Chemical & Biochemical Engineering at Rutgers

cbe news

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inside

Chemical & Biochemical Engineering at Rutgers

Chemical engineering sees a growing role in today's society advancing innovation across virtually every industry. The Department of Chemical and Biochemical Engineering at Rutgers has spearheaded critical research in areas that include biotechnology and bioengineering, materials, pharmaceutical science and engineering, and process systems and reaction engineering, among other new fields of study.

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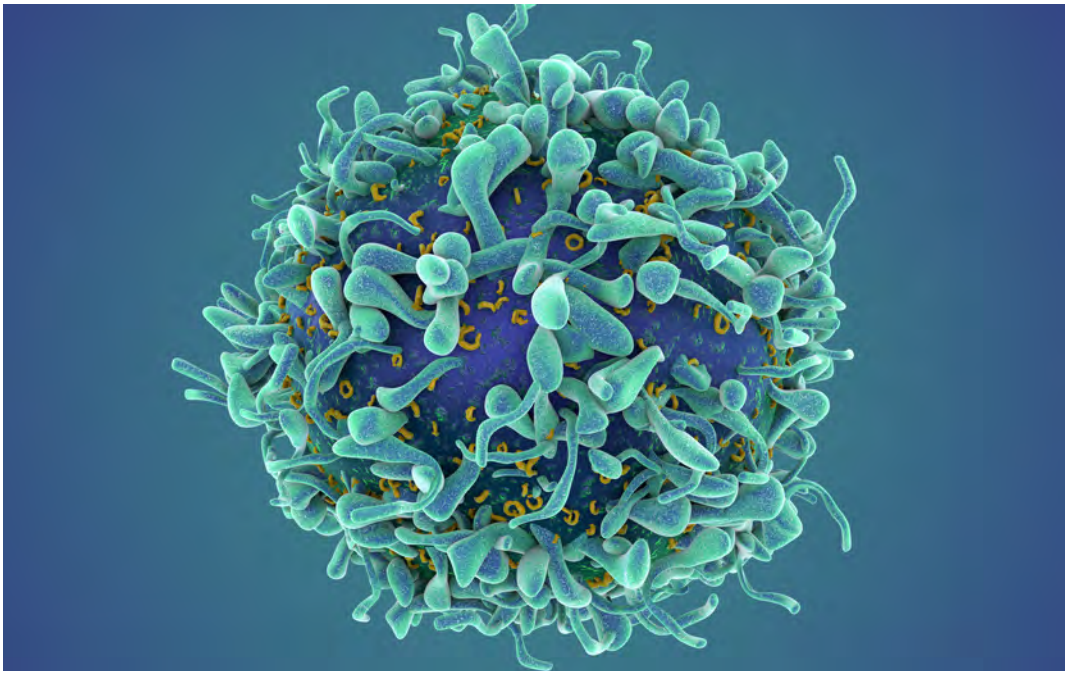
RUTGERS School of Engineering



Faster, More Accurate Cancer Detection Using Nanoparticles

Light-emitting nanoprobes can detect cancer early and track the spread of tiny tumors

By Todd Bates

Using light-emitting nanoparticles, Rutgers engineering researchers have invented a highly effective method to detect tiny tumors and track their spread, potentially leading to earlier cancer detection and more precise treatment.

The technology, announced today, could improve patient cure rates and survival times.

"We've always had this dream that we can track the progression of cancer in real time, and that's what we've done here," said Prabhas V. Moghe, a corresponding author of the study and distinguished professor of chemical and biochemical engineering and biomedical engineering at Rutgers–New Brunswick. "We've tracked the disease in its very incipient stages."

The study, published in *Nature Biomedical Engineering*, shows that the new method is better than magnetic resonance imaging (MRI) and other cancer surveillance technologies. The research team included Rutgers' flagship research institution Rutgers University-New Brunswick and its academic health center Rutgers Biomedical and Health Sciences, or RBHS.

"The Achilles' heel of surgical management

Continued on p. 5

Faculty Achievements

Patents

Shishir Chundawat is awarded a U.S. patent to develop a process to produce value-added products from lignocellulosic biomass.

Masanori Hara is awarded a U.S. patent for the development of inorganic polymers, which have various advantages over organic counterparts including abundance of source material, non-flammability, low toxicity, and excellent thermal and chemical resistance.

Grants

Yee Chiew: *Air Force Office of Scientific Research* ($335,000) – to support developing molecular models for phase transitions, nucleation, and mixing through trans-critical conditions for propulsion systems; *Department of Energy* ($200,000) – to develop thermodynamic and simulation tools for modeling supercritical carbon dioxide power cycles.

Rohit Ramachandran and **Marianthi Ierapetritou**: *Department of Energy* ($225,000) – for fast fingerprinting and detecting of materials using portable NIR sensing.

Rohit Ramachandran: *Handok Pharmaceuticals* ($113,000) – to study real time release and sensing for drug manufacturing.

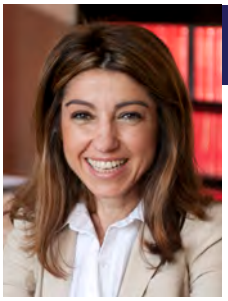
Shishir Chundawat: *National Science Foundation* ($300,000) – to investigate the molecular underpinnings of how to engineer glycosynthase enzymes to produce glycans or carbohydrate-based ligands (or glycoligands) for enabling low-cost and customizable protein bioseparations.

Alex Neimark: *Defense Threat Reduction Agency* ($238,445) – to work on mass transport, kinetics, and catalytic activities of multicatalyst polyelectrolyte membranes.

Silvina Tomassone: *National Science Foundation* ($200,000) – to explore combining plug-and-play cartridges with ZYMchips to conveniently produce metabolites for analytics.

Marianthi Ierapetritou: *Eli Lilly* ($90,000) – for modeling and economic analysis of biopharmaceutical production.

Charles Roth: *New Jersey Health Foundation* ($50,000) – for smart polyelectrolyte nanomedicine for cystic fibrosis.



Message from the chair

Dear Alumni, Friends, and Partners:

I am very happy to share all the exciting CBE news since our last newsletter.

Our faculty and students continue to conduct amazing research, receiving a number of awards highlighted in this newsletter. Among our newest faculty members, George Tsilomelekis received the prestigious National Science Foundation (NSF) CAREER award. This is an incredible accomplishment for George who also secured a Petroleum Research Fund grant to develop novel catalytic conversion routes in renewable and alternative energy.

This year we held our first Industry Meet and Greet event with nearly 20 industry partners (many our alumni) who fielded questions and shared advice and insights with CBE undergraduate and graduate students. Our graduate students held their annual symposium, inviting alumna and Merck associate vice president Elizabeth Liss to deliver the keynote lecture. The department also hosted Juan de Pablo from the University of Chicago's Institute of Molecular Engineering, who delivered the 2018 distinguished lecture.

Alumnus Andrew Intrater ENG'85 was the School of Engineering's 2017 Medal of Excellence Award honoree for his professional achievement. The CBE department also honored alumnus John Donofrio ENG'83 with the Outstanding Alumni Achievement Award.

I would like to close this note by thanking everyone for their support over the last five years, during my tenure as department chair. It has been an amazing journey. As I prepare to step down, I am certain that the department will continue to thrive, grow, and accomplish amazing things under the leadership of the new chair Helen Buettner. Please join me in congratulating Helen!

Best wishes,

Marianthi Ierapetritou, Ph.D.
Chair, Department of Chemical and Biochemical Engineering

Awards

George Tsilomelekis receives the Doctoral New Investigator Award ($110,000) from the American Chemical Society Petroleum Research Fund to develop novel mixed metal oxides as stable solid super acids for alkylation reactions.

Alex Neimark is awarded the prestigious Leverhulme Trust Award which is given to eminent foreign academics for visiting professorship at UK universities. The Leverhulme Award will support his sabbatical research at University College London during fall 2018.

Marianthi Ierapetritou is elected to the board of directors of AIChE and is the recipient of a Greek Diaspora Fellowship. She also recently achieved the rank of distinguished professor.

Helen Buettner receives the 2018 Rutgers Undergraduate Academic Affairs Faculty Award for her "outstanding generosity and commitment to the education of our students." She served as a senior faculty fellow for Undergraduate Academic Affairs from 2016-2017, focusing her attention on Rutgers Learning Centers.

News

Masanori Hara was invited to be a guest editor of *Journal Polymers*, contributing to the "Ionic Polymers" special issue. He has studied various ionic polymers, such as ionomers, polyelectrolytes, and ionic liquid crystalline polymers, for many years.

Teddy Asefa joins the scientific board of the new journal, *Small Methods,* as well as advisory board for the journal *Materials Today Nano.* He was also invited to serve as a guest editor for a special issue on "Electrocatalysis: Energy and Sensing" for the journal *Frontiers of Chemical Sciences and Engineering* and he joined the advisory committee for the third International Symposium on Energy and Environmental Photocatalytic Materials to be held in Kraków, Poland, in spring 2018.

CBE Leaders Advance to New Positions

Marianthi Ierapetritou, Associate Vice President, SciWomen

Helen Buettner, Department Chair, Chemical and Biochemical Engineering

Prabhas Moghe, Vice Chancellor for Research and Innovation

Marianthi Ierapetritou, distinguished professor and chemical and biochemical engineering department chair, has accepted a new position within Rutgers as associate vice president for the promotion of women in science, engineering, and mathematics (SciWomen). Her role will expand to support the Rutgers University mission of outstanding teaching, research, and community engagement by promoting gender and racial equity in science, engineering, and mathematics. SciWomen provides resources and support for engagement and success in the sciences through programs and special events that promote leadership, mentoring, awareness, and professional development. Ierapetritou, who assumes the position on July 1, has made extensive research contributions in the area of modeling and computational analysis for chemical processing, securing more than $40 million in funding.

In a transition that exemplifies Ierapetritou's new role advancing women's careers in STEM, Helen Buettner has been elected by her peers to lead the Department of Chemical and Biochemical Engineering as department chair. Buettner's research and scholarship record in nerve regeneration, growth cone guidance, acupuncture mechanisms, and diversity in engineering education are important to SoE's efforts to partner with Rutgers Biomedical and Health Sciences. She has also served the university well as a member of Rutgers University president Robert Barchi's Instructional Technology Committee, building the school's partnership with the learning assistant program, supporting the community developing new teaching methods for engineering education, leading the Reilly-Douglass Living-Learning Community, and participation in the Big Ten Academic Alliance Leadership Program.

In recognizing these career advancements, Rutgers engineering's dean Tom Farris expressed his respect and regard for both CBE professors. "I look forward to working with Marianthi in her new role advancing women in science." He continued, "I have worked closely with Helen in my time at Rutgers and am confident that she has the vision and persistence to move CBE and SoE forward."

Other advancements include Prabhas V. Moghe, distinguished professor of chemical and biochemical engineering and biomedical engineering, who has been named the inaugural vice chancellor for research and innovation for Rutgers University–New Brunswick. Moghe will be responsible for creating a university-wide culture that promotes faculty innovation. He will work closely with academic departments and campus-level interdisciplinary research centers and develop relationships with government agencies and the private sector to enhance the visibility of faculty research. ■

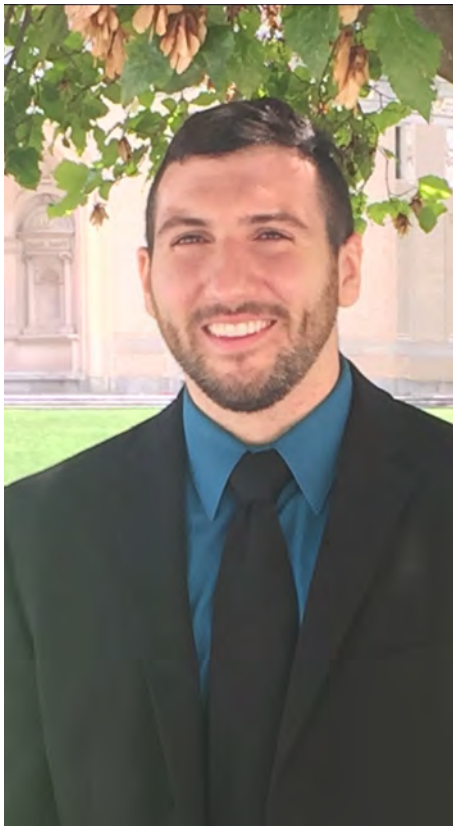
National Science Foundation Recognizes Early Career Achievement of George Tsilomelekis

Chemical and biochemical engineering assistant professor George Tsilomelekis has been awarded a prestigious CAREER award from the National Science Foundation. The honors come with a grant totaling more than $500,000 for his research on developing more energy-efficient production of propylene.

Tsilomelekis' research will develop novel catalysts with dual functionality for converting propane to propylene. He uses spectroscopic techniques under real reaction conditions in seeking new paths to efficient, renewable, and alternative energy sources. The award will also fund outreach for younger students through development of a freeware computer game that teaches principles of molecular symmetry and spectroscopy.

"This is a tremendous honor for George, who has contributed to our innovative environment since coming to Rutgers in 2015," said Marianthi Ierapetritou, chemical and biochemical engineering department chair. ■

Alex Bertuccio: Bringing Energy and Passion to Teaching



Since Alex Bertuccio joined the School of Engineering as a teaching professor at the start of the fall 2017 semester his enthusiasm and energy has engaged students and faculty alike. Bertuccio, who earned a doctoral degree in chemical engineering from Carnegie Mellon, is instructing students in process engineering both as a lecturer and in lab work.

According to department chair Marianthi Ierapetritou, "Alex brings a lot of passion to his teaching. His excitement is contagious, which helps in the classroom and lab to focus students and generate their active participation. He's been a wonderful addition to our faculty."

About to wrap up his first year teaching at Rutgers, Bertuccio has enjoyed the community aspect of the Chemical and Biochemical Engineering Department and has done his part to further strengthen departmental collegiality. He initiated Coffee with the Professors, an every other week informal gathering for students and professors to spend time together in a drop-in, casual setting.

He felt that creating a relaxed and comfortable gathering space would help to develop a stronger sense of community between students, faculty, and staff.

"Students learn that professors are people too," he said. "I think it also allows faculty to make stronger connections and learn more about what everyone is up to."

Bertuccio is also inspired and impressed with the many students he's encountered.

"I am amazed by the motivation I see in Rutgers engineering students," he says. "They all have unique stories to tell and I love seeing how their chemical engineering studies are moving them one step closer to their dreams."

And Bertuccio believes that a chemical engineering degree provides the versatility and opportunity for realizing dreams.

"Chemical engineers have the capacity to work in just about any field from health care, pharmaceuticals, and energy to consumer products, agribusiness, food science, and more." ■

Rutgers Engineering Celebrates the Class of 2018!

Photography: Keith Muccilli

The Department of Chemical and Biochemical Engineering graduated 119 students on Sunday, May 13. Students participated in a ceremony at a university wide commencement event at High Point Solutions Stadium, followed by a convocation event for the School of Engineering at the Rutgers Athletic Center. During the convocation, School of Engineering dean Tom Farris encouraged the students to, "let nothing stand between you and what you can accomplish."

CBE students are heading off to careers in industry, research, and government, while others are pursuing advanced degrees. ■

Pictured left to right: Nicholas Townsend Haas, Jessica McDonald, James Forder, Jonah Williams, Philip Whong, and Jing Wang.

for cancer is the presence of micro metastases. This is also a problem for proper staging or treatment planning. The nanoprobes described in this paper will go a long way to solving these problems," said Steven K. Libutti, director of the Rutgers Cancer Institute of New Jersey, senior vice president of oncology services for RWJBarnabas Health, and vice chancellor for cancer programs for Rutgers Biomedical and Health Sciences.

The ability to spot early tumors that are starting to spread remains a major challenge in cancer diagnosis and treatment, as most imaging methods fail to detect small cancerous lesions. But the Rutgers study shows that tiny tumors in mice can be detected with the injection of nanoprobes, which are microscopic optical devices, that emit short-wave infrared light as they travel through the bloodstream – even tracking tiny tumors in multiple organs.

The nanoprobes were significantly faster than MRIs at detecting the minute spread of tiny lesions and tumors in the adrenal glands and bones in mice. That would likely translate to detection months earlier in people, potentially resulting in saved lives, said Vidya Ganapathy, a corresponding author and assistant research professor in the Department of Biomedical Engineering.

> **"We've always had this dream that we can track the progression of cancer in real time, and that's what we've done here."**

"Cancer cells can lodge in different niches in the body, and the probe follows the spreading cells wherever they go," she said. "You can treat the tumors intelligently because now you know the address of the cancer."

The technology could be used to detect and track the 100-plus types of cancer, and could be available within five years, Moghe said. Real-time surveillance of lesions in multiple organs should lead to more accurate pre- and post-therapy monitoring of cancer.

"You can potentially determine the stage of the cancer and then figure out what's the right approach for a particular patient," he said.

In the future, nanoprobes could be used in any surgeries to mark tissues that surgeons want to remove, the researchers said. The probes could also be used to track the effectiveness of immunotherapy, which includes stimulating the immune system to fight cancer cells.

The study includes 16 authors at the School of Engineering (departments of Biomedical Engineering, Chemical and Biochemical Engineering, and Materials Science and Engineering) at Rutgers University–New Brunswick, the Rutgers Cancer Institute of New Jersey, the Department of Computer Science, and Singapore University of Technology and Design (SUTD).

The study's lead authors are Harini Kantamneni in the Rutgers Department of Chemical and Biochemical Engineering and Margot Zevon in the Department of Biomedical Engineering. The third corresponding author is Mark C. Pierce, an associate professor in the Department of Biomedical Engineering. The collaboration with Mei-Chee Tan at SUTD was integral to this team effort. Other Rutgers–New Brunswick or RBHS co-authors are Michael J. Donzanti, Shravani R. Barkund, Lucas H. McCabe, Whitney Banach-Petrosky, Laura M. Higgins, Shridar Ganesan, Richard E. Riman, and Charles M. Roth. ■

Faculty Members Recognized for Research Excellence

Chemical and biochemical engineering professors were honored as part of the Rutgers University-New Brunswick annual year-end recognition awards.

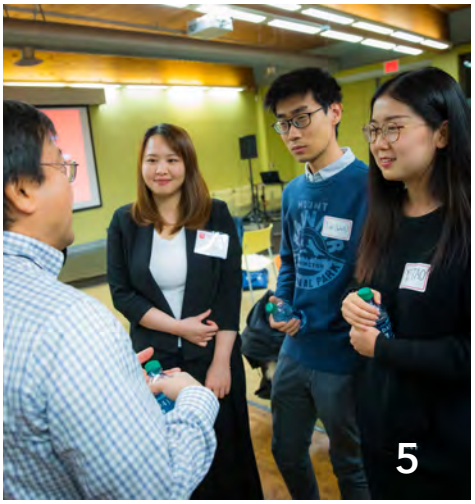
Ioannis Androulakis, who holds faculty positions in chemical and biochemical engineering and biomedical engineering, and Rohit Ramachandran, chemical and biochemical engineering associate professor and Chancellor's Scholar, received the Board of Trustees Award for Excellence in Research. The awards were presented at an event on May 3.

Androulakis pursues research in the areas of systems engineering, system biology, bioinformatics, data mining, and kinetic modeling. He is particularly interested in "functional physiomics," which attempts to establish functional links between cellular events, such as signaling, transcription, and translation, and an expanding envelope of interactions which include the bidirectional links between cells, tissues, organs, environmental signals, and physiological responses.

Ramachandran runs the Particulate Systems Lab at Rutgers, conducting research involving nonlinear distributed and lumped processes. Uniting tools from physics, chemistry, and biology with mathematical modeling and systems engineering, the lab's model frameworks have applications from the pharmaceutical to energy industries. He is also contributing to Rutgers' pharmaceutical manufacturing research by developing the sensors and control systems needed to monitor the production process. ■

Photographed (left to right): Ioannis Androulakis and Rohit Ramachandran

Second Annual CBE Alumni Networking Event and Industry Meet and Greet



Chemical and biochemical engineering alumni, faculty, and friends attended a CBE Alumni Networking event (photos 1–4) in Jersey City. During the event undergraduate students Elizabeth McGinley and Carolina Radecki were recognized as recipients of the Dr. Alkis Constantinides Endowed Scholarship. John Donofrio ENG'83, executive vice president and general counsel at Johnson Controls, received the Outstanding Alumni Achievement Award in recognition of his professional leadership.

CBE also hosted an Industry Meet and Greet (photos 5–8) on campus bringing together students and industry representatives—many of them alumni—for informal conversations. ■

Photography: Roy Groething

CBE Alumni Spotlight: Emmanuel Yamoah ENG'98

In his role at Duracell, Emmanuel Yamoah heads up R&D efforts for Europe, the Middle East, Africa, and Asia (EIMEA). He leads a team that is dedicated to driving the company's product innovation strategy for disposable and renewable power. After graduating from Rutgers with a degree in chemical engineering, he began his career at Procter & Gamble as an engineer in global personal health care, later advancing to roles as senior engineer in North America oral care product development and global feminine care product development. At the time of Duracell's spin-off from P&G, and prior to assuming his current role, Yamoah was serving as R&D manager of Global Duracell product development. He is currently a member of the School of Engineering's Industry Advisory Board.

"At Rutgers I was able to design what I felt my future could be."

Where did you grow up?

I was born in Ghana, but moved to New Jersey with my family when I was three. I grew up in Newark and then Roselle.

Why engineering?

I had the opportunity to go to St. Benedict's Preparatory School, an amazing high school in Newark. I was exposed to chemical engineering while there and was encouraged by a few instructors who helped me realize my potential in math and sciences.

How did your high school experience prepare you for Rutgers?

I carried three things in to Rutgers—leading, building skills, and competing with myself every day to be the best I could be. I'd been the school leader my senior year at St. Benedict's, which gave me the opportunity to build leadership skills at a young age. I'd been exposed to how I could apply my skills and abilities in math and science. Lastly, I was also an athlete. When I got to Rutgers, I walked on to the track team, where I primarily competed in the long jump. I could jump high and run fast—and I committed myself to being competitive and strong at what I did, pushing myself every day to be better than I was the day before.

How would you describe your current leadership style?

I would like to say it is collaborative and inspiring. I encourage my team at Duracell to identify what could be possible and then point a way forward from there. We work as partners, knowing that one plus one is equal to three. There's an element of selflessness, as well, as I am committed to working together with my team to drive the company's mission and vision while also helping to drive their personal aspirations.

What benefits did Rutgers offer you?

A major benefit was the support systems and the many different communities you can be part of—whether clubs, teams, organizations, or academic departments. I always felt a sense of belonging and a sense of camaraderie among my fellow students.

Besides the track team, I engaged with Minority Engineering Educational Task (MEET) and the Rutgers chapter of the National Society of Black Engineers. That organization introduced me to other African Americans and individuals of African descent who were doing what I was doing.

What do you value most about your Rutgers education?

I was able to design what I felt like my future could be. I had great advisors and professors in chemical engineering and in Rutgers Engineering as a whole, who had been there, done that, and seen students like me. This meant they had a tool kit ready that gave me ways to think about options I could leverage to catapult forward. Dean Donald Brown (retired), in particular, was one of the most influential people in my life while at Rutgers.

Tell us about your work at Duracell.

I'm in the power and battery industry at Duracell and am passionate about power and sustainability issues. I hope to be able to drive more visibility and awareness of what is happening in the industry to Rutgers by sharing insights gained from Duracell, which has been confronting these challenges for years.

I also want to expose and help advance people of color, women, and other individuals who are underrepresented in engineering and STEM disciplines. My objective is to help to enable students with support systems that existed when I was at Rutgers, as well as with new ones. I'd like to help identify ways Rutgers can make connections with young students as early as grammar school and right up through middle school, high school, and even into their professional careers.

What do you do these days for fun?

I travel a lot for my job and have two children, so I try to balance that—and keep myself fully engaged for my kids. My wife is a pianist and we both love music and enjoy going to a lot of concerts.

I like running and basketball—though don't have as much time as I like for athletics. My daughter is a softball pitcher and I enjoy being her catcher. My son plays soccer and baseball and I coach his track team.

I've always enjoyed words and language and I also write and used to perform poetry. I'm starting to get back into that creative side of my life more now. ■

LinkedIn

Join the CBE LinkedIn group. Search **Rutgers Chemical & Biochemical Engineering Friends & Alumni** and click "Ask to Join."

RUTGERS
School of Engineering

Department of Chemical and Biochemical Engineering
Rutgers University–New Brunswick
98 Brett Road
Piscataway, NJ 08854-8058

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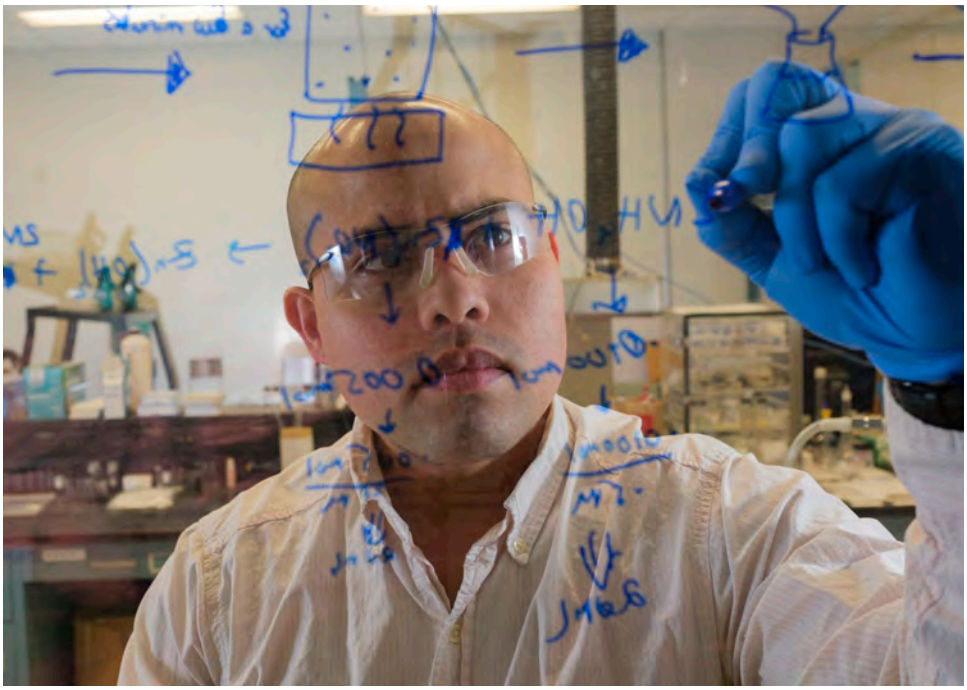
Devising Smart Materials for Chemical Warfare Protection

Chemical and biochemical engineering doctoral student Jonathan Colon is developing smart materials to protect soldiers from the deleterious effects of chemical warfare agents. This protective composite material is comprised of a polymeric film that incorporates metal-oxide nanoparticles.

The technology is intended to block the permeation of agents through military fabrics while at the same time providing decomposition of such agents due to the nanotechnology embedded within the films.

"We envision that this material will be used as a protective layer that would be applied on the external surface of military uniforms to provide protection against exposure to chemical warfare agents in the air," says Colon.

Colon, who is a member of CBE professor Alex Neimark's research group, presented his work at the 2017 National Diversity in STEM Conference in Salt Lake City. ■



Photography: Don Hamerman