UNIVERSITY OF SOUTH FLORIDA
DEPARTMENT OF CHEMICAL, BIOLOGICAL, AND MATERIALS ENGINEERING

The Column

Distilling departmental news just for you....

Fall 2021

On the Rise in Tampa Bay

Whether it is championship sports and athletics, award-winning beaches, groundbreaking medical care, or cutting-edge technology, many people nationally may have heard by now that Tampa Bay is on the rise. What some people may be less aware of is that the University of South Florida and its colleges and departments are rising just as dramatically. In the recent September release of US News and World Report, USF continued to be America's fastest-rising university. Over the past 10 years, USF has risen 48 spots among public universities from number 94 to number 46. This is the third year in a row that USF has ranked in the top 50 among public universities. For our Department of Chemical, Biological, and Materials Engineering, it is also the fourth consecutive year in which the department has maintained its distinction as the fastest rising chemical engineering program and the fastest rising engineering department of any kind in the United States. The department is currently ranked as a top-50 public chemical engineering program and we look forward to continuing that very steep and positive trajectory for many years to come.

Let's take a closer look at some of the reasons why Tampa and USF are great places to live, work, study, and play. *(continued on page 12)*

Courtesy of Visit Tampa Bay

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INSIDE THIS ISSUE:

Dr. Clifford L. Henderson, Ph.D.
Department Chair and Professor

Dear alumni, friends, and members of the USF ChBME community,

First, I hope that this message finds all of you and your families, friends, and colleagues doing well after what have certainly been challenging times for these past two years. We hope that you have managed to weather the storms and disruptions that COVID-19 has presented without significant personal turmoil and loss, but for those that have unfortunately experienced a loss of someone through the pandemic you certainly have our deepest condolences.

Here at USF, as we continue to work our way through the challenges and uncertainties created by the pandemic over these last two years, I want to take this opportunity to say thank you to our tremendous family of faculty, staff, alumni, departmental friends, and students who have helped us to not only make it through those challenges, but have helped us emerge with an even brighter future ahead. As a department, we have used the past year to continue to set plans and actions in place to capitalize on that future potential. For example, by the time you read our next edition of this newsletter, we will be introducing you to a number of new faculty who we are in the process of hiring as I write this column. Those new faculty will help us continue our steep positive climb into our future as a leading department of chemical engineering, help us grow and expand our undergraduate and graduate programs, and solidify us as one of the most forward-thinking departments in the U.S. that is helping to define chemical engineering in the 21st century as the discipline which seamlessly fuses core principles from traditional chemical engineering with emerging principles from bioengineering and materials science to provide both pathways to new knowledge and solutions to some of the toughest problems that lie ahead for humankind. In my view, no other engineering or science discipline is better poised to make a positive impact on society over the next century than chemical engineering, and here at USF we intend to demonstrate that to the world by bringing together a family of expert scholars from across the spectrum of fields and disciplines relevant to the modern practice of chemical engineering.

I am pleased to share with you another edition of our departmental newsletter. I certainly hope it helps to give you a better sense of some of the many exciting developments around the university, the college, our department and even the greater Tampa Bay area that make this such a terrific place to work and live.

These past two years have really highlighted the resilient nature of our faculty, staff, and students. It has also demonstrated the innovative nature of our family of scholars in addressing the many challenges created by the COVID-19 pandemic. Throughout all of these challenges, our departmental family has continued to work hard to push the frontiers of science and engineering, to forge ahead in addressing the toughest problems facing humankind, and to provide a world-class education to our students. For example, in terms of supporting a world-class education for our students, significant efforts were put forth by all of our faculty and staff to ensure an uninterrupted and high-quality education for our students as we transitioned to remote learning due to the outbreak of COVID-19 and the subsequent semesters of hybrid learning that followed during the pandemic. Several of our faculty and graduate teaching assistants for example worked hard to develop virtual laboratory experiences and invented new take-home laboratory kits that allowed students to perform hands-on work safely at home. Those efforts were so successful, that the faculty and graduate student team won a major university award for their innovative work. Furthermore, those efforts are being leveraged to provide long-term benefits to our students through expansion of the use of such take-home laboratory kits throughout the curriculum. Such kits are being used to allow students to do hands-on experiments at the same time they are learning the theory in core chemical engineering courses like thermodynamics, transport phenomena, and separations. In this issue, you will see evidence of those efforts and many more such stories about innovation during the pandemic in both education and research activities across the department.

So hopefully you will come away from this edition with a sense that even though these past two years have presented many challenges, a number of positive things have happened around the department, college, and university that point us toward a brighter future. It continues to be a very exciting time to be at USF and in our department, and we hope that by reading through this edition of the newsletter that you get as excited as we are about USF, USF ChBME, and the future ahead. We hope you enjoy learning a little more about recent events in the department, but realize there are so many things that we could share with you that there simply is not room for it all. So please come visit us and see what all of the excitement is about here at USF. One thing we think you will see is that we have a dynamic, high energy, impactful program that aims to define what it means to be the best chemical engineering program in the country.

Sincerely,

Clifford L. Henderson

Clifford L. Henderson, Ph.D.

FEATURED ARTICLES:

UNDERSTANDING NANOMATERIALS FROM THE MOLECULAR SCALE UP

A profile of research by Professor Simmons to discover the most fundamental secrets of materials

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FACULTY SPOTLIGHT: Dr. Norma Alcantar

A profile of accomplishments by Professor Alcantar leading to her induction in the Florida Inventors Hall of Fame and appointment as the Associate Dean for Research in the College of Engineering

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PROTEIN ENGINEERING FROM HOME: Engineering Natural Molecules using Thermodynamics

A profile of research by Professor Stern on computational protein engineering for the development of the next generation of anti-cancer treatments

PAGE 8

Artist's rendition of the new, state-of-the-art facility in the University of South Florida Research Park that will open in December 2021. This new facility will provide space for academic and commercial research, with a mission to bring together researchers, entrepreneurs, financial investors and corporations to enhance technology commercialization and the Tampa Bay region's growing innovation and knowledge economy.

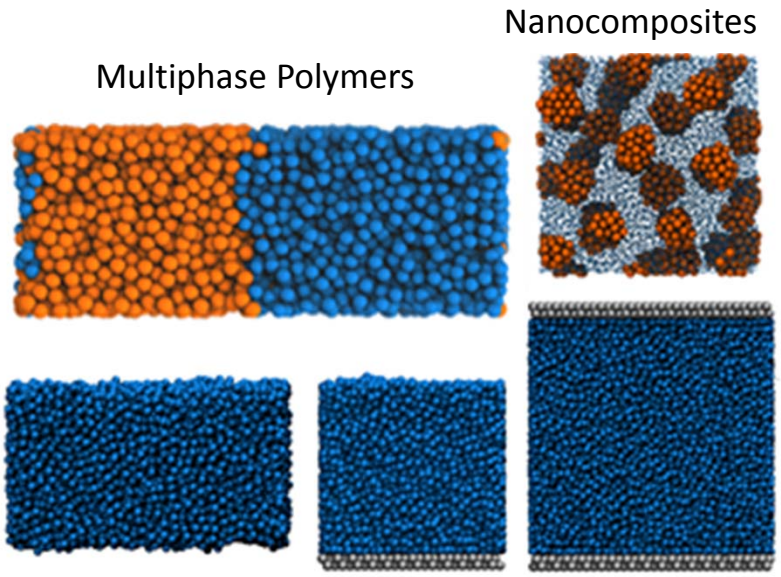
UNDERSTANDING NANOMATERIALS FROM THE MOLECULAR SCALE UP

For decades, polymeric nanomaterials have been viewed as one of the most promising frontiers of materials science, with potential applications ranging from separations membranes to lightweight structural materials to energy storage. Unlike traditional materials, these nanomaterials have dimensions or structure on a scale of just tens to hundreds of atoms across.

Whether it is a separations membrane that is only 20 nanometers thick, or tire rubber that is filled with nanoparticles only 10 nanometers across, or improved battery materials comprised of distinct interwoven regions of different chemistry only a few hundred atoms across, these materials can have properties dramatically different than the traditional 'macromaterials' of the past.

It is precisely this fact that has made them of such great interest to engineers seeking tougher tires, or longer-lasting batteries, or better membranes for clean separations processes. At the same time, these unique properties of nanomaterials also drive the greatest hurdle to their adoption: the origin of their sometimes-remarkable properties, and the ways in which they can be controlled, have been largely a mystery.

In a pair of papers published this August in *Nature* and in *The Proceedings of the National Academy of Sciences (PNAS)*, Dr. David Simmons and his team have potentially resolved some key parts of this mystery.



Their PNAS paper addresses one of the most important changes in properties that occurs in many nanomaterials: their glass transition temperature – a temperature where the substance becomes solid-like without crystalizing – can change dramatically. This change alters the temperature range in which the material can be used, its mechanical strength, how it flows, and how it can be processed. Despite decades of research by the community, the question of why this happens remains one of the largest research areas in soft materials science.

> *"If we can understand what controls these massive changes in properties [in nanomaterials], we have the chance to target the properties we want."*

To tackle this problem, Simmons group Ph.D. student Asieh Ghanekarade performed supercomputer simulations exploring how the motion of molecules is altered in very thin films only nanometers thick. Working with collaborators at the University of Illinois Urbana Champaign, their results have pointed towards a predictive understanding of these changes. According to their findings and their collaborator's theoretical predictions, two things happen to molecules' motion in a thin film. First molecules have more space to rattle around because of the extra freedom provided by the film's surface, and this allows for more rapid motion. Second, the elasticity of the material is reduced, and this also makes it easier for the molecules to move around. All of this adds up to more mobile molecules that can stay liquid to lower temperatures.

These results could play a big role in the design of new nanomaterials. Says Dr. Simmons, "If we can understand what controls these massive changes in properties, we have the chance to target the properties we want. In addition to pointing to a mechanism for these changes, our results suggest that our collaborator's theory could provide a means of actually

predicting them." While their paper focuses on thin films, Simmons says that the results have implications for a wide range of other nanomaterials being studied in laboratories around the world and in some cases integrated into consumer products.

In their *Nature* paper, the Simmons group, together with collaborators at multiple other universities around the world, address a second major piece of the nanomaterial mystery: how do these materials flow and deform differently because of the changes that occur when their molecules are trapped in these nanoscale domains? Their work focused on how these properties change when polymers – very large molecules that comprise plastic, rubber, and many biological molecules – are made into nanomaterials. Because these molecules are so large that a single molecule can reach across an entire nanodomain in these nanomaterials, predicting their properties becomes much harder than in simpler liquids.

Says Simmons, "Imagine that you are a molecule sitting at the surface of a film. Because of all the open space above you, you can move much faster, and you can flow more easily. But now imagine that you are actually part of a much larger molecule that reaches deep into the film below you, like an anchor. How does this affect your ability to move around? Do I move faster because I'm at the surface, or slower because of the anchor, or a bit of both?"

To learn this, Dr. Simmons' student Asieh Ghanekarade again performed supercomputer simulations to watch how this anchor affected polymer motion at the surface. Together, they developed a theory for how this anchor works and how the molecules move. Their collaborators at other institutions created a new class of extremely challenging experiment to actually measure how polymers deform immediately at the surface of a film. Their experimental results showed that Simmons and Ghanekarade's theory and simulations can begin to predict the altered flow behavior near the surface of a polymer film. Their theory provides a totally new tool for the prediction and design of how polymer nanomaterials deform.

Dr. Simmons says his work on nanomaterials isn't done. "Now that we are beginning to understand better what happens to materials at the molecular level when we place them into nanodomains, this lays a foundation for the next big step: how can we add nanomaterials into existing polymeric materials to make them mechanically tougher while potentially improving their other properties as well?"

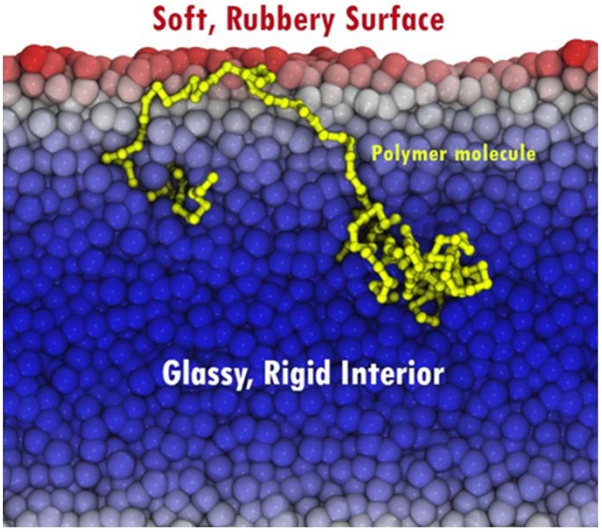
The idea that "polymers nanocomposites" – materials in which nanoscale particles are added to polymers – could offer large improvements has been around for decades. In fact, Simmons says, "every tire on every car you have ever driven is a nanocomposite – that's how the tire rubber can be so incredibly tough." The question now, Simmons says, is "can we understand the mechanical properties of nanocomposites well enough to begin to improve a much wider range of the polymeric materials our society uses?" Opportunities for new nanocomposites could include light-weight auto bodies that could reduce energy consumption, tougher and longer-lasting tires, and energy systems that are more robust and less prone to failure.

Simmons has just received a three-year grant for $465,000 from the Department of Energy Basic Energy Sciences program, on the "Nanoscale origins of nonlinear energy dissipation and toughness in elastomeric nanocomposites" to pursue this challenge.

The Simmons group's recent publications in PNAS and Nature papers are as follows:

Ghanekarade, Asieh, Anh D. Phan, Kenneth S. Schweizer, and David S. Simmons. "Nature of Dynamic Gradients, Glass Formation, and Collective Effects in Ultrathin Freestanding Films." Proceedings of the National Academy of Sciences 118, no. 31 (August 3, 2021). https://doi.org/10.1073/pnas.2104398118.

Hao, Zhiwei, Asieh Ghanekarade, Ningtao Zhu, Katelyn Randazzo, Daisuke Kawaguchi, Keiji Tanaka, Xinping Wang, David S. Simmons, Rodney D. Priestley, and Biao Zuo. "Mobility Gradients Yield Rubbery Surfaces on Top of Polymer Glasses." Nature 596, no. 7872 (August 2021): 372–76. https://doi.org/10.1038/s41586-021-03733-7.



FACULTY SPOTLIGHT: Dr. Norma Alcantar

Born in Mexico City, Dr. Norma Alcantar had a keen interest in science and mathematics at a young age. She received her bachelor's degree in chemical engineering with honors in 1993 from the National Autonomous University of Mexico (UNAM). She credits her success to her grandmother and her mother, who encouraged her as a young woman to pursue science when she was debating whether to go a different route.

She was awarded the UNAM-DeGAPA Studies Abroad Fellowship to support her graduate education at the University of California-Santa Barbara (UCSB), receiving her Ph.D. degree in Chemical Engineering from UCSB in 2000. Her postdoctoral work at UCSB included research in surface properties and intermolecular forces of thin films under confinement at University of California-Davis and the UCSB Materials Research Laboratory in Surface Characterization and Interfacial Phenomena of Thin Films. She also worked as a consultant engineer in SurForce Corp, Santa Barbara, CA. She joined the University of South Florida in August of 2003, where she is currently a professor in the Chemical, Biological, and Materials Engineering Department and Associate Dean for Research in the USF College of Engineering.

With 22 patents, Dr. Norma Alcantar is a leading engineer in critical environmental areas (e.g. clean drinking water and sustainable crops) and transformative health care delivery for ovarium and brain cancer treatments.

Dr. Alcantar is also recognized for her support, mentoring and advocacy for women and people of color in the engineering fields. She is the first woman faculty member and first woman of color to start her professorial career as an assistant professor and navigate the ranks to full professor in the College of Engineering. She also is the founder of the startup company Water, Health and Sustainability, LLC.

Her research interests include interfacial phenomena and chemical characterization of biomimetic membranes, drug delivery systems, micellar surfactants, green chemistry materials, water purification systems, nanoparticles and organic/inorganic thin films. She is an expert in surface force measurements, and Fourier transform infrared spectroscopy, but it's her trailblazing, nature-based inventions that are helping create a cleaner and healthier world.

Soon after arriving at USF, she sought a way to start her research. She remembered her grandmother's stories about an ancient practice of cleaning water with cactus mucilage. While waiting to set up her lab, she asked her postdoc to run some tests on the cactus mucilage as a purification system — a folk practice she first learned from her grandmother in Mexico who boiled the pads of the prickly pear cactus, known as nopales, to produce clean drinking water for her family.

Two days later her postdoc reported that it worked. Mud in the cactus water separated within 10 minutes compared to the other water sample without the cactus, which took about 18 hours. From there, they began looking at what was in the cactus and what they could learn from it. Certain sugars in the cactus fluid, called mucilage, have properties that bind with the contaminants. Further research created a powder from the fluid.

Dr. Alcantar adapted the mucilage technology to other critical needs, such as cleaning water used in aquaculture, which is important in developing countries highly dependent on fish farming; and as an agent for cleaning up oil spills, a discovery made in the aftermath of the Deepwater Horizon oil spill. Her research in the use of the mucilage in the fight against Parkinson's disease focuses on α-synuclein aggregation, a protein abundant in dopamine neurons that becomes toxic in

Parkinson's patients when it misfolds and aggregates into clumps. Low concentrations of the cactus extracts inhibited the aggregation process. The technologies have since been used in Bangladesh, Vietnam, Haiti, and Mexico for cleaning drinking water. Some of her patents have adapted the technology to treat Parkinson's and some cancers.

Her groundbreaking cactus research has produced inventions essential to clean water through the removal of heavy metals and crude oil.

Dr. Alcantar is a Fellow of both the American Institute of Chemical Engineers (AIChE) and the American Institute of Medical and Biological Engineering (AIMBE), a senior member of the National Academy of Inventors, and recently was named a Core Fulbright U.S. Scholar Award. Her distinguished national service includes serving as Chair of the Committee of Underrepresented Minorities, AIMBE; and Member-at-Large, Engineering Section, American Association for the Advancement of Science (AAAS). She is also a member of the USF Research Foundation Board.

In summer 2021, she was selected for induction into the Florida Inventors Hall of Fame, adding to her academic achievements including being awarded the Excellence in Innovation Award by the National Academy of Inventors in 2016.

She is the recipient of the 2018 Summer Faculty fellowship from the Jewish National Fund. She is a departmental Director for the Alfred P. Sloan Foundation Minority Scholars Program to advancing underrepresented minority students in science, technology, engineering, and mathematics, since 2005.

Dr. Alcantar is also co-director of the Water, Health and Sustainability Graduate Certificate and the Director of the Materials Science and Engineering Graduate Certificate. She is the recipient of the 2010 Hispanic Pathways Award. She's currently a member-elect of the Engineering Section Steering Committee of the American Association for the Advancement of Science (2018-2022).

Her graduate students have been the recipients of numerous grants including the 2018 Elsevier Foundation Awards for Early Career Women Scientists in the Developing World, the Faculty of the Future Research Award from the Elsevier Foundation, the Ruth L. Kirschstein National Predoctoral Research Award from the National Institutes of Health, the Faculty for the Future Grant from the Schlumberger Foundation to support doctoral studies in Chemical Engineering (2008-11), and the 2005-USF Graduate School Outstanding Thesis Award. She has presented numerous invited oral presentations nationally and internationally (e.g. Brazil, Bangladesh, Haiti, Mexico, Chile, Germany, Costa Rica, and Puerto Rico), has 22 patents, and has over 50 peer-reviewed publications and book chapters.

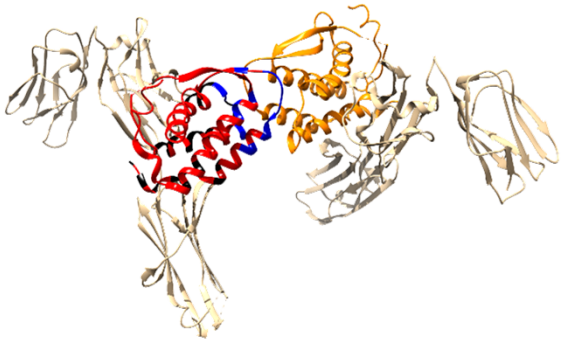
PROTEIN ENGINEERING FROM HOME:

Engineering Natural Molecules using Thermodynamics

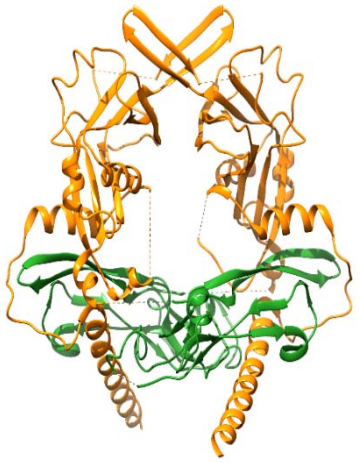
For more than a year, the SARS-CoV-2 (COVID-19) pandemic changed the way that many of our faculty here at USF do research. For Dr. Lawrence A. Stern, an Assistant Professor in the Department of Chemical, Biological and Materials Engineering, this meant significantly reimagining the way his newly launched research program engineers new biomolecules. Being a pure experimentalist by training, the imperative to stay at home as much as possible early-on in the pandemic and the need later to maintain low in-person lab occupancies with physical distancing of personnel provided a new challenge. Like any creative engineer might, Professor Stern turned those challenges into an opportunity.

The Stern Lab launched in January 2020 with an initial focus on protein engineering toward the development of the next generation of chimeric antigen receptor (CAR) T cell therapies with applications in cancer and autoimmune disease. CAR T cell therapy involves engineering a patient's own T cells to express CAR molecules, which direct the T cells to fight diseases that the body's natural immune system would be unable to overcome. Engineering these complex molecules requires molecular biology tools to manipulate these proteins, high-throughput cell-based experiments to test their functions, and DNA sequencing technology to identify improved candidate proteins – none of which are available when working from home. What was available was their computers and the computational resources maintained by the Research Computing group at the University of South Florida.

"We learned together. Sometimes, I was teaching my students and sometimes they were teaching me. The learning curve was steep, but my students really took ownership of learning and applying these techniques."



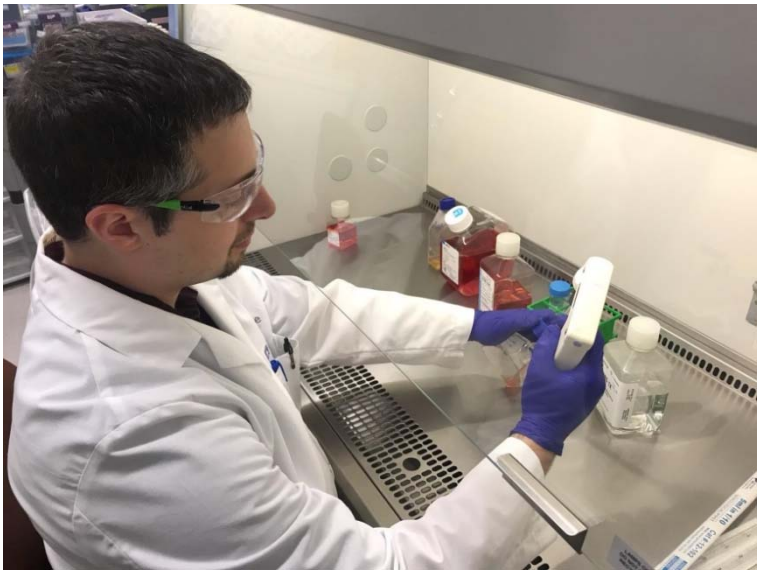
"I'd never done computational protein engineering before," Stern said. "Many successful protein engineering groups perform force field modeling and molecular dynamics simulations to better understand and engineer proteins, but I've always performed high-throughput labora-tory experiments. It wasn't until last yearyear that we began exploring the power of computational protein engineering."



The lab started working with two molecular modeling suites: FoldX and Rosetta. Both programs use thermodynamics to understand the effects of individual and combined mutations on a protein's structure and function. When a mutation is made, each program uses its own sets of parameters to assess energetic differences between the original and modified protein.

"We learned together. Sometimes, I was teaching my students and sometimes they were teaching me. The learning curve was steep, but my students really took ownership of learning and applying these techniques," Stern said about getting started in this area.

One such student was undergraduate researcher Jacob Doon-Ralls. Jacob's initial work took him through understanding how to apply computational protein engineering to antibody



fragments for modifying their binding interactions, which required him to both learn and apply FoldX as well as complete literature searches to better understand alternative techniques that he could use. With these valuable new skills in hand, Jacob looked to branch out into other potentially useful molecules to help combat disease.

"Especially in such a difficult time to stay focused, I want my students to work on projects that they're passionate about. When Jacob approached me with interest in branching out from antibody engineering, I gave him the freedom to select a cancer that interested him, and then to find me a molecule that was implicated in that disease so we could explore engineering it," Stern said.

After literature review, Jacob selected a molecule that was implicated in a variety of immune-suppressive tumor micro-environments. Such molecules are responsible for shutting down the body's natural immune system, creating an opportunity for cancer to grow unimpeded by the normal mechanisms responsible for disposing of diseased or invasive cells. With information available about the protein's structure and its interaction partners, Jacob set out to better understand this protein using FoldX to introduce mutations and report on the potential functional changes.

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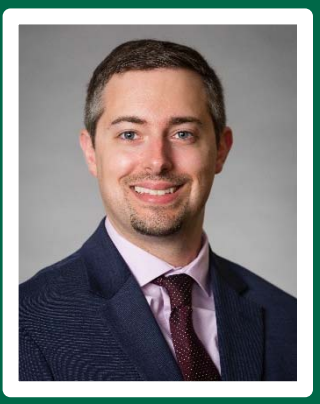
Get to Know the Faculty:

Dr. Lawrence Stern
Assistant Professor
Department of Chemical, Biological, and Materials Engineering
University of South Florida



Research Fields: Protein engineering, cell engineering, high-throughput screening techniques, immunotherapy

Where did you grow up?
I grew up in the Washington, D.C. metro area in a suburb called Reston on the Virginia side.

What areas are your degrees in and what universities did you attend?
I received B.S. degrees in Chemical Engineering and in Chemistry from Virginia Tech and a Ph.D. in Chemical Engineering from the University of Minnesota – Twin Cities.

What other experiences did you have before coming to USF in 2020?
I've been very fortunate to have a variety of other experiences. As an undergraduate, I did internships in many different areas. I spent two summers working with a government contractor on renewable fuel lifecycle modeling and weapons demilitarization projects, one summer working at a small engineering company performing lab scale proof-of-concept experiments on a food waste to oil conversion process, and one summer modeling acid gas scrubbing processes for coal-fired power plants. I benefitted from an NIH T32 training grant in graduate school which enabled me to work with Pfizer for one summer learning about industrial R&D. I also spent two and a half years in postdoctoral training in the Beckman Research Institute at City of Hope National Medical Center in the Los Angeles area.

What brought you to USF?
Everything I have experienced at USF gave me reason to join. The faculty are extremely knowledgeable and supportive, the students are curious and enthusiastic, and the facilities are excellent. The collaborative spirit throughout USF was also a major draw, which leads to interdisciplinary innovation at the interface of engineering and medicine. I look forward to helping maintain the culture of excellence clearly evident at USF.

"Jacob explored the mutational landscape of this protein, and we realized that there was an opportunity to engineer it into an inhibitor that could help free the immune system in the tumor microenvironment," Stern said.

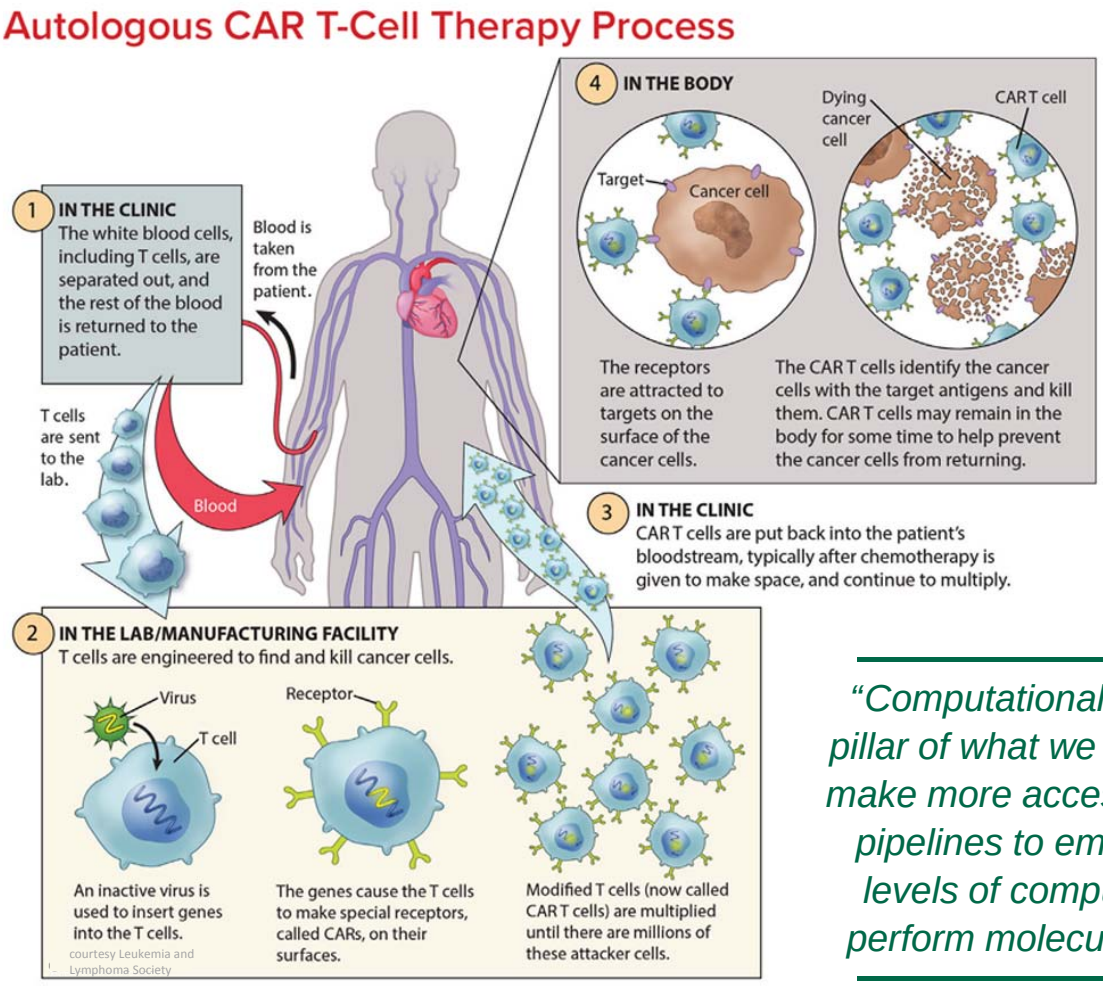
On the strength of Jacob's preliminary data, Stern penned an application for the Oak Ridge Associated University's Ralph E. Powe Junior Faculty Enhancement Award, a competitive award that provides seed money for junior faculty at member universities to enrich their research skills, foster professional growth, and begin generating data as they build their research programs. In June 2021, it was announced that Stern was one of 35 applicants to win this award from a pool of almost two hundred applicants.

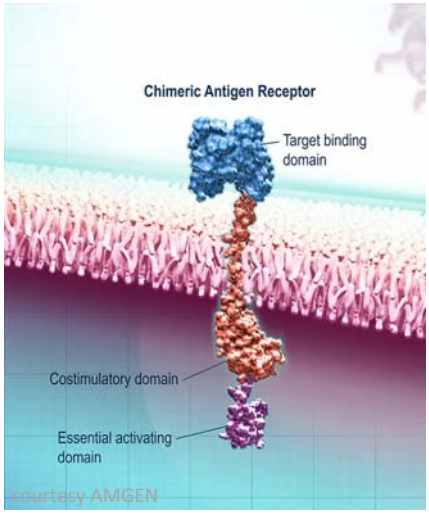
"We're ecstatic about winning this award! I'm looking forward to the work we can do with this support. I'm extremely grateful to the ORAU for funding our proposal," Stern said.

Jacob has since graduated from USF ChBME, going on to attend Ohio State University to pursue a Ph.D. in Chemical Engineering. The funded work is being continued by graduate student Will Stephens, who distinguished himself as an M.S. Student in the Stern Lab by winning a Florida Space Grant Consortium Masters Thesis Fellowship and by successfully defending his M.S. thesis in exploring computational protein engineering pipelines before matriculating in the USF ChBME Ph.D. program in Fall 2021.

With a return to the laboratory at full strength in the summer, the Stern Lab has taken up experiments at the full capacity initially anticipated, working to develop efficient high-throughput protein engineering pipelines with CAR engineering and immunotherapy in mind. Such platforms have potential for sizeable impacts in synthetic biology, inhibitory protein engineering, and receptor engineering. Even with a full slate of experiments, though, the Stern Lab hasn't left the lessons of 2020 behind.

"Computational protein engineering is a pillar of what we do now. We're working to make more accessible protein engineering pipelines to empower scientists with all levels of computational background to perform molecular design experiments. Our work has only just begun," Stern said.





"Computational protein engineering is a pillar of what we do now. We're working to make more accessible protein engineering pipelines to empower scientists with all levels of computational background to perform molecular design experiments."

Retirement of ChBME Faculty Member Dr. Babu Joseph

Dr. Babu Joseph, who joined the USF ChBME department in 2002 obtained his B.Tech from IIT Kanpur (Silver Medalist), India and his MS and PhD from Case Western Reserve University, all in Chemical Engineering. He is Professor and former Department Chair in the USF ChBME department. Dr. Joseph previously held appointments at MIT, Washington University in St. Louis, UC-Berkeley, and IIT/Bombay before joining USF. He is a Fellow of AIChE. He was a Fulbright-Nehru Scholar at IIT/B during 2016-17 academic year.

In celebration of his long and prolific career and upcoming retirement, we sat down with Dr. Joseph to reflect on his time at USF…

What was your most innovative/influential contribution to your field?

I feel that the most influential contribution was a highly cited textbook on process control (Techniques of Model Based Control, published by Prentice-Hall). It was an outgrowth of my doctoral research at Case Western Reserve University. This book published in 2002 is still cited by many authors even after 20 years.

What was your greatest impact on the ChBME department?

I believe I was able to provide strong leadership as Chair during a time of growth of the ChBME department. During this period the department nearly doubled the size of the faculty while more than doubling the student population. USF provided significant financial support to fuel this growth.

What is your favorite USF memory?

My favorite USF memory is being recognized for outstanding teaching by the students in the ChBME department last year. The pandemic had made it difficult for both students and faculty and despite the hardships I was able to work with the students to ensure that their learning was not hampered as a result.

What is biggest change you've seen at USF?

The biggest change is the transformation from a primarily teaching university to one that focuses on both teaching and research.

What advice would you give to yourself as a new Assistant Professor?

I would choose to work on problems of great interest to society. Over the years, I have shifted my research activities in that direction and that has led to more interesting and fulfilling work.

What are your plans for the future?

I plan to be active in research albeit on a reduced scale. I would like to spend more time with my grandchildren who live outside of Florida. So I will be doing a lot of traveling as well. I also plan to spend more time working on the startup company I helped co-found which is on the path to commercializing the research that we did at USF.

Professors Joseph and Kuhn receiving Excellence in Innovation Awards from the National Academy of Inventors

On the Rise

Continued from cover

For many people, Tampa Bay is a familiar place these days due to its many outstanding leisure time options. The Tampa Bay area, with an estimated population of over three million people in the greater Bay area, includes the main cities of Tampa, St. Petersburg, and Clearwater. As a major metropolitan area, it offers all of the things one would expect to find in a major U.S. city, and thanks to its warm climate, coastal location, and vibrant young demographics many that may surprise you. Recently dubbed "Champa Bay", it is the home of two championship teams, the Tampa Bay Buccaneers (NFL) and the Tampa Bay Lightning (NHL). And not to be overlooked, the Tampa Bay Rays (MLB) baseball team have also had the best record in the American League for two consecutive years in 2020 and 2021, and unfortunately just missed out on a World Series Championship in 2020. But, before Tom Brady arrived to lead the Bucs to victory and before an All-Star lineup took to the ice to win back-to-back Stanley Cups for a place that has only seen snow once in the last 100 years, the area was already known by many as an idyllic vacation destination. From the white sand beaches of Clearwater Beach to the towering iconic pink buildings of the Don Cesar resort on St. Pete Beach, and stretching down to the expansive park and historic site of Fort De Soto, beaches and parks in Tampa Bay perennially rank in the top destinations for the US and the world. So it is no wonder that many folks across the country are rapidly deciding to call Tampa Bay home.

Courtesy of Visit Tampa Bay

What may surprise you about Tampa Bay is that it is also a technology hotspot. In fact, it is one of the hottest tech spots in the country.

In April, Forbes named Tampa as the top Emerging Tech City in the US. They cited several factors including, it being home to more than 50 software and IT companies with an anticipated growth of 2,000 new tech jobs in 2021 alone. That growth is being fueled in part by a massive 50-acre, $3.5 billion downtown redevelopment project. Playing an important role in that redevelopment, the Embarc Collective is a new startup hub and model that already supports over 100 early-stage tech companies. More locally here at USF, the Research Park portion of campus is also currently undergoing expansion with the addition of the newest building on campus which will become home to both new academic research laboratories and incubator spaces for start-ups and other early-stage tech companies. (see page 3 for artist rendition of building)

In the field of medicine, the USF College of Medicine in partnership with Tampa General Hospital has created a transformative medical education experience and for the region a transformative medical care system for our community. The new Morsani College of Medicine downtown campus location, which is tied directly into the massive Tampa General Hospital complex that occupies its own island in the bay, in conjunction with the USF Heart Institute recently opened their new facilities in the Water Street district of downtown Tampa. The new facilities offer 395,000 square

feet of new space that cost more than $175 million to build. In addition to new teaching and laboratory spaces, the building houses an urgent care clinic and additional clinical practice space.

As a part of an exciting new direction, Tampa General Hospital and the University of South Florida have also combined their clinical practices into a new organization led by the university which will operate under the University of South Florida Tampa General Physicians group title. The goal is to provide benefits both to the hospital and medical school, and more importantly to the patients served by both organizations and the critical research they are pursuing to help those patients and patients around the country. Also, the NCI H. Lee Moffit Cancer Center, one of the largest National Cancer Institute facilities in the country, is also in the process of a massive expansion of their facilities here on and adjacent to the USF campus. These and other similarly exciting medical developments over the past several years have put the Tampa Bay area into a leading position with respect to both medical research and medical care across the U.S.

So, there are a tremendous number of reasons to be excited about Tampa Bay and life here on the Gulf Coast of Florida. It is no wonder that Tampa has been named one of the top-10 fastest-growing cities in the U.S. in 2020 according to the U.S. Census Bureau. In this edition of the newsletter, we will present a number of stories that will connect you to some of the many reasons here on campus and within our departmental community to be excited not just about Tampa, but about USF, our College of Engineering, and our department as we continue to rise and move forward.

CURRICULAR HIGHLIGHT:

Elective Concentration in Chemical Process Safety

When current Department Chair Dr. Clifford Henderson arrived at USF in the beginning of 2017, one of his first initiatives was to undertake a comprehensive review of the chemical engineering curriculum. One result of that review was identification of an opportunity to give students important training in the area of chemical process safety.

Though the department had originally initiated a Chemical Process Safety elective course back in 2012, the number of students taking that course was small and was constrained by the limited elective hours in the degree at that time. To address those issues and emphasize the importance of safety, one outcome of the comprehensive curriculum review was the incorporation of a required Chemical Process Safety course that is now taken by all ChBME seniors. That new course was completely re-envisioned and was uniquely implemented via a team co-teaching model that combines ChBME faculty with industry experts. In particular, three USF alumni (Dr. Chris Schemel, Joe Guida, and Tom John) have been returning to campus for five week periods each of the last four years to pass on their practical experience and knowledge about process safety to our students.

A second outcome of the comprehensive curriculum review was the incorporation of 15 credit hours of technical electives into the B.S. ChE degree. To support students who would like to gain additional knowledge in safety, two additional classes (Fire Dynamics and Loss Prevention Engineering) were developed and are currently taught as an elective concentration in safety. Dr. Schemel, who developed these courses, has now taught them for the last 3 years. Fire Dynamics teaches the fundamentals of fire behavior and explores how fire science can be used to engineer systems to detect, suppress, increase design robustness, and prevent fire incidents. Loss Prevention Engineering teaches how Environmental Health & Safety programs are managed in industry, how hazardous work is controlled, risk reduction measures, and accident investigation. These two classes provide practical depth in Process Safety and are offered at the undergraduate and graduate level.

USF Institute for Applied Engineering Ramps Up

Although it is still less than five years old, the USF Institute for Applied Engineering (IAE, https://iae.eng.usf.edu/) is on a steep rise and ramp up in its operations. In this article, we will take a quick look at the Institute and its recent activities.

For those not yet familiar with the organization, its formation was spearheaded by current USF College of Engineering Dean Robert Bishop with a vision to "be a world class research and education center dedicated to seeking solutions to the security and economic challenges facing the nation" and a mission to "provide agile, best value engineering products and services to enhance the performance, effectiveness, and safety of its customers". It was designed from the ground up as an organization which can serve a variety of customers and partners including federal agencies, such as the Department of Defense, state and local agencies, and industry and help them to connect to solutions through research within the Institute and at the University of South Florida and the Institute's other partner universities and institutions. Organizationally, it is a USF direct support organization that is chartered as a separately incorporated Florida not-for-profit entity that is authorized to use USF property, facilities, and personel services for the benefit of the university's research, development, and education missions. In other words, the USF IAE is a non-profit that lives within the USF family with full access to all of the university resources including its faculty, students, and lab facilities and capabilities.

Since its inception, the IAE has been growing fast. One of its first major steps was establishment of its physical presence and facilities within and adjacent to USF. A big development in that respect was the establishment of the IAE headquarters facility in the University Mall redevelopment project. That new facility, which opened roughly three years ago, houses

administrative offices and functions as dedicated laboratory space and facilities for customer projects. The IAE also has space that includes rapid prototyping, manufacturing, and other capabilities at its secure facilities which gives it a unique capability to allow for the complete life cycle of sensitive manufacturing, debugging, and validation of engineering systems and system readiness in one place.

More recently, in February 2020, United States Special Operations Command (USSOCOM), headquartered at MacDill Air Force Base in Tampa, Florida, awarded USF IAE a five-year task order contract worth up to $85 million. The contract calls for the USF IAE's expertise in applied research and advanced technology development to be utilized to support USSOCOM's needs in a range of scientific and engineering disciplines. That task order has already led to the launch of a large number of research projects between faculty at the university and customers across USSSOCOM. As a part of those efforts, the IAE has also quickly grown its academic partner institution group to include more than 20 universities across the U.S. (e.g. NC State, University of Arizona, Clemson, University of Colorado, and many more) that work with USF and the IAE to address customer project needs with an endless array of expertise.

According to Tim Baxter, Executive Director of Programs and Customer Engagements at IAE and a retired U.S. Army Special Forces Colonel who worked for many years at USSOCOM, the IAE will be the 'easy button' for future USF and USSOCOM collaborations. "Other research universities have programs or centers to translate engineering research into practical solutions for difficult problems," explains Eric Forsyth, IAE Executive Director for Enterprise Operations and a retired US Air Force Colonel, "but what sets USF apart are our wide range of core competencies and the fact that we have been working with our local defense establishment and industry for a very long time."

So the future of the Institute of Applied Engineering is indeed bright and the organization is definitely on the rise. We look forward to more exciting developments in the coming years.

In ChBME "Engineering is Hands-On"

For those that have gone through engineering classes at the university level, or really anyone who has had to take any college level science course, you may have felt that it was hard to physically connect with the more complicated theory and concepts being taught from textbooks and live lectures. That is particularly true in cases where you may have no practical real-world experience on which to relate the concepts in question. That is of course one of the main reasons that laboratory courses are included in education from the K-12 level all the way through university degree programs in connection with science and engineering classes.

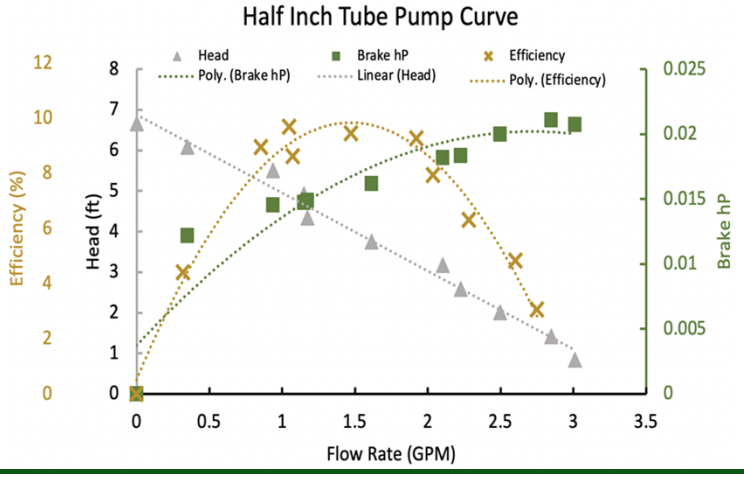
As ChBME Professor and Department Chair Cliff Henderson commented, "There just is something about working with physical systems that you can touch, place your hands on and manipulate experimental equipment and materials, see phenomena occurring in real life with your own eyes, and get the full psychomotor experience including audio, visual, tactile, and other sensations when conducting an experiment yourself that brings theory and concept to life." It is exactly that idea that got Professor Henderson thinking about how he could develop methods to allow students to conduct hands-on experiments while they were in the middle of what traditionally had been lecture-based classes while he was still a faculty member at Georgia Tech. For many, the traditional model in college has always been that lecture classes are where basic facts, concepts, and theory are taught and those classes are distinctly separate from laboratory classes which are designed to reinforce and demonstrate those concepts and principles. In many cases, it is not uncommon for students to take those associated laboratory classes semesters later than the course covering the underlying material to which they are connected.

Professor Henderson decided to test the idea of "take-home" kits that could be used to allow students to perform simple hands-on experiments coordinated with material being covered in a traditional lecture-based course with another colleague at Georgia Tech. While those initial trials seemed promising, he never had the opportunity to truly scale up the concept. Fast forward to 2018, roughly a year after his arrival at USF, and Professor Henderson finally had the perfect opportunity to implement the concept. As a part of the extensive curriculum revision of the chemical engineering undergraduate degree program, Professor Henderson took charge of the redesign of what would become the department's new freshman "Intro to ChBME" course.

So as an integral part of that new course, Professor Henderson designed a take-home project kit in which students apply basic knowledge on topics like "unit conversions" and simple chemistry knowledge to design a small car powered by a gas evolving chemical reaction. Armed with a kit of the same basic parts issued to all students, students had the chance to apply their creativity to accomplishing a simple engineering goal, namely building a car that would travel an exact distance on the day of a class competition. It was an overwhelming success. The students learned that they already knew many things that could be applied to solving engineering challenges; they had fun with it.

Professor Henderson was in the middle of designing his next kit which would be related to fluid flow and pumping when the COVID-19 pandemic struck and disrupted in-person lab operations. So, he enlisted the help of fellow faculty member Professor Sandy Pettit and several graduate teaching assistants, financial support from USF Innovative Education, and they quickly scaled-up a "pump lab in a bucket" idea to produce a take-home kit that could flexibly be used to let students explore fluid flow and pumping operations safely at home. It too was a great success (example pump curve below) and allowed students to continue hands-on experiments for their ChE lab course while in remote learning.

Those same kits, and new versions on other topics, are now being leveraged as they were originally intended, namely to allow students to put their hands on experiments while in earlier courses such as transport phenomena and thermodynamics. So in ChBME, learning has truly become hands-on.



Dr. Norma Alcantar Elected AIChE Fellow and Inducted into the Florida Inventors Hall of Fame

Professor Alcantar was named as a Fellow of the American Institute of Chemical Engineers. Being named as a Fellow of the organization is the highest member distinction bestowed upon its members. Professor Alcantar is also a Fellow of the American Institute of Medical and Biological Engineering. In summer 2021, with 22 U.S. patents, she was selected for induction into the Florida Inventors Hall of Fame.

Dr. Venkat Bhethanabotla Elected National Academy of Inventors Fellow

Professor Bhethanabotla is a pioneering researcher whose discoveries and inventions span acoustic wave and optical biosensors, plasmonic neural stimulation, additive manufacturing, and catalysis for environmental and energy applications. He holds 12 U.S. patents and has published over 120 articles, books, and chapters. He is a Fellow of AAAS, AIMBE and AIChE.

Molekule receives Innovation Award

Dr. Goswami, a USF Distinguished University Professor, received the BioFlorida's inaugural COVID-19 Innovation Award on behalf of Molekule. BioFlorida is an organization that connects a network of emerging and established life science companies, universities, research institutions, hospitals and medical centers. The award recognizes a Florida company that has made significant advances in the fight against COVID-19. Molekule, a company founded by Dr. Goswami, received the award for their air purification device that uses patented photo-electrochemical oxidation technology to break down a wide range of pollutants such as bacteria, chemicals, mold, allergens, and viruses at a molecular level.

Dr. Sandy Pettit Elected to USF Academy of Distinguished Engineering Educators

Professor Pettit, who serves as the Associate Chair for Undergraduate Studies in the department, was elected to the USF Academy of Distinguished Engineering Educators. The election follows recognition as a recipient of the College of Engineering Outstanding Teaching Award and a recipient of a USF Academic Excellence Award. The teaching award recognizes the use of evidence-based pedagogies to improve student success. The academic excellence award specifically recognizes the innovative development of take-home laboratory kits during remote teaching operations due to COVID-19.

T2C Energy Selected for DOE funded Demonstration Plant

T2C Energy (Pinellas Park, FL) is a bioenergy company founded by USF ChBME Professors Babu Joseph and John Kuhn along with USF ChBME alumni Devin Walker, Tim Roberge and Dr. Syed Gardezi. The company was selected by DOE under the Sustainable Aviation Fuels (SAF) Grand Challenge to receive funding for the design of a demonstration scale plant that converts waste landfill gas to SAF or renewable diesel. During their journey from a conceptual process in 2012 to a pilot facility and now to a full demonstration plant, the team has received awards and grants totaling over $1.5 million. The team is excited to put the technology to work at scale.

Professor Ramon Gonzalez Assumes Role as National Science Foundation Program Director in MCB

Professor Ramon Gonzalez, a faculty member in ChBME who holds the position of 21st Century World Class Scholar at USF, started a two-year role beginning in September 2021 at the National Science Foundation after being invited to join as a rotating Program Director (PD) in the Division of Molecular and Cellular Biosciences (MCB). Professor Gonzalez is serving in the Synthetic and Systems Biology cluster within MCB. Such PD roles are prestigious positions which allow experts in their fields to shape the direction of research within the U.S. through actively managing federal research programs.

Dr. Norma Alcantar Chosen to Serve as Next Associate Dean for Research for the College of Engineering

Dr. Norma Alcantar, a faculty member in ChBME, has been selected to serve as the next Associate Dean for Research in the College of Engineering at the University of South Florida. Dr. Alcantar officially began her position as ADR for CoE in October 2021. In her new role, ADR Alcantar will help advance the research mission and vision of the College by nurturing scholarship, assisting with sustaining and growing extramural research funding, and working to build the infrastructure needed to support the cutting-edge research across the College and its faculty.

Professor Lawrence Stern Awarded ORAU Ralph E. Powe Junior Faculty Enhancement Award

USF ChBME Professor Lawrence Stern was recently awarded a Ralph E. Powe Junior Faculty Enhancement Award from the Oak Ridge Associated Universities (ORAU). For those not familiar, ORAU provides innovative scientific and technical solutions to advance national priorities in science, education, security, and health. Through specialized teams of experts, unique laboratory capabilities, and access to a consortium of more than 100 major Ph.D.-granting institutions, ORAU works with federal, state, local, and commercial customers to advance national priorities and serve the public interest. Professor Stern was one of only 35 awards made this year from more than 156 applications across 89 member institutions. More details about the work which is the basis of his award can be found in the earlier article “Protein Engineering from Home.”

Gonzalez Group Publishes Major Advance in Metabolic Engineering

Professor Ramon Gonzalez and his group recently published a major advance in metabolic engineering in an article in the flagship journal *Nature Metabolism*. Since its inception, metabolic engineering has focused on engineering microbial cells by manipulating the native metabolic architecture of the host organisms. Inherently there have been tradeoffs between substrate utilization, central metabolism, and product synthesis pathways that create metabolic conflicts between desired product-forming pathways and growth-sustaining functions of the cell which compete for the same carbon and energy carriers. Professor Gonzalez’s team have now shown how to overcome these problems by engineering metabolic pathways that are not only new-to-nature but also orthogonal to the host metabolism and which can operate efficiently, are amenable to inclusion in different hosts, and can be deployed as both in vitro and in vivo platforms. One important application of the new technology is in addressing climate change through developing new biochemical methods for utilizing C1 molecules like CO_2 and CH_4 and molecules derived from them.

Profs. Henderson & Pettit Win Academic Excellence Award

Efforts by Professor Clifford Henderson, which were focused on developing “hands-on” experimental take-home kits for use in lecture-based engineering courses, recently became the basis for replacement lab experiences in ChBME during the COVID-19 pandemic. Professors Henderson and Pettit, with help from ChBME teaching assistants Molly Skinner and Graham Strauss, scaled up the kit idea, focusing initially on centrifugal pump operations and fluid flow, to serve the entire ChBME senior student body and to work in conjunction with virtual labs to create a distance-learning lab experience. A range of such kits and topics are now being leveraged to supplement theoretical learning in core ChBME lecture courses across the curriculum. As a result of their efforts and the positive impact on student learning, the group was awarded a 2021 USF Academic Excellence Award.

Environmental Research & Education Foundation Scholarship and Accolades for Rarosue Amaraibi

Rarosue Amaraibi, a Ph.D. candidate in chemical engineering, was selected as a 2021 recipient of the prestigious Environmental Research & Education Foundation (EREF) Scholarship for her research in solid waste to energy conversion. Her work was also recognized with a first place award in the National Organization of Black Chemists and Chemical Engineers (NOBCChE) Environmental and Green Chemistry category and a People's Choice Award at the USF Graduate Research Symposium.

Tosin Sokefun Wins NOBCChE Conference Award

Research presented by Yetunde Oluwatosin "Tosin" Sokefun, a chemical engineering graduate student, at the recent National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) annual conference was recognized with a second place award in the Inorganic Chemistry category. Her research focuses on low temperature biogas reforming catalysts to enable intensified biogas upgrading to value-added fuels and chemicals.

Molly Skinner named Outstanding Society of Women Engineers (SWE) Collegiate Member

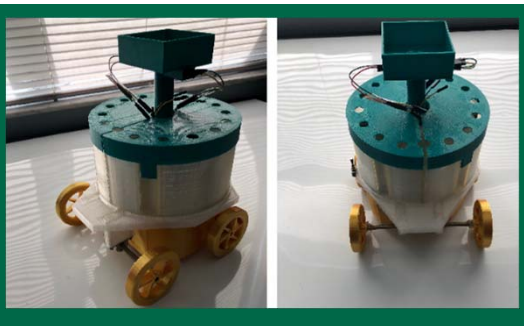
Molly Skinner, a Ph.D. candidate in chemical engineering, was named a 2021 SWE Outstanding Collegiate Member. This national award is given to those who have made an outstanding contribution to SWE, the engineering community, and their campus. After being an active leader in SWE at the undergraduate level, Molly founded a GradSWE Section at USF. She is also a founding board member of the SkinnerStrong Foundation, a nonprofit group whose mission is to support research in the area of childhood leukemia. She hopes that her ongoing research in CAR-T cell therapy will help directly further this mission of curing such cancers.

Jakin Delony Recognized for Outstanding Department Service and Outstanding Research Progress Award

Jakin Delony, a Ph.D. candidate in chemical engineering working under the supervision of Professor Clifford Henderson, was recognized with the recent 2020-21 Outstanding Department Service Award for his many contributions to the department and its students. Outside of his research, Jakin has had many important roles including serving as President of the Chemical Engineering Graduate Student Association. He was also the recipient of the 2020-21 Outstanding Research Progress Award for his scholarly productivity stemming from his research on block copolymers and their use in self-assembly.

2021 Delta Q Outstanding Undergraduate Research Award

Jeremy Brower, a senior in chemical engineering, was awarded the Delta Q Outstanding Undergraduate Research Award for 2021. This annual award recognizes an undergraduate student who has demonstrated outstanding research performance through publications, presentations, and other scholarly works. His research in the Kuhn research group focused on mesoporous silica supported perovskite oxides for the low temperature thermochemical conversion of CO_2 to useful products and resulted in a first-author publication in *ChemCatChem*.



USF AIChE Student Chapter Wins Awards

It has been a busy year for the USF AIChE Student Chapter. Its ChemECar team spent much of the pandemic building and refining a new generation of competition car that is powered by and controlled autonomously via only chemical reactions. The team won first place in the ChemECar poster competition at the Spring 2021 AIChE Southern Regional Student Conference. The chapter as a whole also is the recipient of a 2021 AIChE Outstanding Chapter Award which is a national award that recognizes the top student chapters across the country.

Endowment Fund for Student Success Initiatives Created

Since joining the faculty in 2016, Dr. Sandy Pettit has worked diligently to improve student success through evidence-based pedagogical techniques and initiatives. One example of her efforts is the department's Peer Leader / Learning Assistant Program which brings undergraduate students into classrooms to serve as learning guides during problem solving sessions and recitations. Along with Department Chair Henderson, she helped to create and now manages the Faculty-Student Mentor Program which engages ChBME faculty to provide professional development and career coaching for the department's undergraduates. To further ensure that the department is responsive to student needs, Dr. Pettit led the development of the ChBME Undergraduate Advisory Board. The most recent student success initiative in which Dr. Pettit participated was the development and utilization of take-home laboratory kits for remote operations during the COVID-19 pandemic. In total, Dr. Pettit has secured more than $250k in grant funding to develop these programs, build kits, and improve student success. However, she hasn't stopped there. In an effort to build a sustainable funding source for such efforts, she has now established and endowed the new Dr. Sandy Pettit Endowed Fund for Student Success in Chemical Engineering. The endowment will ensure resources exist to enable such efforts for many years to come.

How Can You Help?
Visit giving.usf.edu or Contact Us at (813) 974-5855

If you would like to contribute to such student success initiatives, please contact us or visit **giving.usf.edu** and select the *Dr. Sandy Pettit Endowed Fund for Student Success in Chemical Engineering*. If you are interested in a more general donation to the department or its scholarship fund, please visit **giving.usf.edu** and select either of these funds:

Chemical Engineering Alumni Scholarship Fund (226340)
Chemical Engineering Operating Fund (220030)

Your generous donation can be in the honor or memory of someone special. Please let us know about your gift by notifying the ChBME Department at 4202 E Fowler Ave ENG 030, Tampa, 33620 when prompted in the gift form.

SPOTLIGHT: ChBME External Advisory Board

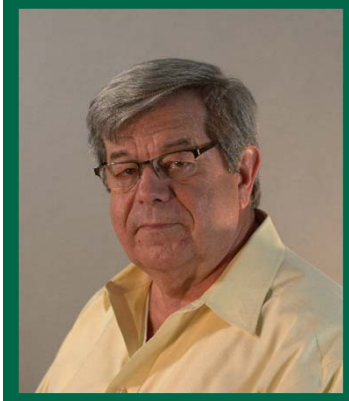
Dr. Chris Schemel, Delta Q Consultants
External Advisory Board Chair

Marcos Ortiz, Mosaic
External Advisory Board Vice-Chair

Nicole Ferrari, Bausch + Lomb
External Advisory Board Recorder

Eid Dahdal, Tampa Electric Co, Emera
Dr. Nada Elsayed, Catalent
Thomas Hartranft, Jabil
Nohra Martinez, AkzoNobel
Gordon Miller, Gordon Miller Consulting
Chris Monteparo, Procter & Gamble
Thomas Osypka, Oscor
Dr. Rachana Vidhi, NextEra Energy Resources

SPECIAL THANKS: Alumni Giving



USF alumni and guest lecturer, Tom John, established the Tom John Graduate Chemical Engineering Scholarship Fund. The scholarship is awarded annually to an outstanding chemical engineering graduate student.

USF alumni and adjunct faculty member, Dr. Chris Schemel established the DeltaQ Consultants Outstanding Undergraduate Researcher Award. The certificate and monetary award are provided annually to a chemical engineering undergraduate student for their research accomplishments.

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