www.chee.uh.edu*

## DEGREES AWARDED *(FALL 2021)*

**71** B.S.

**11** M.S.

**23** PH.D.

## NEW FACULTY

### MINGJIAN WEN

**Mingjian Wen** has joined our Department as an Assistant Professor and Presidential Faculty Fellow. His research focuses on discovering new molecules and materials for energy and healthcare applications using advanced computational techniques, such as machine learning and ab-initio calculations based on density functional theory. Wen earned his doctorate in Aerospace Engineering and Mechanics from the University of Minnesota in 2019. For the past three years, he was a Postdoctoral Researcher at the Lawrence Berkeley National Laboratory.

## FACULTY PROMOTIONS

### PATRICK CIRINO

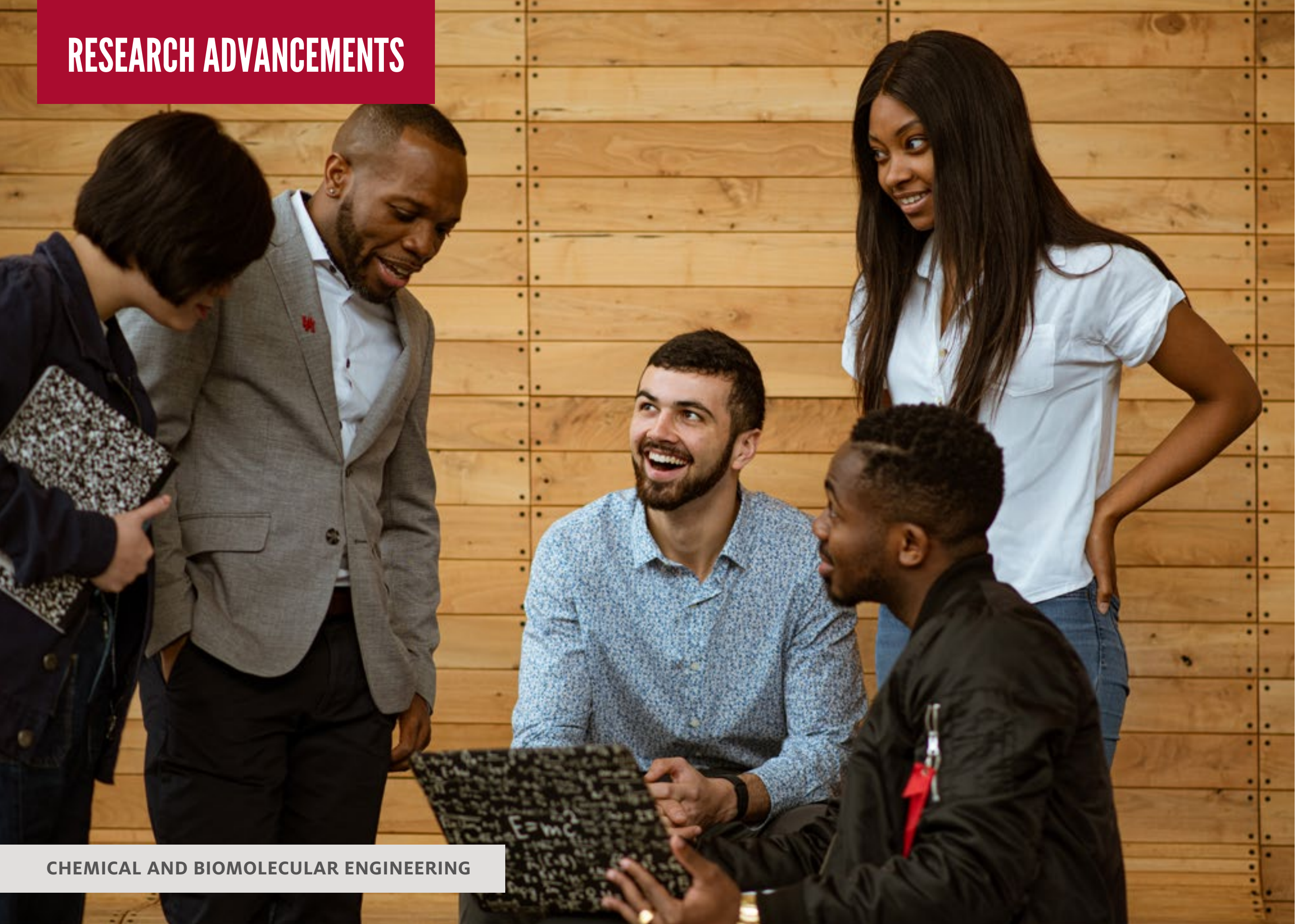
**Patrick Cirino** was promoted to Professor in fall 2022. Cirino also has joint appointments in Biomedical Engineering and Biology & Biochemistry. His research aims to improve biocatalysis through protein and metabolic engineering. Cirino's research group has pioneered the customization and use of bacterial transcription factors as genetically-encoded molecular reporters for high-throughput biocatalyst screening.

# TECHNOLOGY DEVELOPED AT UH COULD ADVANCE TREATMENT OF LYMPHOMA

In the war against cancer, one of the most critical battles is waged on a cellular level as T cells from the immune system are altered in the lab to attack cancer cells. This form of immunotherapy, called chimeric antigen receptor (CAR) T-cell therapy, can be a life-saving treatment resulting in tumor control lasting ten years or longer. Now an engineer at the University of Houston has found a way to determine which patients are likely to respond to CAR T-cell therapy, saving precious time in treating lymphoma, which is most responsive to this form of immunotherapy. It's valuable knowledge to have since not all patients respond to the therapy, and some experience severe side effects.

To determine the best patient prospects, **Navin Varadarajan**, M.D. Anderson Professor of Chemical and Biomolecular Engineering, studied the dynamic interactions between T cells and tumor cells. His findings, reported in the Journal of Clinical Investigation, point to the relationship between a ligand molecule on a cancer cell (CD58) and a protein on a T cell (CD2) which work together to communicate and activate the CD2, turning it into a cancer cell killer.

Varadarajan and his partners at The University of Texas MD Anderson Cancer Center profiled the dynamic interactions between T cells that comprise patient infusion products and tumors, using the TIMING (Timelapse Imaging Microscopy In Nanowell Grids) method, developed in Varadarajan's lab at UH. TIMING is high-throughput single-cell technology that merges artificial intelligence with a nanowell imaging platform to simultaneously evaluate how individual cells move, activate, interact, kill and survive. The University of Houston has obtained a patent on the TIMING process and Varadarajan co-founded the company, CellChorus, to commercialize it. CellChorus is housed at the UH Technology Bridge, which provides space to startup and spin out companies from UH and nurtures their growth.



## ENHANCING UNDERREPRESENTED

# STUDENT ENGAGEMENT IN STEM

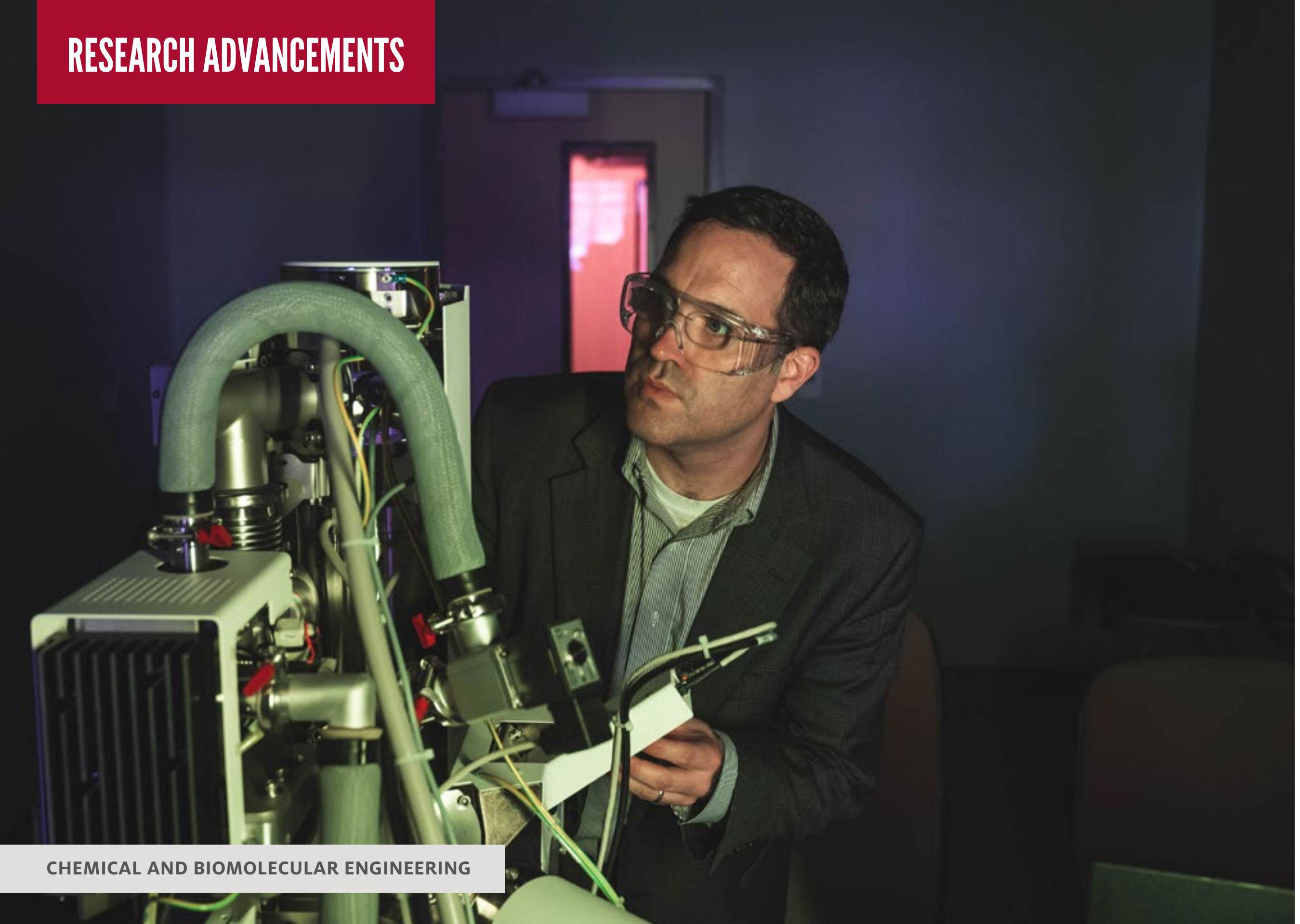
A team from the University of Houston and the University of Michigan have received an additional grant from the National Science Foundation to further their collaborative research into improving underrepresented student engagement in STEM.

The team includes **Jerrod A. Henderson** (PI), Assistant Professor at the Cullen College of Engineering in the William A. Brookshire Department of Chemical and Biomolecular Engineering, and **Rick Greer**, the project co-developer and program manager. The co-PIs are Virginia Snodgrass Rangel, Associate Professor at the College of Education in the Educational Leadership & Policy Studies Department; and James Holly Jr., Assistant Professor of Mechanical Engineering at the University of Michigan.

The grant, "Enhancing Underrepresented Student Engagement in STEM through Mentoring and Family Involvement," is for $739,486. Research started in June and is estimated to run through May 2027. The authors note the need for the research via four questions in the grant's abstract.

Henderson said their goal would be to use data from interviews, observations, and questionnaires to more deeply probe participants' stories and experiences.

This research builds on earlier work from Henderson, Rangel and Mariam Manuel, a Science Master Teacher for teachHOUSTON Instructional Assistant Professor in the College of Natural Sciences and Mathematics Department of Mathematics. The previous grant, "Enhancing Underrepresented Boys' Engagement in STEM through Mentoring and Father Involvement," totaled $1.10 million and ran from February 2018 through July 2022.



# BUILDING THE BEST ZEOLITE

If science and nature were to have a baby, it would surely be the zeolite. This special rock, with its porous structure that traps water inside, also traps atoms and molecules that can cause chemical reactions. That's why zeolites are important as catalysts, or substances that speed up chemical reactions without harming themselves. Zeolites work their magic in the drug and energy industries and a slew of others. With petrochemicals, they break large hydrocarbon molecules into gasoline and further into all kinds of petroleum byproducts. Applications like fluid catalytic cracking and hydrocracking rely heavily on zeolites.

So important is the use of zeolites that decades ago scientists began making them (synthetic ones) in the lab with the total number of crystal structures exceeding 250.

Now, an undisputed bedrock in the global zeolite research community, **Jeffrey Rimer**, Abraham E. Dukler Professor of chemical and biomolecular engineering at the University of Houston, has published a review in the *Nature Synthesis* journal summarizing methods over the past decade that have been used to prepare state-of-the art zeolites with nano-sized dimensions and hierarchical structures.

The findings emphasize that smaller is better and structure is critical.

The review article summarizes advanced methods to accomplish this goal, including work from Rimer's own group on finned zeolites, which he invented. Zeolites with fins are an entirely new class of porous catalysts using unique nano-sized features to speed up the chemistry by allowing molecules to skip the hurdles that limit the reaction.

Rimer also examines how the emergence of data analytics and machine learning are aiding zeolite design and provides future perspectives in this growing area of research. That helps make up the "new methods" that Rimer suggests as imperative, resulting in major advantages of infusing computational and big data analyses to transition zeolite synthesis away from trial-and-error methodologies.

Besides, speeding up the process of crystallizing zeolites, and speeding up the reactions of the zeolites themselves, will result in many socioeconomic advantages, according to Rimer.

# MANIPULATION OF COACERVATE DROPLETS WITH AN ELECTRIC FIELD

Manipulating solid particles of a few micrometers in size using an electric field has been of great interest to physicists. These controllable particles can be assembled into dynamic chains that can effectively control the flow of liquids in thin tubes like capillaries. Replacing these solid particles with liquid droplets would allow for previously unachievable electrorheology applications in biotechnology, as liquid droplets can store and utilize various biomolecules such as enzymes. Until now, it was not possible to use liquid droplets for electrorheology, as they tend to coalesce or deform, rendering them ineffective as electrorheological fluids.

New research led by the University of Houston Cullen College of Engineering* in collaboration with the National Institute of Standards and Technology (NIST) and the University of Chicago, has shown a simple pathway for stabilizing polyelectrolyte coacervate droplets that do not coalesce or deform under an electric field. The study was recently published in the *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*.

Enabled by the high polarizability and residual surface charge, these "stabilized" droplets can be programably steered in an aqueous environment using a low voltage source, e.g. 9V battery. Known as coacervates, these droplets contain charged polymers that enable the encapsulation of biologically relevant charged species such as proteins and genes. Thus, they have the potential to transport and deliver a variety of cargo useful in the manufacturing and medical industries.

**Alamgir Karim**, Dow Chair and Welch Foundation Professor of the University of Houston, led the research project, working with Jack F. Douglas, a long-time colleague and polymer physicist at NIST, with insights provided by polyelectrolyte coacervate expert, Matthew Tirrell, the dean of the Pritzker School of Molecular Engineering at the University of Chicago.

# FACULTY

ACCOLADES

## MEGAN ROBERTSON

**Megan Robertson** was recently elected as a Fellow of the American Chemical Society (ACS) in recognition of her outstanding achievements and contributions to polymer science and engineering and her leadership in the Polymeric Materials: Science and Engineering (PMSE) Division of ACS, of which she is currently the Vice Chair and Program Chair. Robertson is the Cullen College of Engineering Professor in the William A. Brookshire Department of Chemical and Biomolecular Engineering and also serves as Associate Chair for Faculty Development and Inclusive Excellence. Her research focuses on polymer sustainability, including developing polymers from renewable resources, exploring structure-property relationships of biobased polymers, probing polymer degradation behaviors, enhancing polymer recycling, and increasing material lifetimes

# FACULTY

ACCOLADES

## HASAN ZERZE

**Hasan Zerze** has published a research article on "Nucleation and growth of crystals inside polyethylene nano-droplets" that was selected as Cover Art and Editor's pick by the Journal of Chemical Physics. Zerze is a Lecturer in the William A. Brookshire Department of Chemical and Biomolecular Engineering.





# STUDENT

SUCCESS

## AMAN AGRAWAL

**Aman Agrawal**, a graduate student in the William A. Brookshire Department of Chemical and Biomolecular Engineering, has been elected to serve as Chair of the Gordon Research Seminar (GRS) on Bioinspired Materials to be held in 2024 in Switzerland. GRS is organized by junior scientists and provides a forum for them to present their research and interact with leaders in their field. Agrawal is pursuing his Ph.D. degree under the supervision of Professor **Alamgir Karim**.

# The University of Houston
## Cullen College of Engineering

The University of Houston Cullen College of Engineering addresses key challenges in energy, healthcare, infrastructure, and the environment by conducting cutting-edge research and graduating hundreds of worldclass engineers each year. With research expenditures topping $40 million and increasing each year, we continue to follow our tradition of excellence in spear-heading research that has a real, direct impact in the Houston region and beyond.

Cullen College of Engineering
UNIVERSITY OF HOUSTON

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