# Chemical Engineering at UCSB

2020 Newsletter

CHEMICAL ENGINEERING
UC SANTA BARBARA

# A LETTER FROM THE CHAIR

*Dear Friends,*

Fall is normally a wonderful time of anticipation in the department. Research is in high gear while we have had just enough time to wish one graduating class well in their future careers and begin to look forward to and plan for the arrival of a new generation of undergraduate and graduate students. The view from Engineering II is normally spectacular and May Gray and June Gloom make way for blue skies and white water below the cliffs. For all of us, 2020 has been a year of unprecedented and at times unsettling change, but the anticipatory feeling of Fall is the same. We are starting to see the opportunities amidst the challenges and renew our commitment to rising above the storm for the betterment of our society.

I cannot say enough about the remarkable ways in which our faculty, staff, and students have been a bright light this year. As we made an abrupt shift to remote teaching and shut down of experimental research laboratories, creative, innovative solutions emerged from every corner. A core group of faculty taught a series of crash courses in online teaching in early March just before an abrupt shift to remote instruction at the end of winter quarter. We held similar trainings for spring quarter TAs, who later helped us discover that online submission and grading of work is remarkably easier than the usual way. The faculty have now spent this summer realizing that the ability to slow us down and replay us (via recorded lectures) led to greater learning for some students while the loss of personal connection was hard on all of us. In preparation for fall, we are now digging deeper into online teaching including the use of technologyand realizing this is an opportunity for smaller group instruction and "flipping the classroom" in new ways. We are also now designing "take home", remote controlled, and other socially distanced laboratory experiments in transport phenomena, unit operations, and process control in anticipation of a fully remote or hybrid undergraduate laboratory experience.

To keep department community strong, we have held town hall meetings twice monthly with graduate students and researchers since the beginning of March, to brainstorm ideas ranging from COVID mitigation strategies to diversity, equity, and inclusion practices. One discussion at these town halls inspired the creation of a summer virtual seminar series for our faculty to present their recent research and a bit about their own career and personal histories to the department and incoming graduate students, which has been a particularly successful and unique opportunity for us all to get to know each other's work better. While the University officially went remote in March, the UCSB Student Needs Advising Center remained open continuously providing Chromebooks, hand sanitizers and may other resources. The ChemE department has actively distributed departmental laptops to students in our design courses to manufactured hand sanitizer (see picture of myself, Prof Pitenis and ChemE and Materials grad students in early March), 3-D printing face shields and mask clips, and testing respirators from the State's reserve (See page 7 of Convergence, https://engineering.ucsb.edu/convergence/). While our manufacturing is on hiatus, the needs of students for basic resources remains high and we encourage you to reach out to us if you are in a position to help.


ON THE COVER:

Three crystalline phases and one non-crystalline (amorphous) phase of calcium carbonate particles. Calcite is the most stable crystalline phase and vaterite the least. However, vaterite has important potential as a sink for carbon dioxide capture and re-use by a novel process described in Farmer, Schiebel, Chmelka & Doherty, "Polymorph Selection by Continuous Precipitation," Crystal Growth & Design, 18, 4306-4319 (2018).

In mid-June we were able to re-enter the research laboratories with very careful planning around social distancing, scheduling, and personal protective equipment. Each laboratory and building wrote detailed plans for building entry and laboratory practices with COVID prevention in mind which were coordinated at the College and University level. While limited access to laboratories has been an unprecedented challenge for experimental work, it has also been an opportunity to learn to plan research and remember
that every opportunity to do an experiment is valuable. It has also been heartening to see the multitude of ways in which researchers seized this opportunity to learncomputational/theoretical/data mining aspects of their work, write papers, and contemplate new collaborations. We strive to have diversity, inclusion, justice, and safety serve as cornerstones of our departmental culture — these values are foundational to scholarship and innovation. I am proud to be a part of the first university to officially be designated a Hispanic Serving Institution and also a member of the Association of American Universities (an association of America's leading research universities); we have a long way to go as a department, university, and society. We are now writing a new diversity plan that builds on our work in recent years in creating departmental practices and culture around our shared values of inclusion and equity with a new focus on recruiting students and faculty from different backgrounds in every sense. In that spirit, I extend an invitation to our students, alumni, and friends to share your thoughts and ideas for ways we can make our community more diverse and inclusive.


Warmly,

Rachel Segalman
ChE Department Chair

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# FACULTY HONORS & AWARDS

## PROFESSOR RACHEL SEGALMAN

### American Academy of Arts & Sciences

*Professor Rachel A. Segalman at at the induction ceremony*

Professor Rachel A. Segalman, Warren G. and Katherine S. Schlinger Distinguished Professor of Chemical Engineering and Edward Noble Kramer Professor of Materials, and Chemical Engineering Department Chair, was elected to the American Academy of Arts and Sciences, and inducted during a ceremony at Cambridge, Massachusetts, on October 12, 2019. One of the nation's most prestigious honorary societies, the academy is also a leading center for independent policy research. Members contribute to academy publications, as well as studies of science and technology policy, energy and global security, social policy and American institutions, the humanities and culture, and education.

Professor Segalman, along with UC Santa Barbara professors Alison Butler, José Cabezón, Brenda Major, joined 210 other new fellows and international members of the prestigious organization in 2019, including Michelle Obama, Michelle Martin, and Merrick Garland.

The Segalman group works to both understand the effects of structure on properties and gain pattern control in these inherently multidimensional problems, with particular interest in materials for energy applications such as photovoltaics, fuel cells, and thermoelectrics. Since its founding in 1780 by John Adams, John Hancock and 60 other scholars, the academy has elected more than 13,500 leading "thinkers and doers" from each generation, including George Washington, Alexander Hamilton, and Benjamin Franklin in the 18th century, Maria Mitchell, Charles Darwin, Ralph Waldo Emerson, and Daniel Webster in the 19th century, and Toni Morrison, Henry Kissinger, Martin Luther King, Jr., and Albert Einstein in the 20th century. Recently elected to academy membership includes Antonin Scalia, John Lithgow, Judy Woodruff, and Bryan Stevenson. The current membership includes more than 200 Nobel laureates and 100 Pulitzer Prize winners.

## ASSOCIATE PROFESSOR PHILLIP CHRISTOPHER

### Presidential Early Career Award for Scientists & Engineers (PECASE-Army)

Professor Phillip Christopher was selected as a recipient of the prestigious Early Career Award for Scientists and Engineers (PECASE-Army), by the Army Research Office, providing a total of $1 million worth of research funding over the course of the five year grant.

Prof. Christopher was nominated for the PECASE honor in 2015, while at UC Riverside, by Army Research Office Electrochemistry Program Officer, Dr. Robert Mantz, Division Chief of the Chemical Sciences Program. Prof. Christopher was given the PECASE award for his previous and future work on the topic of Controlling Catalysis at Metal Nanoparticle Surfaces by Direct Photoexcitation of Adsorbate-Metal Bonds. Prof. Christopher will continue this research at UC Santa Barbara.

### AIChE Catalysis and Reaction Engineering Division Young Investigator Award

Professor Phillip Christopher received the AIChE Catalysis and Reaction Engineering Division Young Investigator Award in 2020 which recognizes individuals who have made significant contributions to the science and/or technology of catalysis and chemical reaction engineering through publications or practice.

### ACS CATL Division Early Career in Catalysis Award

Professor Phillip Christopher received the ACS CATL Division Early Career in Catalysis Award in 2020 that recognizes and encourages accomplishments and innovation of unusual merit by an individual in the early stages of their career. This award is given to faculty within 10 years of receiving their PhD.

## PROFESSOR SONGI HAN

### Named Fellow of the International Society of Magnetic Resonance

The International Society of Magnetic Resonance named Professor Songi Han as an ISMAR Fellow, honoring her many contributions in the field of magnetic resonance, including both world-leading research activities and support of the magnetic resonance community. Honorees attended the EUROISMAR 2019 Conference in Berlin on August 25-30, 2019, an international conference on magnetic resonance.

### NIH R35 Maximizing Investigator's Research Award (MIRA)

Professor Han won the NIH MIRA award in 2020 that gives labs the freedom to pursue NIH funded research for 5 years and shape their research program with no strings attached, other than to pursue urgent basic biomedical questions.

## PROFESSOR MICHAEL DOHERTY

### Duncan and Suzanne Mellichamp Endowed Chair in Systems Engineering

Rod Alferness, Michael Doherty, Duncan Mellichamp, and Henry Yang.

Professor Michael Doherty was honored during a lecture and celebration for his appointment to the Duncan and Suzanne Mellichamp Endowed Chair in Systems Engineering, on April 17, 2019, at Loma Pelona on the UC Santa Barbara campus.

The afternoon began with a program and presentation by Professor Doherty, "The Rest of the Universe is Running on Hydrogen. Why Aren't You?", followed by a reception on the Loma Pelona Patio.

Guests in attendance for the celebratory event included Duncan and Suzanne Mellichamp, benefactors of the endowed chair, Chancellor Henry T. Yang, College of Engineering Dean Rod C. Alferness, Department of Chemical Engineering Chair Rachel A. Segalman, faculty, staff, students, and many friends of UCSB Chemical Engineering.

In addition to the Endowed Chair position, Professor Doherty received the AIChE John M. Prausnitz Institute Lecturer Award this year. This lectureship is awarded to a distinguished member of the Institute who has made significant contributions to the chemical engineering sciences in their field of specialization.

## PROFESSORS MICHAEL GORDON AND SCOTT SHELL

### Rinker and Myers Professors of Chemical Engineering

Back row: Rod Alferness, Duncan Mellichamp, and Henry Yang. Front row: Michael Gordon and M. Scott Shell.

Professors Michael Gordon and M. Scott Shell were honored during inaugural lectures and a ceremony for their appointments to the Founder's Chair in Chemical Engineering in Honor of Dr. Robert G. Rinker conferred upon Gordon, and Dr. John E. Myers conferred upon Shell on April 22, 2019, at Loma Pelona.

The afternoon featured a presentation by Professor Shell titled, "Molecular Simulations to Understand and Design Complex Materials", and a presentation by Professor Gordon titled, "Manipulating Light with Nanostructures." The presentations were followed by a reception overlooking the UCSB Lagoon. The appointments were made possible by the generosity of Professor Duncan and Suzanne Mellichamp H'09/MA'70, Michael R. Costello '88, Bob Deshotels '72, Darryl T. McCall and Miren Letemendia '78, Dr. John A. Myers and Dr. Rachel Wheeler, William and JoEllen Myers, Dr. Edward and Cynthia Rinker '97, and Michael F. Saucier '83.

# FACULTY HONORS & AWARDS

## PROFESSOR MICHELLE O'MALLEY

### Science News Magazine's 10 "Scientists to Watch"

Professor Michelle O'Malley was named to the annual list of groundbreaking scientists, recognizing early- and mid-career scholars, age 40 or under, who are shaping the science of the future. Awardees were all nominated by Nobel laureates, recently elected members of the National Academy of Sciences, and past Science News scientists to watch. 2020 ASM Award for Early Career Applied and Biotechnological Research.

The 2020 American Society for Microbiology awards in research, education, and leadership, recognized Professor Michelle O'Malley with the ASM Award for Early Career Applied and Biotechnological Research. The award is presented to an early career investigator with distinguished research achievements in the development of products, processes, and technologies that have advanced the microbial sciences.

### 2020 Awardee for the Food, Pharmaceutical, and Bioengineering Division Early Career Award

Professor O'Malley received the inaugural award of the AIChE Division of Food, Pharmaceutical, and Bioengineering Division that is meant to recognize research leadership and accomplishment by an early career member of the Institute.

### American Institute of Medical and Biological Engineering (AIMBE) Fellow

Professor O'Malley was elected as a AIMBE Fellow in 2020. AIMBE Fellows represent the top 2% of medical and biological engineering community, who are nominated by their peers and selected for their contributions in research, academia, industry, and government.

## ASSISTANT PROFESSOR ARNAB MUKHERJEE

### NIH R35 Maximizing Investigator's Research Award

The National Institute of General Medical Scienes awarded Professor Arnab Mukherjee with the Maximizing Investigator's Research Award (MIRA). The program's goal is to provide exceptionally stable funding for five years for "the nation's highly talented and promising investigators," to enhance scientific productivity and the chances for important breakthroughs.

### Discovery Award from Department of Defense Peer-Reviewed Medical Research Program

Professor Mukherjee received the Discovery Award from the Peer Reviewed Medical Research Program to develop imaging technologies for monitoring intracellular energetics in anaerobic microorganisms.

## PROFESSOR MATT HELGESON

### Neutron Scattering Society of America Science Prize

Professor Helgeson received the 2020 Science Prize of the Neutron Scattering Society of America (NSSA) for his development and use of neutron scattering methods with application to nonequilibrium thermodynamics and rheology of complex fluids and soft materials. NSSA established the Science Prize to recognize a major scientific accomplishment or important scientific contribution within the last 5 years using neutron scattering techniques.

# DONOR SPOTLIGHT

## WHERE THEORY AND PRACTICE MEET

**The Rinker Undergraduate Teaching Lab is a study in the power of alumni**

Named after one of the Chemical Engineering Department's founding faculty members, Professor Emeritus Robert G. Rinker, the Rinker Undergraduate Teaching Lab is the home for two core upper-division courses on Unit Operations. In the lab, students apply their knowledge from previous courses in transport phenomena, thermodynamics, reaction kinetics, process control and separations to run hands-on experiments modeled after industrial processes. Students, working in 3-person teams, learn to safety design and perform the types of experiments necessary for their future careers.

In 2007, generations of grateful alumni from the department established the Rinker Undergraduate Teaching Lab Endowment to celebrate both Dr. Rinker and the department's 40th anniversary. Both alumni and faculty recognized the need for continued support to modernize the laboratory facilities and ensure the department can maintain a state-of-the-art teaching facility. Alumni enthusiasm for Rinker Lab did more than raise money; the dean responded by appointing a full-time professor, Mike Gordon, to lead a major renovation effort for the facility. Professor Gordon holds the Founder's Chair in Chemical Engineering in honor of Dr. Rinker has been a consistent leader for the faculty team that teaches the undergraduate laboratory courses.

In 2011, through the alumni-funded Rinker endowment and other philanthropy, Professor Gordon started a multi-year effort by removing bulky and outdated steam-powered experiments to construct modular experiment units that can more easily evolve with the field. The sustained support allows the lab to upgrade existing equipment and construct custom-build experiments that fit the department's pedagogical requirements.  Recent additions to the lab include pressure-swing adsorption columns to purify air, a laser doppler velocimetry experiment to non-invasively measure fluid boundary layers, and a pumping station to measure fluid properties and pump dynamics.

The focus of the lab is to give students an opportunity to put classroom theories into practice with hands on learning.

*Darryl McCall, '78*
*UCSB Foundation Trustee*

*Jim Heslin '73*

"You might not remember an incorrect answer on a test, but you'll remember a mistake in the lab," said Carolina Espinosa '19. Her classmates agree that the hands-on learning is effective. Professor Mike Doherty was appointed as the department chair just before the 40th reunion that catalyzed the Rinker Undergraduate Teaching Lab fundraising effort. He was too familiar with the universal problem of supporting a modern teaching lab but not having a direct line item in the budget. "It never occurred to me that the answer to the problem of having no budget was to fix it yourself," Professor Doherty said. Starting with Professor Doherty's leadership, over 200 chemical engineering alumni have since united to support the Lab. Among them was one of the first UCSB chemical engineering students, Jim Heslin '73. For the department's 50th anniversary in 2017, Jim and UC Santa Barbara Foundation Trustee Darryl McCall '78 offered a joint matching gift to encourage alumni to reach an endowment goal of one million dollars that will fund the lab in perpetuity.

Jim's support is rooted in his belief in public education. "I owe my entire professional existence to the University of California," said Jim, who went on to law school at UC Berkeley. "All UC graduates must understand that it's up to them to support the UC system."

In 2019, Darryl made a final gift that push the department over its fundraising goal and ensured that the endowment payments would meet the lab's ongoing needs. Throughout his 12 years of fundraising for Rinker Lab, Darryl was motivated by helping undergraduates transfer their skills from academia to professions in industry.

"I knew if you gave people the right equipment, there'd be enough time left over to understand the practicalities of things," said Darryl.

Darryl, Jim, Professor Gordon, Professor Doherty, and hundreds of alumni have built a lab where undergraduates can practice skills that transfer from university to industry.

# RESEARCH FOCUS

## PROFESSOR MICHAEL DOHERTY

### Crystals Are All Around Us

Mike Doherty was born a few years after the end of WW II and grew up in Manchester, England while rationing was still in force and where large sections of major British cities were still rubble and bomb sites. Manchester was not an attractive city in those days (although it has undergone a great deal of rebuilding since), and Mike was determined to go to university far away at Imperial College in the West End district of South Kensington, London. London was an exciting place to live in the late 1960s and early 70s for an 18 year old student, and Mike soon discovered that South Kensington was home to many iconic British rock musicians such as Keith Richards who lived just a few blocks away (if you want to get an impression of what it was like to grow up in the 60s read Keith Richards autobiography, *Life* – but beware, this book is not for the faint hearted). On weekends, the bands would play at the many university and club venues in London providing wonderful diversions from ChE labs and homework!

After a handful of action-packed years in London, Mike moved to the more bucolic setting of Trinity College Cambridge to study for his PhD in chemical engineering. Trinity was the home of Isaac Newton, James Clerk Maxwell, Ernest Rutherford, Lord Rayleigh, and many other household names in science – thus we all knew our station. As an undergrad he had been heavily influenced by two professors who set the course for the rest of his career. They were Roger Sargent – the founder of process systems engineering, and John Rowlinson – a world leading figure in both classical and statistical thermodynamics. Both men were inspiring teachers and mentors. In Cambridge, Mike was fortunate to team up with John Perkins, a brilliant young chemical engineering academic, as his doctoral advisor who generously allowed Mike to define his own PhD research topic at the intersection of those fields. He wrote a dissertation on the topic of residue curve map technology which became the basis of the first half of his scientific career at the Universities of Minnesota, Massachusetts and UC Berkeley (where he spent a wonderful lengthy sabbatical in the group of John Prausnitz in the mid-1980s).

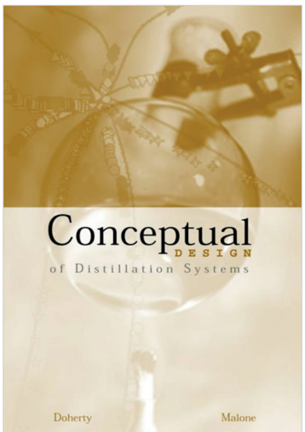



*Figure 1. Cover of Conceptual Design of Distillation Systems.*

During this time Mike and his group extended residue curve map technology to complex multicomponent distillations involving both reactions and azeotropes, all the while collaborating closely with many international chemical companies. Some of the more notable collaborations included working with Eastman Chemical Company on new distillation systems for their chemicals-from-coal technology; with DuPont on their freon replacement technology for combating ozone depletion caused by chloro-fluorocarbons (CFCs); and with GE Plastics on reactive distillation technology for producing polycarbonates without the use of phosgene. During this period he had active and enjoyable collaborations with his colleagues Jim Douglas and Mike Malone with whom he shared many doctoral students and postdoctoral researchers. This period of his career culminated with the publication of his book in 2001, *Conceptual Design of Distillation Systems* which he co-authored with Mike Malone.

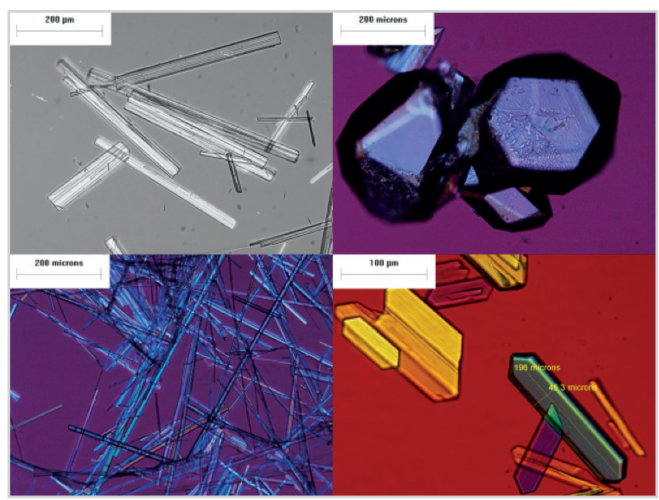



*Figure 2. Selection of pharmaceutical crystals showing typical range of shapes and sizes ranging from polyhedral (top right panel) to rods (top left, bottom right panels) to needles (bottom left panel). Provided courtesy of Merck.*

As the book was being published Mike's wife advised him to find something else to study for the second half of his career, saying, "after all Mike, you wrote the book – what more is there for you to discover in that subject?" So, he switched fields to crystal engineering and in the summer of 2000 he moved from Massachusetts to Santa Barbara where he intends to stay until they carry him out.

Why crystals? Well, crystals are all around us; they are in the kitchen (sugar and salt, and many spices), in the medicine cabinet (almost all medicines are formulated as crystalline products – see Figure 2 - which is a $1 trillion per year industry worldwide, accounting for more than 1% of global GDP), they are in your lightbulbs and LEDs (see Figure 3), and in your jewelry. They are everywhere in nature on land and in the oceans. The shells of all crustaceans are made of calcium carbonate crystals – the subject of biomineralization is hugely popular. Crystals can be very small (tungsten crystals in traditional lightbulbs are about 5 microns in size) or very large – the geological crystals in Figure 4 are many meters in size. Crystals are ubiquitous in industry in "good" forms such as catalysts (metal nanoparticles, metal oxides, zeolites, etc.), and in "bad" forms such as scales on pipes and process equipment. And all the crystals cited above grow the same way! But the mechanism of growth was not discovered until 1951.

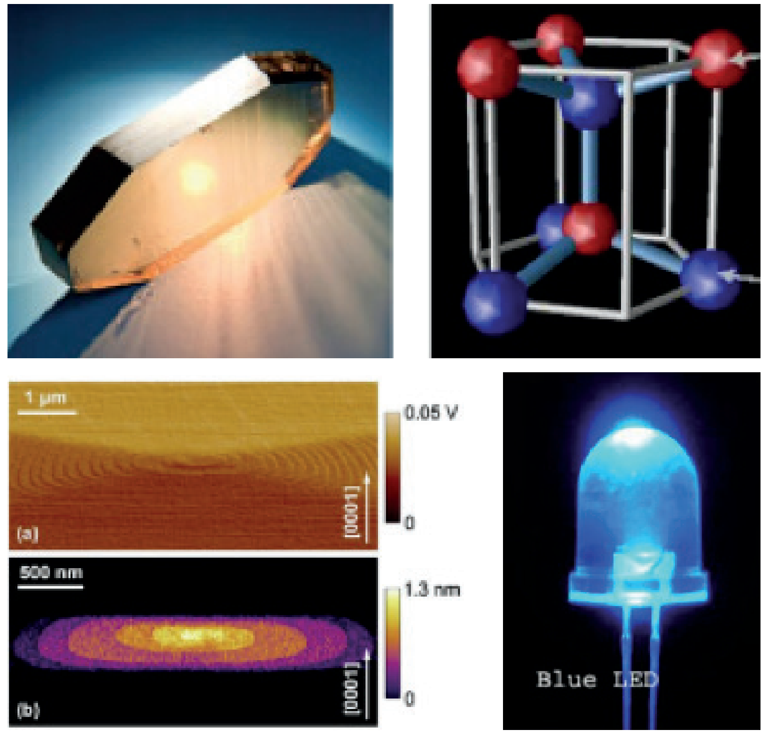



*Figure 3. Gallium nitride crystals used in light emitting diodes (LEDs). Nakamura et al, Appl. Phys. Lett. 96, 231907 (2010).*

Prior to 1951 scientists had pondered the question of crystal growth for over a century without success. It was known that a perfectly flat crystal surface could not grow at low levels of supersaturation, yet it was also known through countless experiments and observations in nature that crystals did grow at low supersaturation. This became one of the foremost unsolved problems in solid-state physics, and it took the genius of Sir Charles Frank (a remarkable physicist at Bristol University) to propose an answer. His proposal was so counter-intuitive that it was rejected at first by many in the field. He proposed that crystal surfaces grew by spirals emanating from surface defects on the crystal faces. Since nobody had ever seen a crystal surface at the resolution needed to detect spirals it was easy to reject Frank's concept. The matter was soon settled however by the invention of electron microscopy which made it possible to image surfaces at the nano length scale necessary to observe the surface structures, and behold, the images revealed beautiful spirals decorating a variety of crystal surfaces – organic crystals, inorganic crystals, zeolite crystals, and many more (see Figure 5). This has led to the adage in crystal growth that crystals are like people, it is their defects that make them interesting.

*Figure 4. Cueva de los Cristales. Cave of the Crystals or Giant Crystal Cave is a cave connected to the Naica Mine at a depth of 300 meters (about 1000 ft), in Naica, Chihuahua, Mexico. The main chamber contains giant selenite crystals (gypsum, $CaSO_4 \bullet 2H2O$), some of the largest natural crystals ever found. The orange objects are people.*

For the past 20 years Doherty and his group have focused on developing high fidelity mechanistic growth models based on spiral growth (and also on other mechanisms of growth) that has resulted in the awarding of 14 PhD degrees (with 3 more in progress) and many postdoctoral researchers, and undergraduate research assistants. Along the way there were terrific collaborations with Glenn Fredrickson and Baron Peters, who provided both insight and expertise in statistical mechanics, with Duncan Mellichamp, who provided novel approaches to engineering economics and more, and with Brad Chmelka, whose expertise in NMR techniques allowed for much deeper understanding of bonding and molecular interactions on crystal surfaces at the nanoscale. One useful engineering product from all this scientific research is a digital design aid which we call ADDICT for predicting the morphology of organic crystals, especially drug crystals. All of the financial support for the development of ADDICT has come from name brand pharmaceutical companies, many of them are actively beta-testing ADDICT to help us make it a useful tool in the workflow of new drug product and process development. After 45 years of fun, Doherty's career continues to live at the intersection of thermodynamics, kinetics and process engineering.

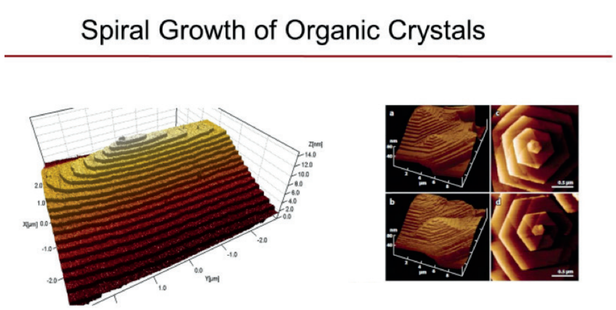



*Figure 5. Growth spirals on the surfaces of crystals imaged by atomic force microscopy. Left, (001) face of paracetamol, imaged by Zubin Kuvadia and published in Kuvadia and Doherty, AIChE Journal, 59, 3468 (2013). Right (001) face of L-cystine imaged by Jeff Rimer and published in Rimer, An, Zhu, Lee, Goldfarb, Wesson and Ward, Science, 330, 337 (2011). See the Mike Ward web site for amazing AFM images of spirals turning in real time on crystal surfaces. wardresearchlab.com/videos*

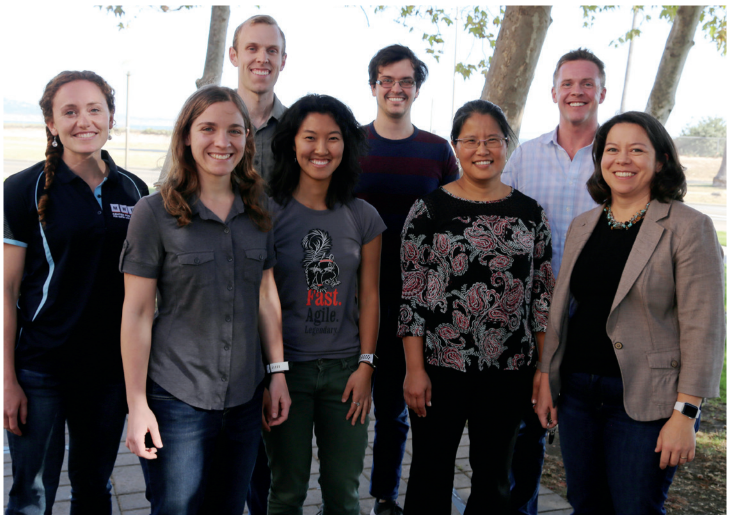
# INDUSTRIAL PARTNERSHIPS: M-WET

## Efficient Next-Generation Membranes

Synthetic polymer membranes are widely used to purify water, but currently available membranes are ineffective when it comes to cleaning water, such as that used in oil and gas production, that is heavily contaminated with diverse pollutants and toxins. Better membranes are needed, but gaps in scientific understanding stand in the way.

In 2018 the U.S. Department of Energy provided a four-year, $10.75 million grant to fund the Center for Materials for Water and Energy Systems (M-WET) as one of its Energy Frontiers Research Centers. Involving teams at UCSB, the University of Texas Austin (UT), and the Lawrence Berkeley National Lab, the highly collaborative center is intended to address those gaps and develop transformative polymer materials for energy-water applications.

UCSB M-WET researchers include nine UCSB professors and numerous graduate students and postdoctoral researchers working in four collaborative research units — three "Gap Attack Platforms" (GAPs) and an Integrating Framework group. Here, graduate students and postdocs share what each GAP is doing.



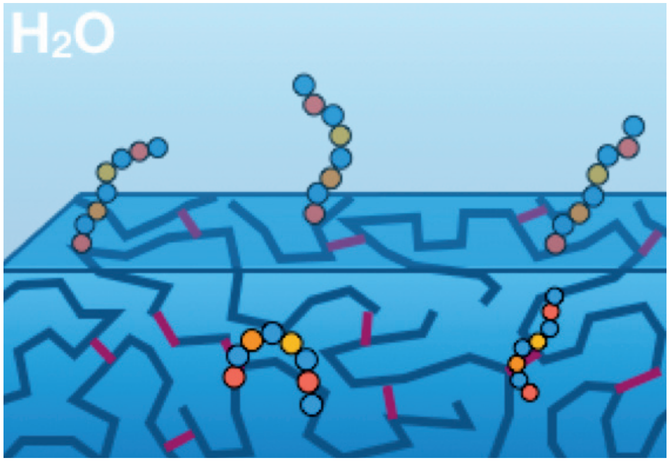
*(L to R) Audra DeStefano, Mikayla Barry, Thomas Webber, Sally Jiao, Dennis Robinson-Brown, Prof. Songi Han, Prof. Scott Shell, Prof. Rachel Segalman*

### GAP 1: EMERGENT PROPERTIES OF FLUIDS AND INTERFACE

Third-year PhD researcher Sally Jiao says that the challenge for her GAP 1 colleagues is to use experimental and computational characterization techniques to understand and tune the nanoscopic interactions between surfaces, solutes, and water.

Jiao explains that the entire M-WET center is focused on studying a single nanoscale membrane platform called the universal membrane chemistry platform (UMCP). "It is a specific triblock co-polymer used to create the membrane," she says. "The polymer is composed of three different blocks, and you get a bunch of the self-assembling blocks together to create a porous structure. You can remove single blocks to create pores that allow solutes to pass through, and other blocks can be functionalized with polymers called peptoids, to modulate the hydrophobicity and hydrophillicity of the surface."

"Another person in GAP 1 is working on modeling the part of the triblock copolymer that forms the surface adjacent to the water, and I'm working on testing models for the peptoids" Jiao says. "Eventually we'll put those models together and simulate the actual realistic surface that the water is going to see."



*Sequence-specific polymers, polypeptoids, tethered to a polyethylene-glycol surface provide an ideal model system to probe the effects of nanoscale chemical heterogeneity on water and solute behavior.*

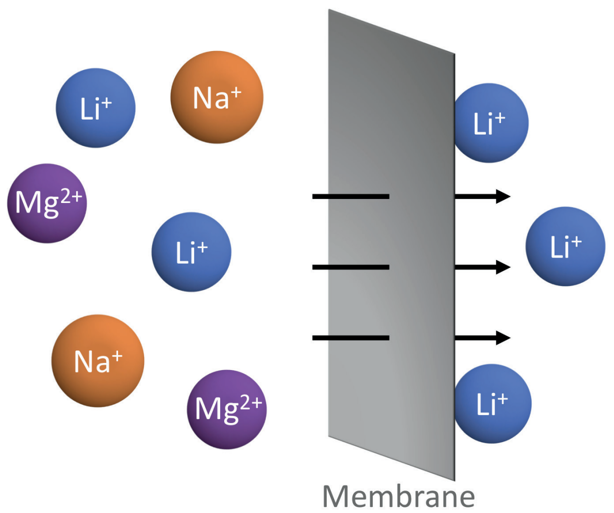
### GAP 2: DESIGNING SPECIFIC INTERACTIONS

"In M-WET, we want to design membranes for the specific water and the specific purpose we're interested in," says Sam Warnock, a second-year PhD student on GAP 2. The group is working to design a thin separation layer that has selected chemical functionalities incorporated into it to target specific solutes the researchers either want to remove from the water and save for use, such as lithium for batteries, or remove and discard, such as pollutants like boron. "In this case, we hope to change the membrane's transport characteristics so that it will interact specifically with lithium, ignoring other ions, such as sodium and magnesium," Warnock says.

The work requires he and research partners, Shou Zhao and Kalin Hanson, to examine various aspects of the polymer, especially *water uptake*, which is the mass of water inside the membrane divided by the mass of the membrane itself. That ratio dictates the amount of free volume inside a membrane.

"Too much free volume and ions can pass right through, because they won't meet any resistance," Warnock notes. "Too little, and transport of ions will be slow, resulting in lower throughput"

Gap 2 researchers are inspired by natural, biological membranes, which achieve both rapid transport and high selectivity. Says Warnock, "We hope to achieve similar results by adding these selective interactants while optimizing materials properties like water uptake"




*A lithium-selective membrane allows lithium ions to pass through while rejecting other ions, such as sodium and magnesium*

## GAP 3: MESOSCALE STRUCTURES TO TAILOR FLUID FLOW

"The membranes commonly used in the water-purification industry look a lot like Swiss cheese or sponge, with the holes, called pores, having different sizes and shapes in the nanometer scale" says Ségolène Antoine, a postdoctoral researcher on GAP 3.

"Understanding the relationship between the membrane's pore structure and the flow of solvent versus solute [dissolved particles] is crucial for developing next-generation membranes," she explains. "Our mission consists of understanding the relationship between the structure of a membrane and its properties."

GAP 3 researchers seek to develop membranes having controllable and tunable pores with known and optimized geometry and pore-wall chemistry, in order to establish a relationship between the membrane architecture and the resulting transport of water and solute through the membrane. "In this project, we employ multiple experimental and computational tools, both to generate membranes of varying geometrical parameters and to characterize their performance," Antoine says.

The team is also developing a model for the transport of fluids in moderately sized, moderately complex cylindrical pores to understand how these parameters depend on pore geometry and on the chemistry of both pore wall and fluid," says Antoine. "After comparison with experimental results, this model will serve as the training set for the design of the 'best' pore."

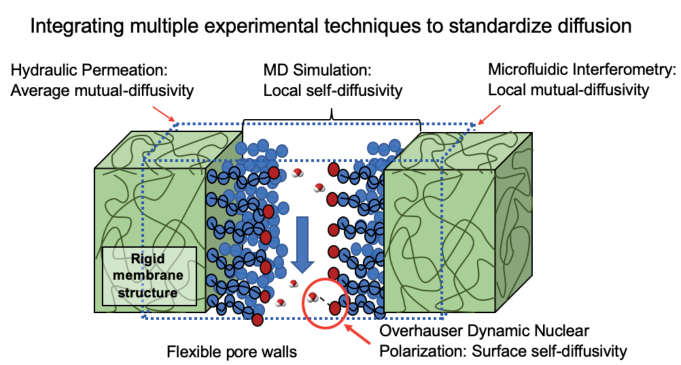
## THE INTEGRATING FRAMEWORK

According to third-year PhD student Varun Hegde, the main job for him, his UCSB faculty colleagues in the mathematically oriented Integrating Framework Group — Professors Michael Doherty and Todd Squires — and their UT collaborators is twofold: "to make sure that all the groups can relate to each other's work, and to help direct future research."

In the former effort, standardization of an important central value is key. "When we look at a membrane, we want to know what its permeability is, and that is often dominated by the diffusion coefficient of the solvent moving through it," Hegde says. "All the different GAPs, through all their different experiments, interact with this value in some way."

Various important processes — simulations, macroscopic flux measurements, microscopic interferometry measurements, and nuclear magnetic resonance measurements to study water molecules moving in polymer membranes — can be used to determine diffusion coefficient values that are not necessarily the same.

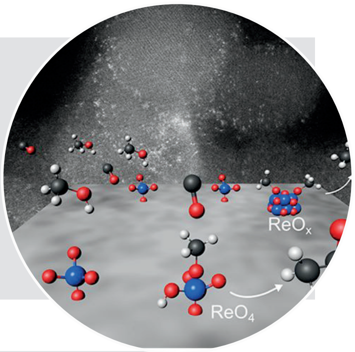
"You can get a different form of the value depending on whether conditions change or you factor out a variable for a given experiment or simulation," Hegde notes. "It is important that the value is either always the same or, if it isn't, it is important to know why so we can standardize the theoretical transport framework. We hope that this will allow other researchers to use M-WET determined values in the context of their research."

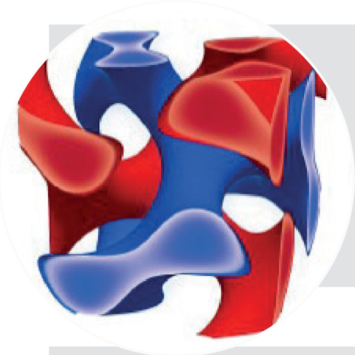



*The IF is investigating solvent diffusion within porous membranes with PEO chains grafted to the pore walls using an integrated set of experimental and computational techniques at multiple length scales.*

# RESEARCH HIGHLIGHTS

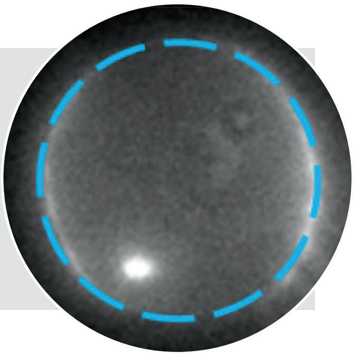
*Selective Methanol Carbonylation to Acetic Acid on Heterogeneous Atomically Dispersed ReO4/SiO2 Catalysts. J. Am. Chem. Soc., 2020*
In this paper, the **Christopher** group introduces a new class of promising heterogeneous catalysts for methanol carbonylation to acetic acid with rates and selectivity that compete with industrial homogeneous catalysts without requiring halide co-feeds.



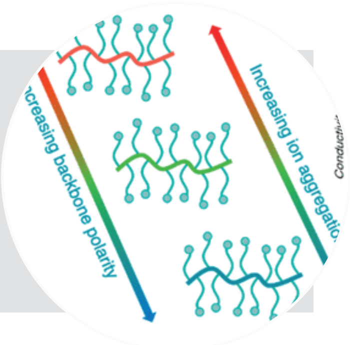
*Complete Photonic Band Gaps with Nonfrustrated ABC Bottlebrush Block Polymers. ACS Macro Lett., 2020.* In this paper, the **Fredrickson** group developed a new modeling workflow to guide the design of bottlebrush block polymers with novel optical properties, such as full photonic band gaps.

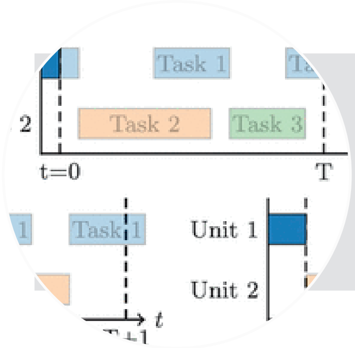
*Active Contact Forces Drive Nonequilibrium Fluctuations in Membrane Vesicles, Phys Rev Lett, 2020.* In this paper, the **Takatori** lab analyzed the deformations of membrane vesicles encapsulating motile bacteria, groupnd observed a significant increase in the magnitude of the membrane fluctuations owing to bacteria-membrane collisions, compared to the thermal equilibrium spectrum.



*Dynamic Bottlebrush Polymer Networks: Self-Healing in Super-Soft Materials. J. Am. Chem. Soc., 2020.* In this paper, the **Bates** group developed a type of super-soft elastomer that can self heal in analogy to living tissue.

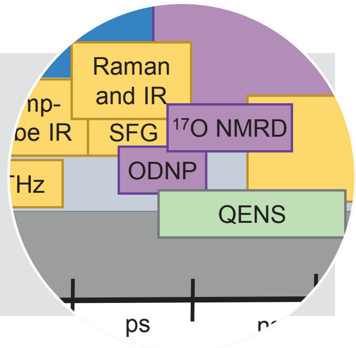
*The Role of Backbone Polarity on Aggregation and Conduction of Ions in Polymer Electrolytes. J. Am. Chem. Soc., 2020.* In this paper, the **Segalman** group, in collaboration with the **Fredrickson**, **Seshadri**, and **Han** groups demonstrate new design rules for polyelectrolytes to transport multi-valent ions based on ligand-coordination bonds.

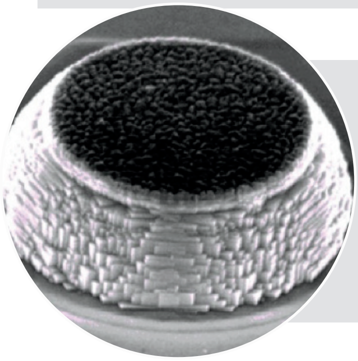



*Rescheduling Penalties for Economic Model Predictive Control and Closed-Loop Scheduling. Ind. Eng. Chem. Res., 2020.* In this paper, the **Rawlings** group modify economic model predictive control to allow rescheduling to be penalized for production scheduling applications and establish that this modification does not affect the performance guarantees of the original economic model predictive control formulation.

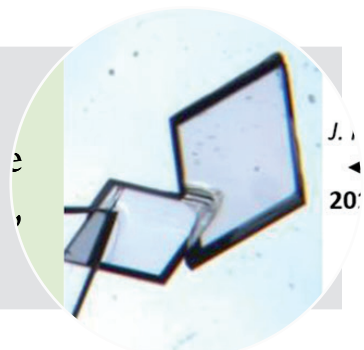
*Water Structure and Properties at Hydrophilic and Hydrophobic Surfaces. Annu. Rev. Chem. Biomol. Eng., 2020.* In this review paper, the **Shell**, **Han**, and **Segalman** groups, along with collaborators in the Center for Materials for Water and Energy Systems highlight experimental and computational techniques that shed light on the numerous open and fundamental questions regarding the nanoscopic behavior of water near chemically complex surfaces and its consequences *for functional properties of the interface.*

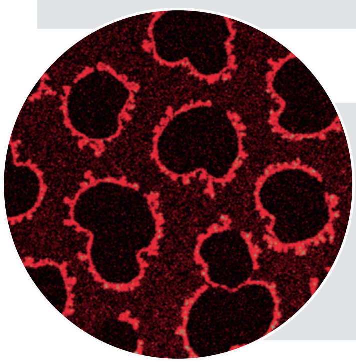


*Revealing the Importance of Light Extraction Efficiency in InGaN/GaN microLEDs via Chemical Treatment and Dielectric Passivation. Appl. Phys. Lett., 2020.* In this paper, the **Gordon** group showed how nonradiative losses in next-generation microLEDs can be minimized with appropriate processing and that light extraction efficiency can actually be increased as device sizes shrink below 10 microns.

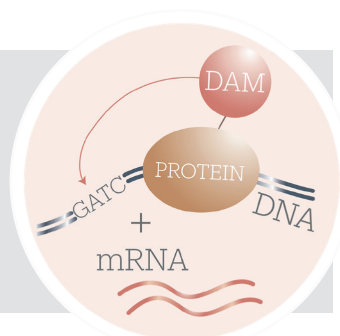
*A New Software Framework for Implementing Crystal Growth Models to Materials of Any Crystallographic Complexity. Cryst. Growth Des., 2020.* In this paper, the **Doherty** group has developed a new software architecture for our digital crystal design tool that allows it to predict the morphology of organic materials of any crystallographic complexity. This advance paves the way for predicting how the crystal growth environment (solvent, supersaturation, etc.) steers pharmaceutical crystals toward desired shapes.

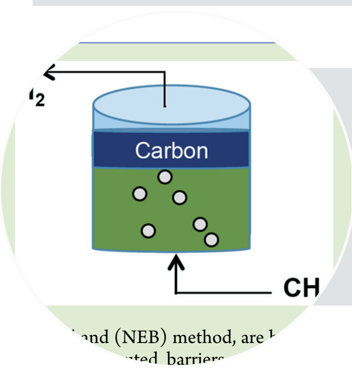




*Interfacial Rheology and Direct Imaging Reveal Domain-templated Network Formation in Phospholid Monolayers Penetrated by Fibrinogen. Soft Matter, 2019.* In this paper, the **Squires** group discovered a mechanism by which a blood serum protein can 'inactivate' a model lung surfactant film, as occurs during Acute Respiratory Distress Syndrome (ARDS).

*Simultaneous quantification of protein–DNA contacts and transcriptomes in single cells. Nat. Biotechnol., 2019.* In this paper, the **Dey** lab developed the first sequencing technology to simultaneously quantify genome-wide protein-DNA interactions and mRNA from the same cell to understand how variability in upstream epigenetic regulators tune gene expression heterogeneity.




*Methane Pyrolysis with a Molten Cu–Bi Alloy Catalyst* In this paper, the **McFarland** group combine theory and experiments. The group showed that in a molten combination of two metals, which are poor catalysts for C-H bond activation, high activity for complete decomposition of methane can be achieved.

# POST DOC PROFILE: HARUN OZBAKIR

## DARYL AND MARGUERITE ERRETT DISCOVERY AWARD IN BIOMEDICAL RESEARCH FOR 2019-20

Department of Chemical Engineering Postdoctoral Researcher Harun F. Ozbakir, of the Mukherjee Lab, was selected to receive the Daryl and Marguerite Errett Discovery Award in Biomedical Research for 2019-20.

The award honors Daryl and Marguerite Errett, by providing support to one outstanding post doc or research professional annually, to enable cutting-edge research in biomedicine and to launch promising projects that nurture the careers of gifted young investigators who will have an impact on pioneering developments that advance human health. The award is highly competitive, bestowing upon the recipient a significant measure of independence. Recognition from the honor supports Ozbakir's research to engineer the first genetically encodable MRI reporter for imaging calcium activity.

"I am incredibly honored that I was selected to receive this prestigious Discovery Award, and I cannot thank the committee enough for recognizing and supporting this innovative research," Ozbakir said.

The total amount of the award is $70,500, and can be used to cover salary and benefits for himself or a researcher working on the project, research supplies, or access to equipment or instrumentation. Ozbakir's long-term goal is to start an independent career in a university setting that affords ample opportunities to teach, mentor, and conduct cutting-edge research.

"The recognition and funds by the Errett Fisher Foundation will have a significant impact to help me continue and enhance my journey towards an academic career," he said.

As part of Professor Arnab Mukherjee's Lab, Ozbakir's research focuses on calcium importance as a signaling molecule with critical roles in regulating several neurological functions including learning, memory, addiction, and neurodegeneration.

"Researchers have developed various calcium-responsive fluorescent proteins – which can be detectable with optical techniques – for studying neural signaling in cells and organisms for the past few decades," Ozbakir explained. "Unfortunately, these fluorescent proteins are not optimal for studying calcium activity in deeper tissues and do not provide full brain coverage."

Magnetic resonance imaging (MRI) is an alternative to these techniques as it provides ways to safely and noninvasively image organisms with full brain coverage. However, the issue is that there are no available MRI-compatible proteins for studying calcium activity in live organisms.

"Recently, we hypothesized that a calcium-sensing protein could be used for this purpose, and our preliminary experiments confirmed our hypothesis," Ozbakir said.

*Harun Ozbakir*

"Building on these very exciting results, we are now working on engineering the first genetically encodable MRI reporter protein for imaging calcium activity."

He finds that one of the more challenging aspects in his research is the shift from the first phase of his research on bacterial organisms to his current work with mammalian organisms.

"I am currently working with mammalian organisms, which are more complex than bacteria. This has its own challenges and difficulties, but it is very rewarding to learn something new about this organism and address the issues that may arise," Ozbakir explained.

Additionally, he has been using MRI frequently and learning new aspects as part of his research.

"Having no experience with MRI prior to my postdoctoral studies, it has been very interesting to learn how it works and how to get good images," he said.

Ozbakir first met Professor Mukherjee during a Skype interview for his current position, and he is grateful to have found a supportive mentor who has provided him with ample opportunities for his research career.

"During that interview, Professor Mukherjee's enthusiasm while describing his lab's research interests made me very excited and was one of the reasons I wanted to work with him," Ozbakir said. "I am glad to have done so."

# POST DOC PROFILE: JOAQUIN RESASCO

## JOAQUIN RESASCO
## FORBES 30 UNDER 30

A large portion of today's commodity chemicals — which underlie many of the products we use — are based on processes enabled by petroleum, a finite resource is environmentally costly to extract and produce. Joaquin Resasco foresees this changing, with his own work potentially playing a role.

A chemical engineering postdoctoral researcher at UC Santa Barbara, Resasco anticipates a future in which the chemicals we rely on to run our modern lives will come by way of green methods, sustainable processes and renewable sources.

"Today this industry revolves around petroleum, but it could be replaced by one that runs off renewable electricity," said Resasco, a researcher in chemical engineering Professor Phillip Christopher's group. "Renewable electricity could provide the energy to take air and water and turn them into chemical building blocks. Then, with additional renewable electricity, these building blocks could be stitched together to create the products that our society relies on."

For his far-sighted efforts aimed at "shifting the decades-old paradigm of using petroleum for chemical energy," Resasco, 29, has been named to Forbes' 30 Under 30 list in the Science category. He joins a cohort of 600 young movers and shakers in a total of 20 categories for Forbes' class of 2020.

"This is a great recognition of Joaquin's accomplishments early in his career, along with the significant potential of his future research," Christopher said. "Joaquin is a deep thinker and I expect interesting and impactful science and engineering research to continue to come from his work."

"I was ecstatic when I heard the news," said Resasco, who arrived at UC Santa Barbara in 2018 after obtaining his Ph.D. in chemical engineering from UC Berkeley. "I feel honored to be part of a group with such talented and influential people."

He chose to come to UCSB, he said, specifically to learn from Christopher's expertise with catalytic materials — a class of materials that enable chemical reactions without themselves being consumed by the reaction. Resasco's specific goal is to discover electrocatalysts that can use renewable electricity sources to replace the conventional ones that rely on petroleum as sources of energy to power these reactions.

"These processes, added together, use as much energy and produce as many greenhouse gases as transportation worldwide," Resasco pointed out.

"Making efficient catalysts driven by renewable electricity could single-handedly replace the fossil fuel-based chemical industry."

Though they are often overshadowed by the processes and products they enable, catalysts are vitally important to our modern lives; without them, reactions used to produce common products and goods may happen far too slowly or not at all.

"Catalysis fascinates me because it allows you to use an understanding of what is happening at a molecular level to control large-scale industrial processes," Resasco said. "At a place like UC Santa Barbara, I can work on cutting edge research in catalysis and contribute to next-generation sustainable solutions."

*Joaquin Resasco*

# UCSB AIChE STUDENT CHAPTER NEWS

*As one of the most active professional societies on campus, UCSB AIChE is fully invested in catalyzing the professional development of our members through industry speaking events, plant tours, career building workshops, and research seminars. The goal of our organization is to create an opportunity-enriched environment in which students can fulfill their true potential.*

**Professional Development**

UCSB AIChE partners with numerous industries to create an environment where industry representatives can interact with and recruit directly from chemical engineering students. We host, co-host, or otherwise promote over a dozen events with companies ranging from small start-ups to global corporations. We've hosted process engineers from local startups (Apeel). Our organization also holds strong ties with Clorox, our main sponsor, who has continued to return in support of UCSB AIChE and to recruit multiple interns and full-time graduates each fall. Beyond recruitment, we host plant tours to Hyperion water reclamation plant, Clorox, and Apeel. Another one of our more popular events, Lunch with Faculty, establishes dialogue between students and professors. Not only is this is a great chance to learn more about the department and possible paths to graduate school, but students can also find out what professors do outside of office hours. We value these events as an opportunity to build our network and connect speakers with our talented undergraduate students.


*Photo of Lunch with Faculty*

**Social Events**

Starting the year off with a blast, we hosted a Welcome Back Barbeque. This was a great opportunity for new students to meet upperclassmen and professors. Besides the traditional UCSB social event, AIChE Trivia Night was a fun-filled addition last year. At the Rockfire Grill, we had more than forty participants—undergraduate students, graduate students, and faculty—in groups battling it out to answer trivia about chemical engineering and pop culture. Another successful event was our mentor/mentee program, in which freshmen and sophomores were given one-on-one guidance (academic, social, personal) by juniors and seniors.

**Community Outreach**

AIChE has been participating in coastal fund projects twice a year. The major projects involving planting trees, removing weeds, and cleanup the local environment to help with sustainable development in Santa Barbara area. Another event we host is MESA Day. Here, AIChE members teach local middle schoolers about the fun in science. This year, we taught them how to make ice cream using liquid nitrogen!

**Future Plans**

This academic year, AIChE will strive to uphold its previous agenda and expand its current impact. Amassing more members and attracting freshmen to be part of the student body will be our focal point in the fall. With this come social events that develop a tight-knit community, an upperclassmen-underclassmen mentorship program, and community outreach opportunities. During the winter, we will focus on career-building. From a wider variety of alumni discussion panels and talks with industry representatives, we hope to bring a vast number of internship and job opportunities to AIChE members. We will also host our annual Chemical Engineering Research Fair in which students will have the opportunity to share their research projects and learn about those of their peers. Finally, as the year wraps up, we welcome networking and social events in the spring. From Lunch with Faculty, Trivia Night, to a graduate school panel, we ensure that our members have the connections they need to plan opportunities for the summer or simply end the year with a bang. In essence, we aspire to achieve the goal of our organization: to create an opportunity-enriched environment in which students can fulfill their true potential.

*Visit UCSB AIChE's website at [www.ucsbaiche.com](http://www.ucsbaiche.com) for event updates and schedules, video interviews with industry and academia professionals, and more!*

**UC Santa Barbara AIChE Student Chapter Officers (2020-21)**

***Co-President:*** **Ginny Wang**
***Co-President:*** **Eric Tang**
***External VP:*** **Freda Lababidi**
***Internal VP:*** **Michael Xing**
***Treasurer:*** **Eugene Li**
***Industry Chair:*** **Yu Ling Zeng**
***Internal Department Chair:*** **TBD**
***Webmaster:*** **Natasha Aji**
***Outreach Chair:*** **Abhiram Devata**

# ALUMNI HIGHLIGHTS

## Ryan C. Ng, BS 2014

After graduating from UC Santa Barbara Chemical Engineering with a minor in statistical engineering, Ryan C. Ng received an MS in Chemical Engineering with a minor in materials science at Caltech, and in December 2019 he completed a PhD in Chemical Engineering with the Greer Group at Caltech.

Ng's research is in nanophotonics and photonic crystals—periodic structures with alternating refractive indices. The work focuses on various light confinement phenomena in dielectric materials in different contexts. The main project of his thesis work was focused on designing guided mode resonance based optical filters for spectral imaging/remote sensing (multi- or hyper-spectral imaging) applications in the near-IR.

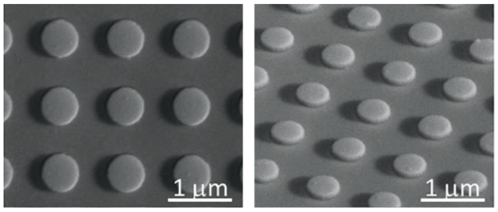
"In layman's terms, I create light filters that can be used in imaging systems, such as an airplane or a satellite, for a wide variety of applications," Ng shared.

The technology enables extremely high spectral resolution although there are limitations in realistic imaging applications as the realization of this guided mode resonance optical phenomenon requires very large filters laterally, resulting in large pixel sizes that are not ideal for imaging.

"Beyond attempting to develop a well-rounded understanding of this phenomenon and design, the latter part of my PhD focused on trying to miniaturize these filters, and we've now created and demonstrated designs that are competitive with state-of-the-art optical filters both commercially and in literature," said Ng.

"If we can identify and separate these electromagnetic signatures, we have a really powerful tool to differentiate all of these chemical species from one another. Although the 'spectral resolution' of two species is very close in wavelength, are we still able to get fine enough resolution that we can tell them apart? The applications for such a technology are very wide reaching and can be incorporated anywhere you may need non-invasive or remote imaging."

Some example applications would be environmental, oil spill detection in the ocean, detecting pollution in the atmosphere, military surveillance, the detection of mines in the ground, or camouflage detection. In sensing, detectors are sensitive to anywhere from several to hundreds of electromagnetic bands. Based on the number of bands and bandwidth, these systems are separated into multispectral and hyperspectral imaging systems with multispectral systems capturing under 10 bands and hyperspectral imaging capturing hundreds to thousands of bands of narrow width (around 10-20 nm) that allow for a continuous measurement across a spectrum.




*Pillar Array*

*Ryan taking a break from his research in Costa Rica.*

Ng found that research opportunities at UCSB were widely available to him during his studies, both within and outside the department. He spent three years in Prof. Michael Gordon's lab, and also had a strong research mentor, Alex Heilman.

"I remember Professor Gordon would always make an effort to show up to all the talks I gave— to date I've never met another professor who actually cared enough to show up to the talks of an undergraduate in their lab, and he showed up to almost all of mine!" Ng exclaimed.

"Professor Gordon always made time to chat with me about research and general career plans for graduate school. To date, I still credit my ability to put together a good research presentation due to the advice I had gotten from both Professor Gordon and Alex."

"I'm [also] a recipient of the Marie-Curie fellowship in Europe, which is a super prestigious research fellowship from the European Union. I'm going to begin a two year post-doc as a Marie-Curie fellow at the Institut Català de Nanociència i Nanotechnologia (ICN2) in Barcelona, Spain sometime this fall/winter depending on coronavirus and visa timelines, where I will be studying cavity optomechanics within phononic/photonic crystals with applications in quantum information, thermal transport, and high-sensitivity force, mass, and displacement sensors. This new fellowship position is a natural transition from some of my work in my phD - A lot of my work and other projects in my PhD focused on photonic crystals (PhCs) with projects such as additive manufacturing of metallic/ceramic 3D PhCs, or studying effects such as structural color or all-angle negative refraction/dispersion engineering in 3D PhCs."

# STUDENT AWARDS AND ACHIEVEMENTS

## Parth Shah Receives Prestigious Dow Discovery Fellowship for 2020-21 through 2023-24

Chemical engineering faculty have awarded Parth Shah the department's top honor for a rising third-year PhD student, the prestigious Dow Discovery Fellowship.

"Parth is such an enthusiastic researcher, brimming with ideas and excitement," said his PhD advisor, Todd Squires. "Even though labs have opened in a limited way, he's been so productive, creative, and happy to be back to his project. With students like Parth, it's best to give them support and guidance, and then let them blaze their own trail. I'm really looking forward to playing my part in Parth's journey."

Shah's research proposal, "Self-Propelling Particles: A New Paradigm for Targeted Delivery," focuses on developing strategies for targeted delivery in dead-end pores by using self-propelling particles (SPP). Dead-end pores are areas in a porous medium where advective and diffusive characteristics are affected within the "dead zone." His project seeks to overcome challenges associated with dead-end pores and SPP, which convert chemical energy from the environment into mechanical motion.

The fellowship is made possible by a generous contribution from the Dow Chemical Company. The three-year, $150,000 fellowship is designed to support students over the remaining three years of their graduate work.

## Nathan Prisco Awarded Department of Energy Fellowship for 2020-21

Nathan Prisco, Chmelka Group, has received a highly competitive post-doctoral fellowship from the Dept. of Energy, specifically the Advanced Manufacturing Office's "Arctic Innovator Program". He defended his PhD thesis on Aug. 31 and will soon thereafter relocate to Fairbanks, Alaska.

## George Degen Receives Schlinger Fellowship for 2019-20

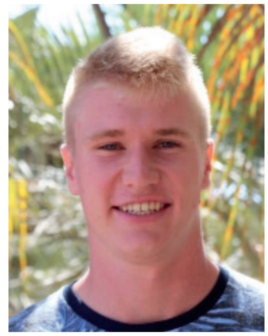
The 2019-20 Schlinger Fellowship for Excellence in Chemical Engineering Research has been awarded by the faculty of the Department of Chemical Engineering to George Degen. The Schlinger Fellowship is awarded based on publications, submitted manuscripts, and other measures of impact.

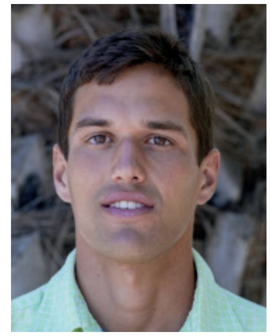
Established through a generous gift from Warren and Katharine Schlinger, the award recognizes outstanding accomplishments in doctoral research in Chemical Engineering. The Fellowship is open to all graduate students in their fourth or fifth year of the doctoral program in the Chemical Engineering Department at UC Santa Barbara, and is not restricted to any particular areas of research. Degen is part of the Israelachvili and Shea Labs.

## ChE Grad Students Jordan Finzel, Gordon Pace, and Evan Pretti Honored with Prestigious NSF Graduate Fellowships

UC Santa Barbara Department of Chemical Engineering Graduate students Jordan Finzel, Christopher Lab, Gordon Pace, Segalman Lab, Evan Pretti, Shell Lab, and Kimberlee Keithley, Fredrickson Lab, were awarded NSF Graduate Research Fellowships this year.

The purpose of the NSF Graduate Research Fellowship Program (GRFP) is to help ensure the vitality and diversity of the scientific and engineering workforce of the United States. The program recognizes and supports outstanding graduate students who are pursuing research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) or in STEM education. The GRFP provides three years of support for the graduate education of individuals who have demonstrated their potential for significant research achievements in STEM or STEM education.





DANIEL CHU
BS 2019

FRANCIS CUNNINGHAM
BS 2017

DORIAN BRUCH
BS 2019

## Three UCSB BS Graduates Awarded NSF Graduate Research Fellowships

UCSB Chemical Engineering graduates Daniel Chu, BS 2019 and current 1st year PhD student at MIT, and Francis Cunningham, BS 2017 and current 1st year PhD student at Berkeley, were awarded NSF Graduate Research Fellowships. Dorian Bruch, BS 2019 and current 1st year PhD at CalTech, was awarded a National Defense Science and Engineering (NDSEG) Fellowship.

## Koty McAllister, Chad Wangsanuwat, and Pavel Shapturenka Awarded CSP Technologies Teacher- Scholar Fellowships

Department of Chemical Engineering graduate students, Koty McAllister, Rawlings Lab, Chad Wangsanuwat, Dey Lab, and Pavel Shapturenka, Gordon Lab, have been awarded a CSP Technologies Teacher- Scholar Fellowship for 2019-20 and 2020-21.

"As a part of the award each CSP Fellow co-teaches an undergraduate course with a faculty mentor." said Scott Shell, Professor and Vice Chair of Graduate Affairs. "Congratulations, Chad, Koty, and Pavel" said Professor Shell. "We look forward to your contributions to our department pedagogy, and wish you the highest success in your teaching roles."

KOTY MCALLISTER
CSP Teacher-Scholar
*Rawlings Lab*

CHAD WANGSANUWAT
CSP Teacher-Scholar
*Dey Lab*

PAVEL SHAPTURENKA
CSP Teacher-Scholar
*Gordon Lab*

# ALUMNI UPDATES

## Adriane Turner, BS 2014

Adriane recently graduated from MIT with her MBA and masters in mechanical engineering. She will be joining the operations consulting division at McKinsey & Company in Denver.

## Raje Jaideep, MS 2006

Raje Jaideep is currently working as VP, Customer Innovation and Products at FutureBridge in Utrecht, Netherlands. He was married in April 2019.

## Michael Pullon, BS 1994

Michael Pullon is currently working as a CVD Process Engineer at G.E., Aviation, in Madison, Alabama, building a new factory for ceramic composites.

## Michael Costello, BS 1988

This October, after more than 24 years of service, Michael Costello will be retiring from The Clorox Company . Most recently he was the Senior Vice President and General Manager of the company's Nutranext and RenewLife. Previously, Costello served as SVP International Division, where he was responsible for the company's businesses in Australia, New Zealand, Africa, Asia, the Middle East, Latin America, Europe and Greater China.

## Aimee Flores, BS 2012

Aimee Flores is providing manufacturing support for design and development of a tricuspid transcatheter valve repair system at supplier sites. Collaborating with suppliers she ensures that selection, development, and validation of manufacturing processes, equipment, and tooling are performed to meet business procedures, ISO 13485, and regulatory requirements.

## Connor Valentine, BS 2017

Connor Valentine is a Ph.D. candidate in the chemical engineering department at Carnegie Mellon University. He is a graduate researcher in Professor Lynn Walker's group in the Complex Fluids Engineering lab

## James Heslin, BS 1973

Jim Heslin is a partner focused on intellectual property at Wilson Sonsini Goodrich & Rosati, the premier provider of legal services to technology, life sciences, and growth enterprises worldwide. Jim's medical and surgical device clients span a broad array of technologies. Jim was appointed as a UCSB ChE external advisory board member in 2017.

## Ahmet Tezel, PhD 2004

Ahment Tezel is the Worldwide Vice President of R&D at Ethicon (a Johnson and Johnson company). He leads all R&D activities for Ethicon's $9 Billion portfolio including wound closure, biosurgery, endomechanical and energy platforms.

## Doug Freymeyer, BS 1979

After a career of 41 years in the oil, gas, and refining business, primarily in project management, Doug Freymeyer has retired from BP America, Inc. He has settled along the Gulf Coast of Florida where he will take on the lifestyle of the prized Cabana Boy and enjoy boating, fishing, diving, kayaking, biking, and just about ever other sport there is to do along the water's edge.

## Peter St. John, PhD 2015

Peter St. John is a staff scientist at the National Renewable Energy Lab (NREL) in Golden, Colorado working on using computational tools to better engineer microbes to produce replacement for petroleum-derived feedstocks in order to speed up the process of developing new bio-derived fuels and chemicals.

# CONGRATULATIONS TO OUR 2018-20 PHD GRADUATES!

| NAME | ADVISOR | DISSERTATION |
|---|---|---|
| **Abe Pressman** | Dey/Chen | Measuring Biochemical Possibility Spaces in Evolutionary Engineering |
| **Alexandra Bayles** | Helgeson/Squires | Visualizing Soft Material and Ionic Liquid Dynamics Using Interferometric and Fourier Microscopy |
| **Anirudha Banerjee** | Squires | Soluto-Inertial Phenomenon: Driving Colloidal Migration Over Millimeter Distances |
| **Chih-Cheng (Peter) Chang** | Squires | Aging Oil-Water Interfaces with Asphaltene and Demulsifier Adsorption: Interface Rheology and Heterogeneity |
| **David Smith** | Mitragotri/Leal/Shell | A Multiscale Biophysical Platform for Charting Design-Specific Interactions of Nanoparticles with Model Cellular Membranes |
| **Howard Dobbs** | Chmelka/Israelachvili | Role of Electrostatic Forces on Non-Equilibrium Processes at Confined Inorganic Solid-Liquid-Solid Interfaces |
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*A snapshot of The Chemical Engineering Department's Town Hall meeting from this August*

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