OCTOBER 13, 2014

C&EN

CHEMICAL & ENGINEERING NEWS

NSF'S NEW LEADER
Director France Córdova prioritizes research **P.21**

ENGAGING EMPLOYERS
Our annual look at some great places to work **P.33**

LOOKING INSIDE MATERIALS

Atom-probe tomography reveals what's beneath the surface **P.11**

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VOLUME 92, NUMBER 41
OCTOBER 13, 2014

C&EN

CHEMICAL & ENGINEERING NEWS

Serving the chemical, life sciences, and laboratory worlds

COVER STORY

THE INSIDE THAT COUNTS

Atom-probe tomography looks within materials, elucidating their properties and how they're formed. PAGE 11

QUOTE OF THE WEEK

"We have to have science in the backyard, in the schoolyard, in every nook and cranny because you don't know at what age a person is going to be inspired to start thinking about scientific questions."

FRANCE A. CÓRDOVA, DIRECTOR, NATIONAL SCIENCE FOUNDATION

PAGE 21

NEWS OF THE WEEK

COVER: *These specimens used for atom-probe tomography have tips approximately 100 nm wide. Mitch Jacoby/C&EN*

BUSINESS

GOVERNMENT & POLICY

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WATCH YOUR MAILBOX ... ACTUAL OR VIRTUAL

BALLOTS FOR THE ACS ELECTION MAILED ON FRIDAY, OCT. 3, AND THE ONLINE POLLS ARE OPEN. YOUR VOICE COUNTS, SO VOTE FOR THE 2015 ACS PRESIDENT-ELECT AND ANY OTHER RACES ON YOUR BALLOT. POLLS CLOSE ON NOV. 14.

DEFINE VOLATILE

THANKS FOR Glenn Hess's article "U.S. Seeks Tighter Rail Safety Rules" (C&EN, Aug. 18, page 22). However, the word "volatile" is misused when he writes that "ethanol is less volatile than crude oil."

"The Associated Press Stylebook and Libel Manual" gives the following guidance: "**volatile** Something that evaporates rapidly. It may or may not be explosive."

A Newscripts item from back in the 1970s reported that emergency personnel evacuated an area after the spill of "highly volatile" liquid nitrogen. The public believes the word means explosive, and media, too, often misuse the term.

In what sense is ethanol less volatile than crude oil? Most of us would measure volatility by weight loss in an oven for an hour at say 120 °C. By this test, ethanol is more volatile than crude oil.

Experts say the headspace in a tank of a volatile like gasoline is not explosive because vapor pressure pushes the composition above the upper explosive limit. Less volatile materials, such as diesel fuel, can be within the explosive range. In that sense, ethanol might be less volatile, but that implies that Hess meant explosive rather than volatile. Or is the statement based on flash point?

Interestingly, the word volatile is used correctly on page 23 of the same issue in describing hexanoic acid.

Paul E. Eckler
Wildwood, Mo.

IN PRAISE OF PRINT

YES, "moving to an exclusively digital format" would preserve natural resources, as Chris Erickson lucidly explained in his letter to the editor (C&EN, July 28, page 4). But I beg ACS to retain the print version of *Chemical & Engineering News.* It is, frankly, the principal benefit I derive from membership.

Receiving C&EN in my otherwise crowded-with-catalogs mailbox is a weekly delight. I can read it anywhere. It gives me real-world examples of innovation that I can share with all my students. Moreover, I share issues with my AP chemistry students, who use them to help satisfy curricular requirement 4 from the College Board.

C&EN helps them connect their knowledge of chemistry and science to major societal or technological components better than any other resource. Thanks to you and the ink and trees that you use in a responsible way to communicate important news to us.

W. Patrick Cunningham
San Antonio

CALLING OUT UNSAFE BEHAVIOR

I HEARTILY AGREE with Manfred E. Wolff's point that C&EN should not inadvertently endorse unsafe behaviors by showing examples without comment and proper warnings (C&EN, Aug. 18, page 3). Protective eyewear must fit. If the hazard that the worker or student is exposed to could be in the form of a liquid spray, then tight-fitting goggles over safety glasses may be required.

However, I heartily disagree with his recommendation that C&EN avoid terms such as "recipe" and "from scratch." C&EN articles are accessible to a wide range of people and need not comply with the requirements of a scientific paper.

John Paterson
Mississauga, Ontario

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- Letters should generally be 400 words or fewer and should include the writer's full name, address, and home telephone; letters may be edited for purposes of clarity and space. Because of the heavy volume of mail received at C&EN, writers are limited to one letter in a six-month period.

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1155—16th St., N.W., Washington, DC 20036
(202) 872-4600 or (800) 227-5558

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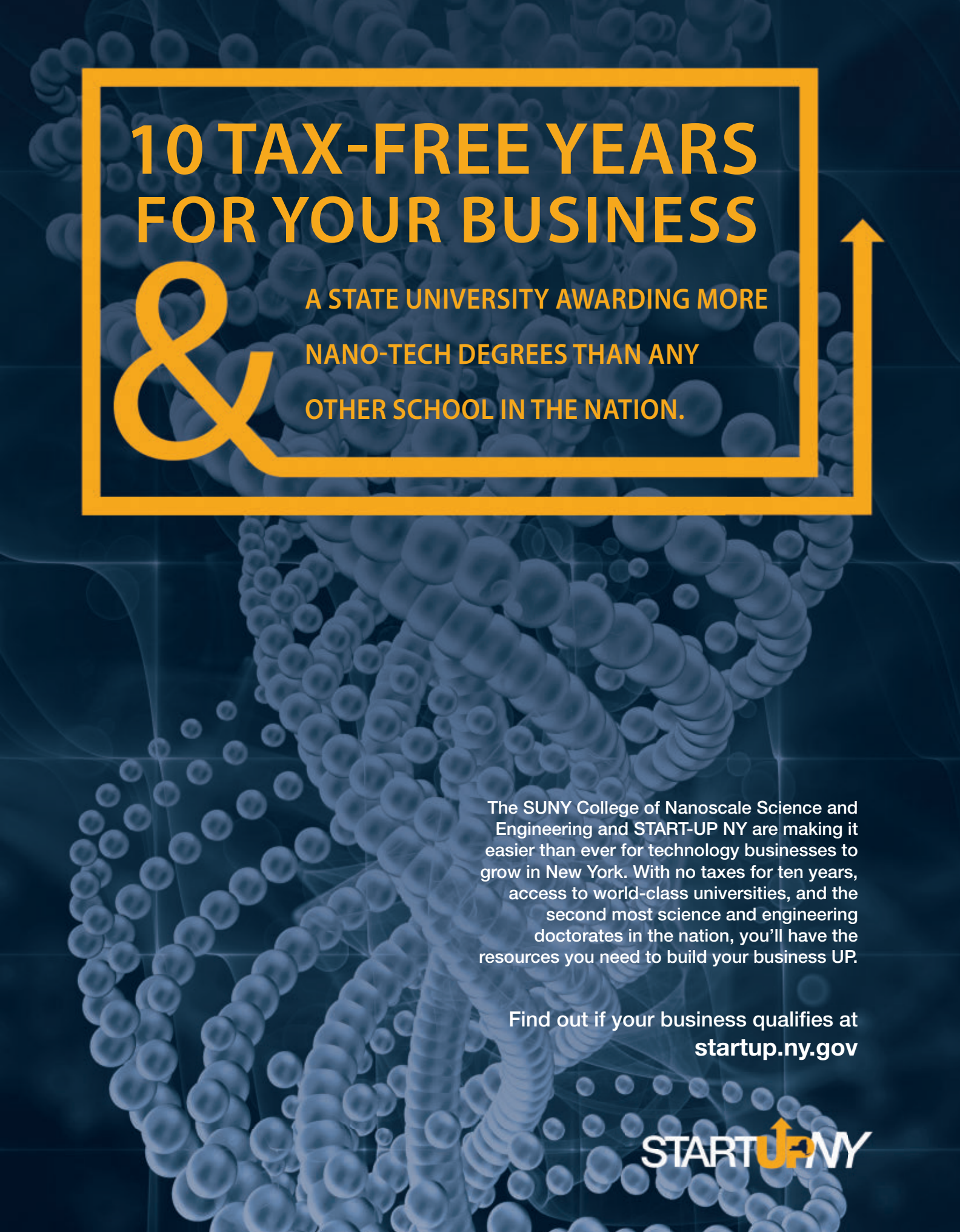
Recognition For National Chemistry Week 2014

ACS IS PROUD TO ANNOUNCE special recognition and greetings for National Chemistry Week 2014 and its celebrants from President Barack Obama and the U.S. Senate. The President issued a message of greetings to all those observing National Chemistry Week, and the Senate unanimously passed a resolution, sponsored by Sen. Chris Coons (D-Del.) and Sen. Pat Toomey (R-Pa.), recognizing National Chemistry Week. The resolution can be found at http://cenm.ag/resolution.

National Chemistry Week is Oct. 19–25, and the theme is "The Sweet Side of Chemistry—Candy." ACS thanks all members and volunteers preparing to celebrate NCW 2014 in their communities!

For more information about National Chemistry Week 2014 and how to get involved in the celebration, visit http://cenm.ag/ncw2014.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C&EN news of the week

OCTOBER 13, 2014 EDITED BY WILLIAM G. SCHULZ & SOPHIA L. CAI

NANOSCALE IMAGING TAKES CHEMISTRY NOBEL

AWARDS: Eric Betzig, Stefan Hell, and W. E. Moerner win for superresolution fluorescence microscopy

THE 2014 NOBEL PRIZE in Chemistry honors three individuals for the development of superresolution fluorescence microscopy, which has made it possible to obtain optical images at the nanometer scale—well below the diffraction limit.

Eric Betzig, 51, of the Howard Hughes Medical Institute's Janelia Farm campus in Ashburn, Va.; Stefan W. Hell, 51, of the Max Planck Institute for Biophysical Chemistry, in Göttingen, Germany, and the German Cancer Research Center, in Heidelberg; and William E. (W. E.) Moerner, 61, of Stanford University will share the $1.1 million prize.

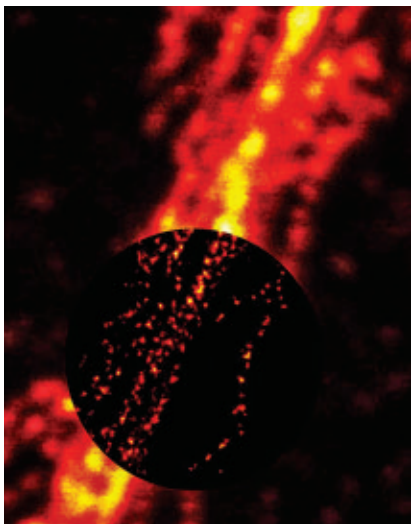
Moerner was the first person to detect a single fluorescent molecule, which he achieved while working at IBM's Almaden Research Center in San Jose, Calif. Before that, researchers could only detect many molecules simultaneously.

Moerner later discovered, while working at the University of California, San Diego, that one variant of green fluorescent protein could be turned on and off on command. The protein would fluoresce when excited with 488-nm light, but once it faded the protein wouldn't turn back on. But Moerner discovered that exposure to 405-nm light reactivated the protein. It could again be excited with 488-nm light.

Such photoswitchable fluorescent proteins form the basis of photoactivated localization microscopy (PALM), which Betzig coinvented with Harald Hess in 2006. They built the original instrument in Hess's living room.

In PALM, photoactivatable fluorescent proteins are toggled on and off a few at a time. The method requires that the activated proteins be far enough apart that their locations can be precisely determined. An image can be built by repeating the cycle many times and superimposing the images. Similar methods were also developed in 2006 by Xiaowei Zhuang of Harvard University (stochastic optical reconstruction microscopy, or STORM) and by Samuel T. Hess of the University of Maine (fluorescence PALM, or fPALM).

The method developed by Hell—stimulated emission depletion (STED) microscopy—works differently. In that method, one laser beam stimulates fluorescence in labeled biomolecules. A second overlapping doughnut-shaped laser beam turns off that fluorescence in all but a nanometer-sized volume. By scanning across a sample, it is possible to build an image with nanometer-scale resolution.



G. DONNERT & S. W. HELL/MAX PLANCK INSTITUTE FOR BIOPHYSICAL CHEMISTRY

The filament structures within a nerve cell are clearly resolved in a STED microscopy image (circular inset) but blurry in a conventional light microscope image.

"I'm glad not to be in the shoes of the Nobel Prize committee which had to make the decision who *not* to include as an award winner," says Joerg Bewersdorf, a superresolution microscopy expert at Yale University. "The field has benefited tremendously by contributions of quite a few pioneers over the last two decades."

These original superresolution methods improved lateral resolution, but they did little to improve depth resolution. Since the introduction of PALM, STORM, STED, and fPALM, the inventors and others have further developed them to acquire three-dimensional images.

The awarding of the prize for superresolution imaging "reflects the amazing impact this technology is having throughout biology," says Jennifer Lippincott-Schwartz, a cell biologist at the National Institutes of Health who has collaborated with Betzig. These techniques "are revolutionizing our concepts of some of the most fundamental components of living cells, which up until now were hidden because of our inability to see below the resolution limit of light."

"I see this as a confluence of areas of science," American Chemical Society President Thomas J. Barton says. "There's no question it's chemistry. But we see a lot of sciences playing a role in the whole picture. I think that's a very healthy thing."—CELIA ARNAUD

HHMI

Betzig and Harald Hess built their original instrument in Hess's living room.

MAX PLANCK INSTITUTE FOR BIOPHYSICAL CHEMISTRY

Hell

MATT STANLEY/HHMI

Betzig

L.A. CICERO

Moerner

SEEKING PHARMA BRIGHT SPOTS

CPhI: Business niches offered the most promise for conference attendees

ANN THAYER/C&EN

CPhI attendees found order at the Paris convention center but chaos in the streets outside.

FINE CHEMICALS MANUFACTURERS came to the CPhI pharmaceutical ingredients trade show in Paris last week hoping to drum up customers and keep a modest business recovery going. But booth traffic was modest. For the 35,000 attendees and 2,250 exhibitors, the crush came instead in the form of taxi, bus, and metro jams, plus a rail strike.

The news from the companies managing to do business there was that the best opportunities are in select areas, such as biologics, or in specialized technology or capacity offerings, such as finished-product formulation.

In biologics, executives from Catalent Pharma Solutions arrived in Paris having just acquired Redwood Bioscience, a University of California, Berkeley, spin-off that offers antibody-drug conjugate technology. The acquisition was the New Jersey-based company's first since its initial public offering in July, but it is expected to soon make more. Meanwhile, IDT Biologika announced at the show that it has finished building a large facility for lyophilizing and filling biologic and vaccine products in its home city of Dessau, Germany.

Targeting both biologics and small molecules, Switzerland's SGS Life Science Services promoted a multimillion-dollar investment in its testing lab network. Later this month SGS will open a lab in Carson, Calif., that will place it close to West Coast pharma and biotech customers for the first time. In 2015, the company will debut lab expansions near Paris and in Shanghai, according to Frédéric Gaussens, the firm's vice president for strategy and business development.

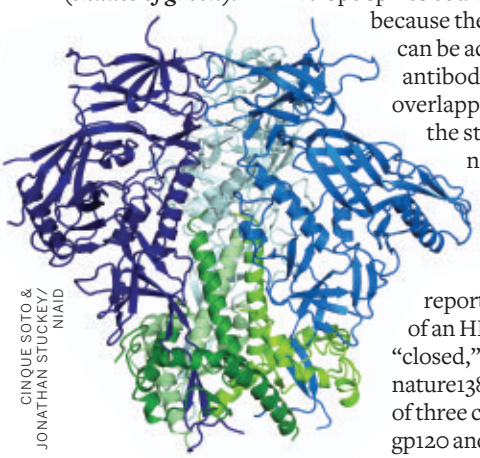
Next month, France's Minakem will start up a plant in Memphis to make building blocks for agrochemicals and cosmetics, CEO Frédéric Gauchet told C&EN. The company is also increasing capacity at its Leuna, Germany, facility where it is validating a new active pharmaceutical ingredient for a Russian customer.

Patheon, a unit of DPx Holdings, announced that it will invest $159 million to expand its operations in Greenville, N.C., by the end of 2019, adding nearly 500 jobs. In the process, Greenville will become the home of Patheon's North American sterile drug facility. In late September, Patheon acquired St. Louis-based Gallus BioPharmaceuticals, a contract manufacturer specializing in biologics.—ANN THAYER

A BETTER VIEW OF HIV'S SPIKES

STRUCTURAL BIOLOGY: Teams uncover detailed structure, dynamics of virus's protruding proteins

A side view of an HIV envelope spike trimer, showing gp120 (shades of blue) and gp41 (shades of green).



CINQUE SOTO & JONATHAN STUCKEY/ NIAID

THE SURFACE OF HIV is studded with protein structures that help it penetrate healthy cells. A detailed understanding of these so-called envelope spikes could help scientists develop vaccines, because they are the only part of the virus that can be accessed by the immune system's antibodies. Now, in two related studies, overlapping groups of researchers report the structure of HIV's envelope spikes at near-atomic resolution and their conformational dynamics.

In one study, Peter D. Kwong of the National Institute of Allergy & Infectious Diseases and coworkers report a 3.5-Å-resolution crystal structure of an HIV envelope spike in its unbound, or "closed," state (*Nature* 2014, DOI: 10.1038/nature13808). The envelope spike consists of three copies each of the glycoproteins gp120 and gp41. This structure is the first with enough resolution to see the entire outer portion of gp41.

To obtain the structure, the researchers captured the spike in its closed conformation with broadly neutralizing antibodies. The structure reveals that gp41 wraps itself around the amino- and carboxy-terminal strands of gp120 and pins itself in place. The spike undergoes significant rearrangement during fusion with a healthy cell's membrane.

In the other study, Walther Mothes of Yale University School of Medicine and coworkers use single-molecule fluorescence resonance energy transfer (FRET) to determine the motions of HIV's envelope spikes (*Science* 2014, DOI: 10.1126/science.1254426). The FRET measurements suggest that unbound envelope spikes shift rapidly between three conformational states. The dominant state is the closed form seen in the crystal structure. The other two states are ones that the spike adopts as it activates to enter a cell.

The structural study "greatly improves our understanding of the conformational changes that are likely to occur with HIV entry," says Sriram Subramaniam, a biophysicist at the National Cancer Institute who studies HIV entry and spike structure. "The work on dynamics of intact virions provides a broader context to understand the flexibility of HIV envelope glycoproteins."

"We show that these very potent, broadly neutralizing antibodies stabilize the closed conformation," Mothes says. "Any vaccine design should involve stable scaffolds that mimic the closed conformation in order to elicit antibodies that can recognize it."—CELIA ARNAUD

NOBEL PRIZE IN PHYSICS

AWARDS: Three honored for developing blue light-emitting diodes

THE 2014 NOBEL PRIZE in physics honors the inventors of blue light-emitting diodes (LEDs), which have made possible inexpensive, efficient white light for a variety of applications.

Isamu Akasaki, at Meijo University, in Nagoya, and Nagoya University, both in Japan; Hiroshi Amano, at Nagoya University; and Shuji Nakamura, at the University of California, Santa Barbara, will share the $1.1 million prize.

White LED light is produced from a combination of red, green, and blue diodes. Red and green LEDs were fabricated in the 1960s. But blue light-emitting LEDs weren't invented until the 1990s.

"The blue LED is a fundamental invention that is rapidly changing the way we bring light to every corner of the home, the street, and the workplace—a practical invention that comes from a fundamental understanding of physics in the solid state," says H. Frederick Dylla, the executive director and CEO of the American Institute of Physics.

LEDs are layered semiconducting devices in which a layer of one semiconductor is sandwiched between a layer doped with electrons and another with electron holes. Electrons and holes combining in the middle layer produce photons.

A major roadblock to blue LED development involved the fabrication of suitable crystals of semiconductors, with gallium nitride being the most promising contender. The task vexed scientists for years.

"As the wavelength of the emitted light from an LED gets shorter as you move from red to green to blue and on to the ultraviolet, the sensitivity to very low levels of impurities and imperfections in the crystalline lattice becomes more acute," Dylla says.

Akasaki, 85, worked with Amano, 54, at the University of Nagoya, while Nakamura, 60, did his research at Nichia Chemical, a small company in Tokushima. In 2000, Nakamura became a physics professor at the University of California, Santa Barbara.

NEWSCOM

Akasaki

NEWSCOM

Amano

Both teams labored, and finally succeeded, in producing quality gallium nitride crystals, and improved them further with aluminum and indium alloys of gallium nitride. "They made different versions; they improved each others' results," said Per Delsing, a physics professor at Chalmers University of Technology, in Göteborg, Sweden, at a press conference announcing the prize.

RANDALL LAMB

Nakamura

Now everyday products including cell phones and flashlights emit white LED light. The technology is rapidly replacing inefficient incandescent light sources and mercury-containing fluorescent light sources.

It's also been a source of some contention: A Japanese court in 2004 ordered Nakamura's old employer, Nichia, to pay him $180 million for his role in developing commercially valuable blue LEDs.

The LED light technology is quite close to the theoretically possible ultimate efficiency of one electron-hole combination producing one photon, noted Delsing. "It will be hard to find something that will be better," he said.—ELIZABETH WILSON

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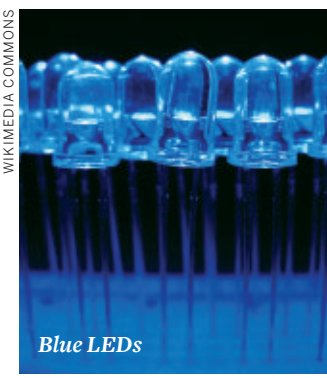


Blue LEDs

NATIONAL MEDALS Chemists recognized with nation's highest science honor

President Barack Obama has awarded the National Medal of Science to 10 of the nation's most important contributors to science, including three chemists.

Biochemist Bruce M. Alberts of the University of California, San Francisco, won for his work on DNA replication, as well as his advocacy for science education and international research cooperation. UC Berkeley professor Judith P. Klinman, a physical organic chemist, was recognized for her work on enzymes. And Jerrold Meinwald, professor emeritus at Cornell University, distinguished himself as the father of chemical ecology.

"These scholars and innovators have expanded our understanding of the world, made invaluable contributions to their fields, and helped improve countless lives," Obama said in announcing the awards.

Obama also named eight recipients of the National Medal of Technology & Innovation. They include two American Chemical Society members: chemist and inventor Edith M. Flanigen of Honeywell's UOP company, whose work includes molecular sieve zeolites, and physicist Cherry A. Murray, dean of Harvard University's School of Engineering & Applied Sciences. ACS publishes C&EN.

The National Medal of Science was established in 1959 to recognize individuals who have made outstanding contributions to U.S. science and engineering. Created in 1980, the technology medal recognizes those who have made lasting contributions to U.S. competitiveness.

The winners will receive their awards at a White House ceremony later this year.—ANDREA WIDENER

FARMERS SUE SYNGENTA

AGRICULTURE: U.S. corn prices plunge after China rejects shipments

U.S. FARMERS FROM five major corn-growing states have filed multiple class-action lawsuits against Syngenta, claiming that the company's genetically modified MIR162 corn has caused more than $1 billion in damages. The farmers allege that U.S. corn prices have plummeted because China is rejecting shipments that contain traces of MIR162, which is not approved for sale in China.

IOWA STATE U BIOECONOMY INSTITUTE

MIR162, also known as Agrisure Viptera, is engineered to make a *Bacillus thuringiensis* protein that is toxic to several insect pests. None of the farmers involved in the lawsuits planted MIR162 seed in their fields in Illinois, Iowa, Kansas, Missouri, and Nebraska. But their harvested crop was contaminated with traces of the transgenic trait, rendering it unsalable to the Chinese market.

How their corn got tainted with MIR162 is unknown, although one possibility is commingling of corn from multiple sources.

The lawsuits claim that Syngenta misled farmers into thinking Chinese approval of corn with the trait was imminent. They also say the company downplayed the importance of China as a major export market for U.S. corn.

"By promoting and marketing a genetically modified corn seed before the seed had received import approval from China, Syngenta placed its own profit margins over corn farmers' livelihoods," says James J. Pizzirusso, a partner with Washington D.C.-based law firm Hausfeld, which is representing the farmers.

The class-action lawsuits come just one month after agribusiness firm Cargill sued Syngenta, claiming it suffered $90 million in damages when China rejected Cargill's corn shipments containing traces of MIR162.

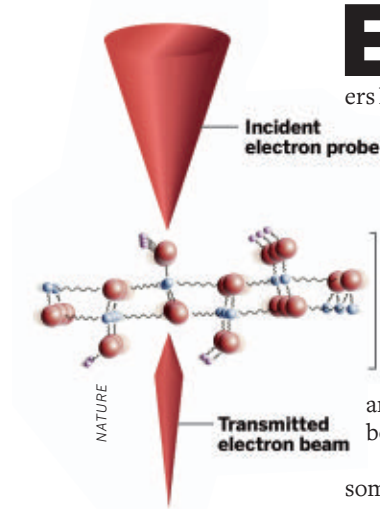
Syngenta says the cases are without merit, adding that growers should have the right to use "approved new technologies that can increase both their productivity and their profitability." The MIR162 seeds were approved for planting in the U.S. in 2010. Syngenta says the company followed all regulatory and legal requirements and "obtained import approval from major corn importing countries."

The National Grain & Feed Association estimates that U.S. growers of corn, distillers' grains, and soy—which may be stored in facilities that previously contained corn—have sustained losses of up to $2.9 billion since China began enforcing its zero-tolerance policy on MIR162 in November 2013.—BRITT ERICKSON

SHAKING UP MICROSCOPY

MATERIALS SCIENCE: High-resolution vibration information now comes with atomic precision

The new microscope is better equipped to measure vibrations excited by an electron beam than previous instruments.



ELECTRON MICROSCOPY is a workhorse of nanomaterials characterization, famed for its ability to image at the atomic scale. Researchers have now coupled this capability with improved vibrational spectroscopy, which could enable scientists to better understand the nanostructures involved in processes such as catalysis, heat transfer, and solar energy harvesting (*Nature* 2014, DOI: 10.1038/nature13870).

Scanning tunneling electron microscopes have induced atomic lattice vibrations for decades, but the instruments could not detect low-energy jitters. Scientists had to rely on Raman or infrared spectroscopy to analyze these vibrations and characterize atoms and bonds within a sample.

"If you ask an organic chemist to tell you what's in some goo you know nothing about, they will take a Raman spectrum," says Ondrej L. Krivanek, a cofounder of Nion, a firm that develops electron microscopes. "We're going after a signal that's been very powerful in other fields but really hasn't been used in electron microscopy."

To detect these vibrations with an electron microscope, Krivanek and a team of researchers boosted the sensitivity of a technique known as electron energy-loss spectroscopy. By measuring how much energy electrons lose as they shoot through a sample, researchers can determine how much of that energy goes into exciting vibrations.

Most electrons, however, zip through the sample without shedding any energy. This creates broad and intense peaks in spectra that can bury low-energy vibration signals, Krivanek says. But the new instrument slims the breadth of these peaks by more than a factor of 20. Combined with a high-resolution spectrometer, the microscope can discern vibrational modes that the researchers say were "hidden in plain sight" until now.

"This is the next level," says Nigel D. Browning of Pacific Northwest National Laboratory, who was not involved with the study. "The ability to look at and characterize single nanoparticles is going to be huge."

But Krivanek believes his team can still improve the tool's energetic and spatial resolution to retrieve vibrational spectra from single atoms. "This is just the start of the road," he says.—MATT DAVENPORT

NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE

AWARDS: Trio wins for discovering the brain's mapping system

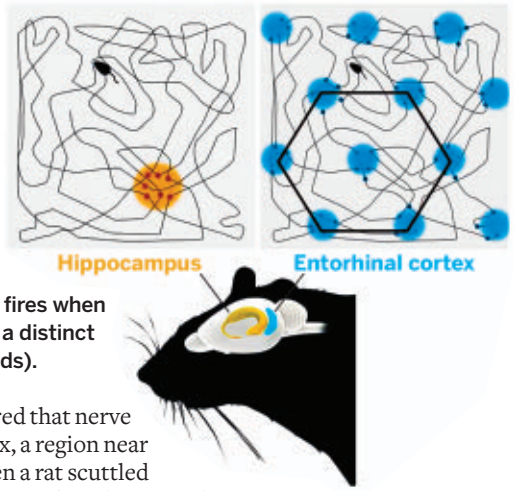
THIS YEAR'S NOBEL PRIZE in Physiology or Medicine was awarded to John O'Keefe, May-Britt Moser, and Edvard Moser, for discovering the networks of cells that form the brain's navigational system. This fundamental work in neuroscience could have applications in Alzheimer's and other diseases.

For hundreds of years, questions about how humans understand their location in their environment, and how they develop a sense of distance, have intrigued scientists and philosophers alike. It was 20th-century advances in psychology and neuroscience that allowed researchers to probe their questions experimentally.

Once scientists understood that rats could learn to find their way through a maze, they sought the areas of the brain responsible for this behavior. In 1971, by recording electrical signals from individual nerve cells, John O'Keefe of University College London found cells in the hippocampus region of the brain that were active only when rats were in a certain place in their environment. He concluded the activity of these cells must form an inner map of the rat's whereabouts and dubbed them "place cells."

O'Keefe's work "opened up a whole area of research about how the hippocampus contributes to memories," says Oxford University physiologist and neuroscientist John Stein. "To navigate, you have to remember where you are."

In 2005, May-Britt and Edvard Moser, a husband-wife team at the Norwegian University of Science & Technology, in Trondheim, built on O'Keefe's and others' work. They discovered that nerve cells in the entorhinal cortex, a region near the hippocampus, fired when a rat scuttled past particular locations arranged in a hexagonal grid. These "grid cells" work with place cells as well as other cells to form the brain's positioning system.



NOBELPRIZE.ORG

GETTING SOME BEARINGS As a rat (black oval) navigates around a lab arena, place cells fire when the animal reaches a particular location (orange field). Meanwhile, a single grid cell in the entorhinal cortex fires when the rat reaches locations in a distinct hexagonal pattern (blue fields).

The Mosers briefly worked in O'Keefe's lab in 1995. "They were already clearly destined to be stars," O'Keefe told Nobelprize.org.

The human brain's spatial navigation system appears to be composed of similar nerve cells. And because the entorhinal cortex, the location of grid cells, is often damaged during the first phases of Alzheimer's disease, the work may explain why the disease's early symptoms include getting lost.

DAVID BISHOP/UCL

O'Keefe

KÖRBER FOUNDATION/ FRIEDRUN REINHOLD

May-Britt and Edvard Moser

May-Britt Moser almost didn't take the Nobel Committee's call because she was in a meeting. Meanwhile, Edvard Moser was on a flight when the prize was announced. "I had no idea what was going on when I was welcomed at the airport with flowers," he told a Swedish news agency.—CARMEN DRAHL

MERGERS AND ACQUISITIONS Actavis will acquire antibiotic maker Durata

In the latest chapter in the saga of the antibiotic dalbavancin, Actavis will acquire its developer, Durata Therapeutics, for $675 million.

Dalbavancin, marketed as Dalvance, was approved in May after a nearly 20-year odyssey from discovery to market, comprising many owners and regulatory setbacks. Durata paid a mere $10 million in 2009 to buy the compound from Pfizer, which had acquired it in 2005 through the $1.9 billion acquisition of Vicuron.

Vicuron first filed for FDA approval of dalbavancin in 2004 as a treatment for serious skin infections. But the drug, a second-generation semisynthetic lipoglycopeptide, languished after the agency changed the goalposts for antibiotic studies.

ISI stock analyst Umer Raffat calls the deal "okay" but "not a home run," noting that Dalvance's key advantage over other gram-positive antibiotics—a long-acting formulation—might not be enough to keep up sales next year when Pfizer's Zyvox loses patent protection and low-priced generics proliferate.

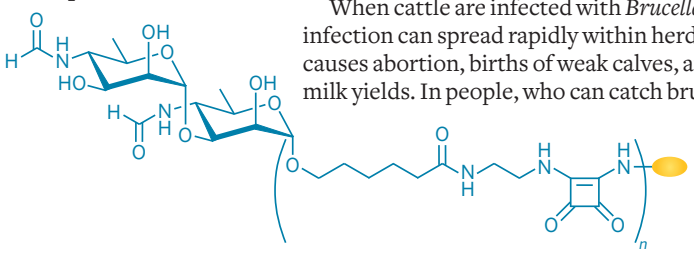
For Actavis, the acquisition caps a rapid transformation that began in 2012 when the firm merged with Watson Pharmaceuticals. Then last October, Actavis paid about $5 billion for Dublin-based Warner Chilcott and moved its headquarters to Ireland. In February, Actavis shelled out $25 billion to acquire Forest Laboratories.

At the time, stock analysts expected Actavis to pursue other deals, and ISI's Raffat says Actavis still has enough cash. Indeed, rumors surfaced last week that Actavis is in talks with Allergan, which for months has been battling a takeover by Valeant Pharmaceuticals.—LISA JARVIS

SYNTHETIC SUGARS AID DIAGNOSIS

INFECTIOUS DISEASE: Work could solve brucellosis detection problem

M-antigen disaccharide conjugated to a carrier protein (yellow) could make it possible to diagnose brucellosis while minimizing false-positive results.



A NEW OLIGOSACCHARIDE SYNTHESIS could lead to more reliable diagnoses of the bacterial disease brucellosis, which afflicts animals and people worldwide.

When cattle are infected with *Brucella* bacteria, infection can spread rapidly within herds, where it causes abortion, births of weak calves, and reduced milk yields. In people, who can catch brucellosis from unpasteurized dairy products or contaminated meat, symptoms include excessive sweating and joint and muscle pain, and the condition can be chronic or even lifelong.

Brucellosis is typically diagnosed by detecting antibodies the body produces to fight the bacteria. But the *Brucella* cell-wall molecule contains two oligosaccharide antigens, A and M; other bacteria carry the same A antigen; and antibodies to A and M cannot currently be detected independently. So brucellosis diagnostic tests often give false-positive results, which complicate human treatment and cause commercial animal herds to be declared disease-tainted when they're not.

Now, David Bundle of the University of Alberta; John McGiven of the Animal & Plant Health Agency, in Surrey, England; and coworkers have synthesized several versions of *Brucella* antigens and have conjugated them to carrier proteins (*J. Am. Chem. Soc.* 2014, DOI: 10.1021/ja5081184). The conjugates can bind and detect A and M antibodies independently. The researchers suggest that the disaccharide M-antigen conjugate could be used to unambiguously detect the immune response to brucellosis infection in humans and animals.

"We have established collaborations to evaluate the synthetic antigens for diagnosis," Bundle says.

Brucellosis expert Jacques Godfroid of the University of Tromsø—the Arctic University of Norway, says, "For the brucellosis scientific community and all those fighting brucellosis—farmers, veterinary services, and food safety and veterinary public health scientists—this work represents the first major breakthrough in decades toward avoiding false-positive serological reactions in brucellosis testing. A test would have to go through validation steps, but for the first time in decades there is something extremely promising."—STU BORMAN

SCIENCE CUTS SPARK PROTESTS

EUROPE: Declining R&D budgets across continent provoke month of action

AFTER YEARS OF BUDGET CUTS, scientists in the European Union are mounting protests this month to bring attention to problems caused by shrinking science funding.

The largest demonstrations are taking place in France, where several thousand researchers are riding their bikes and walking across the country to highlight reduced research funding. The Sciences en Marche campaign will culminate this Friday with a gathering in Paris.

French scientists walked and rode bikes across the country this month to protest cuts to research funding.

ANNABELLE HAUDRY

A number of Southern European countries are holding corresponding events to draw attention to problems, such as a brain drain to Northern European countries and abroad as well as lost opportunities for technology to improve the EU economy.

Researchers from seven countries have sent a letter to the newly elected European Parliament and Jean-Claude Juncker, who will become president of the European Commission, the EU's administrative arm, on Nov. 1. They are encouraging all scientists to sign it.

"Many European countries are suffering a hemorrhage, really. But [legislators] don't seem to be aware of it or think much about it," explains Amaya Moro-Martín, a Spanish astrophysicist who wrote about the cuts last week in *Nature* (DOI: 10.1038/514141a).

For example, basic research funding in Italy has fallen to almost zero since cuts began in 2008, says Italian physicist and blogger Francesco Sylos Labini. One result was a 90% cut in new positions for young scientists.

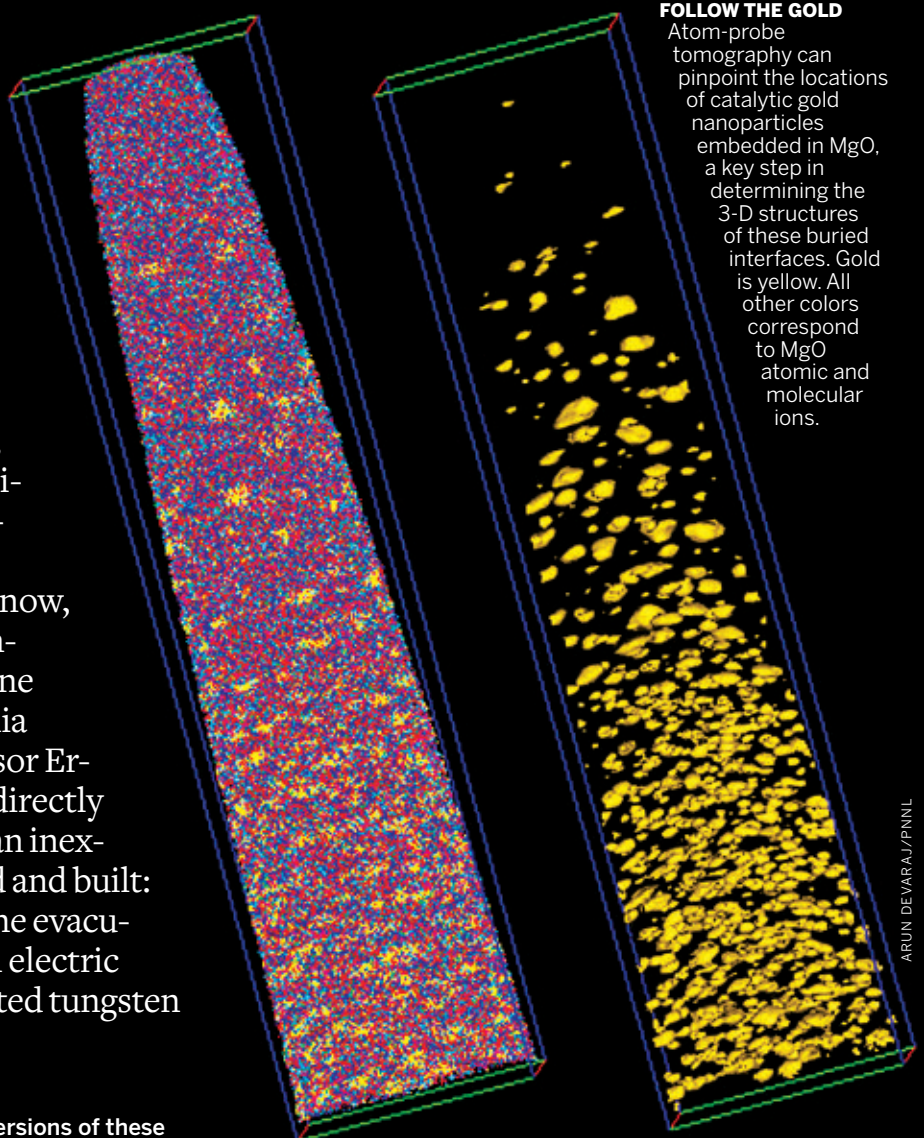
The budget austerity measures imposed by the EC include no protections for research, he says. "If you produce too much milk, then Europe will give you a fine," but the EC has failed to regulate R&D funding.

Biochemist Gilles Mirambeau, who works in both France and Spain, says he hopes the convergence of European scientists against these cuts will convince lawmakers of science funding's importance. "It is very dangerous if we cannot maintain a critical mass of people in academic research," he says.—ANDREA WIDENER

MICROSCOPY METHOD GOES DEEP

Atom-probe tomography reveals the **3-D POSITIONS OF ATOMS** inside hard-to-analyze materials

MITCH JACOBY, C&EN CHICAGO



FOLLOW THE GOLD Atom-probe tomography can pinpoint the locations of catalytic gold nanoparticles embedded in MgO, a key step in determining the 3-D structures of these buried interfaces. Gold is yellow. All other colors correspond to MgO atomic and molecular ions.

ARUN DEVARAJ/PNNL

AS A TEENAGER, David N. Seidman was so fascinated with atoms that he longed to be able to look at them. "But my high school chemistry teacher said it was impossible to see atoms," recalls Seidman, now a professor of materials science and engineering at Northwestern University.

Little did Seidman's teacher know, atoms were about to show themselves for the first time. Fifty-nine years ago this week, Pennsylvania State University physics professor Erwin W. Müller made history by directly imaging individual atoms with an inexpensive instrument he designed and built: a field-ion microscope. Inside the evacuated glass apparatus, a powerful electric field ran through a sharply pointed tungsten

& VIDEO ONLINE To see rotating versions of these 3-D structures, go to cenm.ag/tomog.

specimen, causing atoms to fly off the surface of the metal tip and reveal themselves by lighting up a nearby fluorescent screen.

Seidman did eventually get to "see" atoms by using field-ionization methods as a young faculty member at Cornell University in the 1960s. Today, he and other atom-loving researchers carry on Müller's work by using atom-probe tomography (APT), a direct descendant of field-ion microscopy, to examine the building blocks of matter.

Like the older method, APT provides single-atom sensitivity. But the modern technique is more powerful: Not only can it determine, with subnanometer resolution, the three-dimensional atomic structure of internal or buried interfaces, it can also determine the chemical identity of the atoms in samples. Understanding the atomic structure deep within a material is important because it dictates that material's properties. The position of atoms at the interface of two materials inside a semiconductor device, for instance, often controls its function.

Despite APT's analytical prowess and more than a dozen years of instrument commercialization, the technique's reach and popularity have grown slowly. In just the past few years, however, the number of instruments, practitioners, scholarly journal papers, and classes of materials analyzed by APT has increased by leaps and bounds.

Once limited mainly to probing metals and alloys, APT now exposes hidden 3-D nanostructures in oxides, semiconductors, biological specimens, and other classes of materials that were previously inaccessible to APT and microscopy methods. With its expanded reach, the method is giving scientists a deeper understanding of materials phenomena critical to a host of topics ranging from technology applications, such as catalysts, batteries, and microelectronics, to basic biology, geology, and planetary science.

Innovations in sample preparation and APT instrumentation get much of the credit for the technique's recent expansion to new materials. With regard to sample preparation, field-ionization aficionados such as Seidman, one of the field's longest-practicing researchers, note that a key challenge in doing this type of analysis is making the requisite needlelike specimens.

AS WAS THE CASE in Müller's day, an ultrasharp tip with a radius of about 50 nm is still required to concentrate an electric field and eject atoms from a sample. In APT, researchers deduce structural information about a specimen from the trajectory of these atoms—which become ions—and from the points at which they strike the instrument's detector. Flight times reveal ions' mass-to-charge ratios and, hence, their chemical identity. Powerful computers then collect and crunch all these data to construct a 3-D rendering of a specimen.

To prepare the sharp samples, researchers have typically used electropolishing, a traditional electrochemical method. This technique was used to make nearly all of the specimens shown on the cover of this issue of C&EN.

Unlike electropolishing, a newer method does not require choosing suitable electrolytes and is amenable to preparing samples from a wider variety of materials. The technique combines focused ion beam (FIB) sputtering—atomic-scale sandblasting, typically with gallium ions—to sharpen the tip and scanning electron microscopy to observe and provide feedback on the microscopic sharpening process as it occurs. These so-called dual-beam FIB systems are now available commercially.

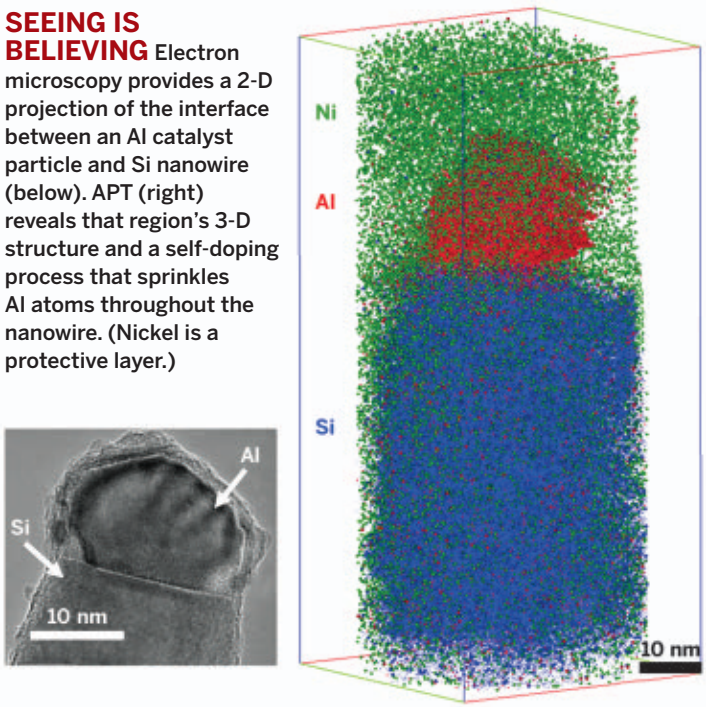
Another key advance, according to Thomas F. Kelly, a vice president with Philadelphia-based electronic instruments firm Ametek, is the integration into APT instruments of pulsed ultraviolet lasers, which assist in evaporating ions from the specimen tip. Cameca, an Ametek company located near Paris, is currently the only commercial manufacturer of APT instruments.

Earlier tomograph designs relied on rapid voltage pulsing of a small electrode positioned close to the sample. That design works well for metal specimens but is unsuitable for extracting ions from electrically insulating materials. Laser pulsing gets around that limitation by transferring thermal energy to the specimen tip, explains Kelly, whose APT company was acquired by Ametek in 2010 and folded into Cameca. The energy excites atoms in the tip and causes them to fly off as ions. The laser deposits very little energy per pulse, which spares the specimen from being heated too high and breaking.

That variant of APT analysis has been applied to a wide variety of sample types. Last year, for example, Oussama Moutanabbir of Montreal Polytechnic worked together with Seidman, Northwestern scientist Dieter Isheim, and others to probe the doping process in silicon nanowires. Doping semiconductors with select impurity atoms is an industrywide method for customizing a material's electronic properties for various applications. Yet atomic-level control and understanding of doping processes remain elusive and difficult to probe via electron microscopy.

The team grew the nanowires with a vapor deposition method catalyzed by aluminum nanoparticles. From APT analysis, the researchers found that aluminum triggers a self-doping process, resulting in an unexpectedly high concentration of alu-

NATURE

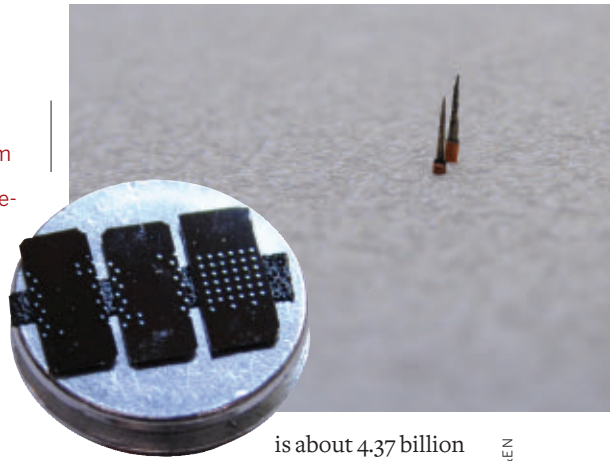


SEEING IS BELIEVING Electron microscopy provides a 2-D projection of the interface between an Al catalyst particle and Si nanowire (below). APT (right) reveals that region's 3-D structure and a self-doping process that sprinkles Al atoms throughout the nanowire. (Nickel is a protective layer.)

minum atoms evenly distributed throughout the wires (*Nature* 2013, DOI: 10.1038/nature11999). Because the presence of aluminum enhances silicon's charge conductivity, self-doping might be a simple way of avoiding time-consuming doping of full-grown nanowires, a procedure commonly used in industry. The researchers developed a solute-trapping model to explain the findings, which they propose may lead to nanowires with tailored shapes and chemical compositions.

METAL NANOPARTICLE catalysts can mediate nanowire growth. More often, however, the tiny materials are used to facilitate reactions in industrial processes. In these cases, scientists usually disperse the nanoparticles on an oxide material. Scientists would like to use APT to better understand the structure of these metal-insulator hybrids.

Arun Devaraj of Pacific Northwest National Laboratory (PNNL); François Vurpillot of the University of Rouen, in France; and coworkers recently analyzed samples of magnesium oxide-embedded gold nanoparticles with APT. This material exhibits surprisingly high catalytic activity for carbon monoxide oxidation, a key step in scrubbing automobile exhaust. By correlating tomography results with transmission electron microscopy (TEM) data, the team learned that metal-insulator combos can be trouble for APT. MgO evaporates preferentially, which degrades the method's spatial resolution and the accuracy of metal nanoparticle composition analysis. The researchers determined that the errors can be corrected, however, via a theoretical treatment that accounts for differences in the components' properties (*J. Phys. Chem. Lett.* 2014, DOI: 10.1021/jz500259c).



LEAVE A TIP Scientists typically prepare sharp-tipped specimens for APT analysis via electropolishing (far right) or ion beam sputtering (inset). At the center of these 0.1-mm-diameter sputtered dots are cone-shaped structures. Their tips measure less than 100 nm in diameter.

MITCH JACOBY/C&EN

Some analytical techniques require fresh samples. APT isn't particular about such things. In fact, the method is in some ways ideally suited to analyzing really old samples, ones dating to the dawn of the solar system and even earlier.

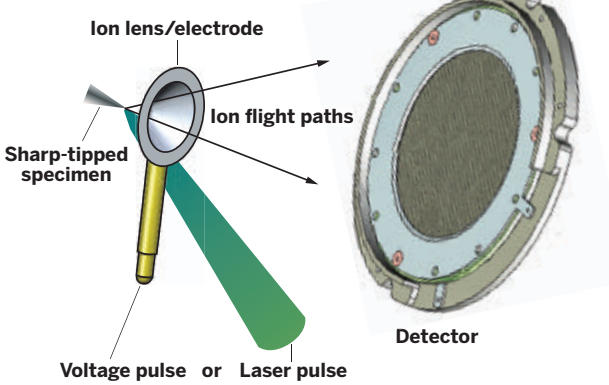
Because APT measures the mass-to-charge ratio of all ions impinging on a detector, the technique is a natural when it comes to analyzing isotope abundance—the key to radiometric dating. A team led by John W. Valley, a geoscientist at the University of Wisconsin, Madison, together with coworkers from Puerto Rico, Australia, and Canada, exploited the isotope analysis feature and APT's subnanometer spatial resolution to date samples of Earth's oldest known minerals. These zirconium silicates, or zircons, came from the Jack Hills, in Western Australia. Earlier studies concluded that those specimens are 4.4 billion years old. But because of radioactive decay processes that can cause atoms to diffuse in and out of zircon crystals and skew the dating results, that value is the subject of much debate.

The dating technique calls for quantifying uranium and lead isotopes, which must remain fixed in place inside a specimen for analysis to be a success. APT analysis of FIB-sharpened zircons recently revealed that lead isotopes are mobile enough to form clusters. According to Valley and coworkers, however, those changes occur on such a small scale that they do not affect dating results. As such, the team's findings confidently confirm that the oldest known zircon on Earth is about 4.37 billion years old (*Nat. Geosci.* 2014, DOI: 10.1038/ngeo2075).

Philipp R. Heck, an assistant curator at Chicago's Field Museum, together with a team of researchers from about 10 institutions, applied similar methods to determine the carbon-12 to carbon-13 ratio in meteoritic nanodiamonds. Samples, which the team embedded in platinum tips, came from the thoroughly studied Allende meteorite, a massive rock that predates the solar system and broke up over northern Mexico in 1969.

The team's aim was to determine whether carbon's isotope distribution in

FLIGHT PATH In APT, applying a voltage or laser pulse to a sharp-tipped specimen helps drive ions from the surface. Measuring the flight time and contact point at a detector reveals an ion's chemical identity and original position in the tip.



THOMAS KELLY/CAMECA

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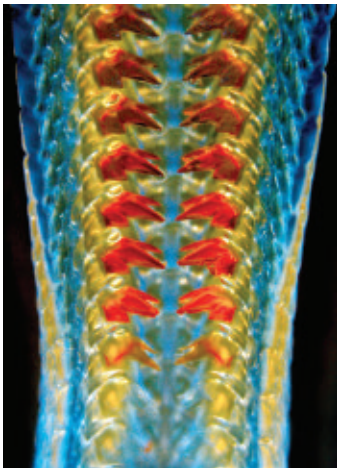
the nanodiamonds differs markedly from its distribution on Earth. Finding such a sample would suggest that the carbon was formed via a nucleosynthesis method different from the one that formed Earth's carbon. Major differences in isotope abundances have been measured in other extraterrestrial material. So far, the nanodiamond study has not turned up obvious differences in carbon isotope distributions.

But it's not "case closed" just yet. The analysis has proved difficult because it pushes APT's detection limits. The nanodiamond study requires accurately counting and sorting very small numbers of atoms from approximately 3-nm-diameter particles and spotting a difference from the earthly ^{13}C abundance, which is only 1.1%. The investigation has so far shown that APT is well suited to the cosmic science task, but larger data sets need to be generated (*Meteorit. Planet. Sci.* 2014, DOI: 10.1111/maps.12265).

Back on Earth, numerous organisms form mineralized tissues with unique properties and function through subtle interactions of organic matrices and minerals. As materials such as shells, bones, and teeth grow, the organic-inorganic interfaces that direct tissue growth become buried inside the tissue, making them largely inaccessible to imaging techniques. As such, researchers cannot fully determine the secret to these hybrid materials' unique properties such as shape and strength, limiting their ability to mimic them in synthetic materials.

To test whether APT could help reveal the structure and composition of such hidden interfaces, Northwestern materials scientists Lyle M. Gordon and Derk Joester used FIB methods to prepare specimens of teeth from marine mollusks known as chitons. These critters' teeth are remarkably hard and wear-resistant—capable of chewing through rock.



LYLE GORDON & DERK JOESTER/NORTHWESTERN U

TOUGH CHOPPERS By revealing the composition and structure of these micrometer-sized chiton teeth (red structures in this optical micrograph), researchers are starting to find out why they are remarkably wear-resistant.

In 2011, the team showed that, indeed, APT can image hidden interfaces in these teeth with exceptional detail. The study revealed 3-D chemical maps of organic fibers 5–10 nm in diameter surrounded by nanocrystalline magnetite, Fe_3O_4. Unexpectedly, similar-looking organic fibers turned out to be chemically distinct. Some fibers hosted clusters of sodium ions—others magnesium. The researchers propose that the cations control mineral-matrix interactions, water retention in the tissues, and other factors that prevent the teeth from becoming brittle and affect their ability to accommodate large strains and dissipate energy (*Nature,* DOI: 10.1038/nature09686).

If mineralized mollusk tissue yields to APT analysis, hard vertebrate tissues may soon follow suit. That line of reasoning led Gordon and Joester to try forming needlelike specimens from nanocrystalline biological apatites—the mineral phase of vertebrate bone and tooth. As with other electrically insulating materials, it was not obvious at the outset that the researchers could prepare robust specimens or that the specimens' nanoscale structural and chemical complexity could be scrutinized via APT.

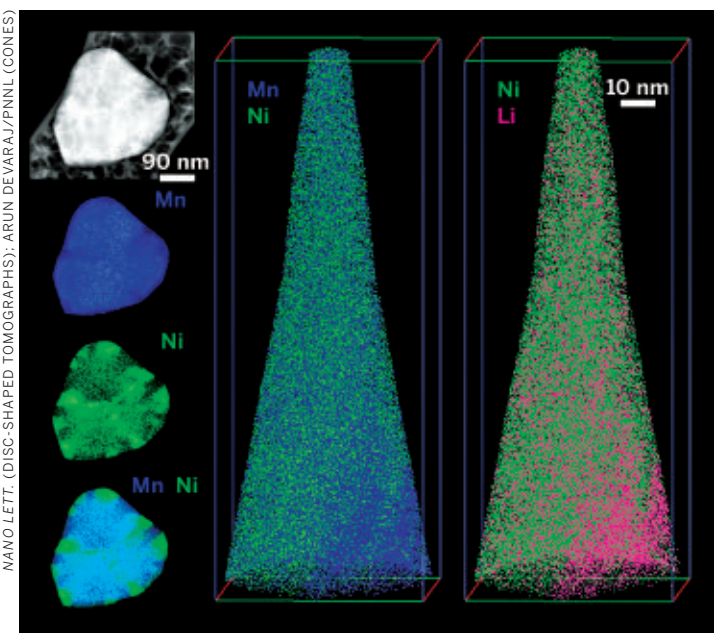
Yet things turned out well. The team generated the first 3-D reconstruction of a roughly 10 million-atom dentin sample (*ACS Nano* 2012, DOI: 10.1021/nn3049957). The results show the fibrous nature of the collagen organic matrix in dentin, which is one of the components of teeth.

"We also found that the interface between the mineral and organic phases is nowhere near as sharp as transmission electron microscopy images imply," Joester says. TEM shows flat platelets of crystals. "Atom probe paints quite a different picture," he stresses. "It's going to be really interesting to find out why."

THUS FAR, most biomaterials that have been subjected to APT analysis are the "hard" type, such as bone and tooth. A number of researchers, including PNNL's Daniel E. Perea, are working to develop general procedures for analyzing soft biomaterials. One strategy Perea and others are pursuing involves freezing soft biomaterials by cooling them to cryogenic temperatures and maintaining them in that frozen state from sample preparation through the conclusion of APT analysis.

Field-ionization techniques used to be of interest mainly to metallurgists. But the past few years have turned up a dizzying array of materials capable of revealing their innermost structural and chemical secrets to APT. Classes of materials that once seemed out of bounds to the field's early practitioners now are welcome in the lab.

Reflecting on those fast-paced changes, Northwestern's Seidman says, "If someone asked me today, 'Is it worthwhile to look at this material or that one?' I would say, 'Yes, you should try anything.'" Glad his high school chemistry teacher was proven wrong, he adds, "There's no guarantee it will work or that you'll get beautiful results. But it's definitely worth a shot." ■



NANO LETT. (DISC-SHAPED TOMOGRAPHS): ARUN DEVARAJ/PNNL (CONES)

WHERE'S THE LITHIUM? TEM results (left column) pinpoint most of the elements—but not lithium—in this Li-Ni-Mn-O Li-ion battery cathode. APT (cones at right) reveals that Li segregates to Mn-rich regions, which may lead to poor battery performance.

A123 SELLS BATTERY MATERIALS PLANT

A123 Systems, a maker of nanophosphate lithium-ion batteries owned by the Chinese auto parts company Wanxiang, has sold its lithium iron phosphate (LFP) cathode materials plant in China to Johnson Matthey. A separate agreement calls for Johnson Matthey to make LFP exclusively for A123. Johnson Matthey says the deal strengthens its position in the battery technology sector. Wanxiang bought A123 for $257 million in 2012 after the battery maker filed for bankruptcy reorganization. Earlier this year, NEC bought A123's grid energy storage business for $100 million.—MSR

BASF OPENS BIG COMPLEX IN INDIA

BASF has inaugurated several facilities in Gujarat, India, that it says represent its largest single investment in India to date. The plants include a splitter for purifying crude methylene diphenyl diisocyanate (MDI) to make polyurethane, a polymer dispersion plant, and a care chemicals facility. The company invested $190 million at the Gujarat site, which is inside a government-promoted industrial park. The BASF facility will employ about 200 people directly and 300 indirectly.—JFT

BASF

BASF's new complex in Gujarat, India.

DOW WILL LAUNCH APPRENTICE PROGRAM

Dow Chemical plans to launch a U.S. apprentice program next year. The firm will hire a total of 60 apprentices at seven manufacturing sites and train them over two to four years as chemical process operators and instrumentation and equipment technicians. Working with local colleges, Dow hopes to give people the technical skills needed for roles in the manufacturing sector, which is growing because of the availability of shale gas. Dow says it will draw on knowledge gained from apprentice programs it has run in Europe for 40 years.—MSR

GAS FIRMS SUPPLY H_2 STATIONS

As Toyota, Honda, and Hyundai ready fuel-cell-powered vehicles for California drivers, efforts to build the infrastructure that will fill them with hydrogen are gaining traction. In May, the California Energy Commission announced $50 million in grants for the construction of 28 new stations. Now, awardee FirstElement Fuel has chosen industrial gases firm Air Products & Chemicals to supply hydrogen for its initial network of 19 fueling stations. The stations will be in addition to nine Air Products stations currently in use and another nine being installed. Meanwhile, gases firm Linde is nearing completion of its first fueling station and plans two more. Made from natural gas via the steam reforming of methane, hydrogen can be generated at a central location and then transported to filling stations or it can be made on-site. Compression and dispenser technology continues to advance. Linde now compresses hydrogen with an ionic liquid, rather than a mechanical piston. And Air Products has developed a dispenser to ensure fast and reliable fill-ups, according to the firm.—MMB

VERSALIS EYES ETHANE FOR FRENCH CRACKER

Versalis CEO Daniele Ferrari disclosed at the European Petrochemical Association conference in Vienna last week that his firm will proceed with a project to upgrade its naphtha cracker in Dunkirk, France, so that it can also consume ethane. The Italian firm plans to import low-cost ethane from the U.S. The conversion is set to be completed in 2016 at a cost of between $130 million and $190 million. Versalis's move follows initiatives by Borealis, Ineos, and Saudi Basic Industries Corp. to import U.S. ethane as feedstock for their European crackers.—AS

SLOVAK REPUBLIC GAINS CELLULOSIC ETHANOL ...

Beta Renewables, the Italian operator of the world's first large-scale cellulosic ethanol plant, has signed an agreement to supply a cellulosic ethanol plant in Slovakia for the local firm Energochemica. The facility will produce 55,000 metric tons of ethanol per year using Beta's Proesa technology, which converts biomass to fermentable sugars. Novozymes will supply the needed enzymes. Start-up of the plant is expected in 2017. Beta operates a facility in Crescentino, Italy, and plans to open one in Brazil this year.—MMB

... AS P&G SIGNS UP FOR DUPONT ETHANOL

P&G

Procter & Gamble plans to use cellulosic ethanol produced by DuPont in its Tide Cold Water laundry detergent. P&G has long added ethanol to Tide as a solvent. It says the cellulosic ethanol, to be made in a DuPont facility now under construction in Nevada, Iowa, will improve the sustainability of the detergent without compromising its performance.—MM

FRONTFOUR CAPITAL IS AFTER INNOPHOS

The activist shareholder FrontFour Capital has phosphorus chemicals maker Innophos Holdings in its sights. FrontFour sent a letter to Innophos executives demanding that they raise dividends, repurchase more shares, and consider selling their company, in whole or in part. In particular, FrontFour

would like to see the company divest its cyclical phosphate fertilizer business and focus on food and beverage applications. And given the high values that similar companies are garnering, FrontFour thinks Innophos's managers should explore a sale of the firm as well. In the letter, FrontFour executives say they left an Aug. 14 meeting with Innophos with the impression that the firm may instead "pursue an expensive, value-destructive acquisition." Innophos responds that it will pursue a strategy in its own best interest. FrontFour, which owns a 3.3% stake in Innophos, previously targeted the chemical makers Ferro and Sensient Technologies, both of which responded with restructuring actions.—AHT

KULLMAN AWARDED PALLADIUM MEDAL

DuPont CEO Ellen J. Kullman will receive the International Palladium Medal of the Société de Chimie Industrielle at a dinner in her honor in New York City on May 7, 2015. The medal, which recognizes individuals who have made outstanding contributions to the chemical industry, has been awarded to 28 industry executives since 1958. Kullman is the first woman and fourth DuPont leader to receive the award.—MSR

DUPONT

Kullman

COOL PLANET GETS USDA LOAN BACKING

Cool Planet Energy Systems, a start-up biofuels firm, has received a $91 million loan guarantee from the U.S. Department of Agriculture to support construction of a plant at the Port of Alexandria in Louisiana. The company has developed a pyrolysis system that produces gasoline and aromatic fuel blendstocks from wood chips. A carbon side-product of the process called biochar is used as a soil amendment. Cool Planet, which has attracted investors including Google Ventures, BP, and Exelon, broke ground at the site earlier this year and expects to start up in early 2016.—MMB

TEVA QUITS ONCOLOGY, WOMEN'S HEALTH R&D

In an overhaul of its R&D operations, Teva Pharmaceutical Industries is exiting research in women's health and oncology and shedding 14 related programs from its pipeline. The Israeli drug firm says it will retain its sizable commercial presence in the two fields and keep an eye out for potential partnerships involving market-ready products. Discontinuing or selling the drug candidates is expected to save Teva some $150 million next year and more than $200 million in 2016 and 2017. The firm says the roughly $550 million in savings will be put toward R&D in central nervous system and respiratory diseases. It isn't saying how many jobs will be affected by the cutbacks.—LJ

TWO EBOLA DRUGS GET TESTED ON PATIENTS

Patients afflicted with the Ebola virus have received drugs from Chimerix and Fujifilm. Chimerix's experimental drug brincidofovir was administered last week to Thomas Eric Duncan, a patient at a Dallas hospital who later died. An oral nucleotide analog, the compound may be effective against all five families of double-stranded-DNA-containing viruses that affect humans, the company says. Meanwhile, Fujifilm's Avigan, approved in Japan as a flu treatment, may have helped cure a nurse who was being treated for Ebola and later was released from a French hospital. Fujifilm notes that a German hospital also requested the drug to treat an Ebola patient.—JFT

MERCK TEAMS WITH U.K. CANCER RESEARCHERS

Merck Serono and two London-based charitable organizations, the Institute of Cancer Research and the Wellcome Trust, are joining to identify chemical compounds for the treatment of various cancers. The collaboration will build on independent research programs at Merck and ICR to identify inhibitors of tankyrase, an enzyme of the poly (ADP-ribose) polymerase family. The collaboration will be funded jointly by Merck and the Wellcome Trust. At the end of the collaboration, Merck will take over responsibility for selected clinical development candidates.—AS

BUSINESS ROUNDUP

Ashland will sell its elastomers business to the synthetic rubber maker Lion Copolymer for an undisclosed sum. The business, which operates a plant in Port Neches, Texas, has annual sales of about $270 million and mainly serves the North American replacement tire market with styrene-butadiene rubber.

BIOAMBER, a Canadian developer of biobased succinic acid, has signed a five-year supply agreement with Xuchuan Chemical, a Chinese maker of polyester polyols. Xuchuan will replace adipic acid with 300–500 metric tons of succinic acid per year to produce polyols for shoe soles.

CLARIANT has opened a project engineering center in Louisville. The center will oversee Clariant projects such as a new polypropylene catalyst plant in Louisville and the expansion of an ethoxylation plant in Clear Lake, Texas.

COLORCON, a drug delivery technology firm, will incorporate BASF's Kollicoat immediate-release polymer into its line of ready-to-use drug coatings. Kollicoat is an ethylene glycol and vinyl alcohol graft copolymer.

SIGMA-ALDRICH has agreed to acquire Cell Marque, a Rocklin, Calif.-based firm that provides antibodies and staining kits for immunohistochemistry. It employs more than 90 people. Sigma-Aldrich, which is itself being acquired by Merck KGaA, says Cell Marque complements its existing immunohistochemistry offerings.

EXOSTAR, which specializes in cloud-based technology for business collaboration, has won a $5 million investment from the Merck Global Health Innovation Fund to expand its life sciences business. Exostar says its technology could help health care organizations safely share information.

TEIJIN will spend about $21 million to build a new R&D center in western Japan by next fall for its health care business. Equipped with pilot plants that comply with international manufacturing standards, the site will develop materials such as fibrin sheets used in surgical procedures to stop bleeding and help seal tissue.

JEAN-FRANÇOIS TREMBLAY/C&EN

WHOSE ASSET? A short-seller claimed that Gulf Resources does not own this plant, which is on its balance sheet.

SELLING CHINA SHORT

Several Chinese chemical makers are targets of **INVESTORS BETTING** on falling stock prices

JEAN-FRANÇOIS TREMBLAY, C&EN HONG KONG

IS THAT COMPANY a leading producer of a high-priced chemical, or does it just manufacture cheap solvents used to make it? Does this firm actually own the buildings and plants it has on its balance sheet? Is another company's output really just a fraction of what it claims?

If such basic questions were being raised about a publicly traded U.S. company, the firm would quickly try to defend itself before severe harm was done to its stock price. Next, the company would likely consult its lawyers and initiate a lawsuit against the source of the allegations. But if the company were not able to defend itself, it would likely face charges that it defrauded investors.

It's a different story in China. In recent years, medium-sized Chinese firms that are listed on foreign stock exchanges, several of them chemical producers, have been devastated by critical reports published by obscure short-sellers—traders that benefit when a stock price declines. In cases involving chemical firms, the stock either crashed or was hit with a trading suspension. None of them has yet to sue anyone for defamation or starting unfounded rumors.

Although the truth is elusive in all the cases, if nothing else they show that China is fertile ground for both questionable companies and traders that target their stocks.

"The problem is that people rely upon Internet research and no one actually visits the site or performs any investigative due diligence to verify business reality," says Rupert Utley, a former Hong Kong police inspector and forensic accountant who is now a director at the advisory firm Censere. "Many Chinese firms are quite adept at creating fictitious but convincing websites that give a false impression that a company has certain assets and facilities."

Trading in two chemical companies listed on the Hong Kong Stock Exchange, which is considered a foreign stock market because it is not regulated by China, was suspended earlier this year after the companies were targeted by three research outfits that short-sell stocks. And in 2011, a Chinese bromine chemicals producer saw its stock price collapse after a short-seller issued a scathing report.

One of the two recent cases involves Tianhe Chemicals, a northeastern China producer of lubricant additives and fluorochemicals that listed on the Hong Kong exchange in June of this year.

A few weeks ago, Anonymous Analytics issued a highly detailed report arguing that Tianhe is "one of the largest market frauds ever conceived." An offshoot of the hackers' group Anonymous, Anonymous Analytics professes to seek corporate transparency. It claims not to engage in stock short-selling but acknowledges that other people and entities it has contacted may be doing so.

TIANHE'S SALES, Anonymous Analytics asserts, are only a small fraction of what the firm claimed in its launch prospectus. Tianhe's largest customers—which Anonymous Analytics researchers seem to have spent considerable energy tracking down—are either quite small or nonexistent. The most devastating of Anonymous Analytics' claims is that Tianhe does not actually have the technical know-how to make its most profitable product, an expensive fluorochemical treatment, known as an anti-mar, that protects touch screens from damage.

Earlier this year, two short-selling outfits, Glaucus Research and Emerson Analytics, issued separate reports on China Lumena New Materials, a Hong Kong-listed firm whose stock was later suspended. According to the researchers, Lumena is at best a minor maker of the engineering plastic polyphenylene sulfide and certainly not the world's largest producer, as the firm claims.

Glaucus and Emerson also expressed doubts about Lumena's production of other materials. In particular, Glaucus estimated that Lumena's claimed output of medical-grade thenardite—which is used in the manufacture of laxatives—would be enough to produce 30 doses per year for every adult in China. "Is China so constipated?" Glaucus asked.

Three years earlier, in April 2011, Glaucus attacked Gulf Resources, a northern China company that calls itself China's largest producer of bromine chemicals. Glaucus alleged that another company owns the plants that Gulf lists on its balance sheet. The facilities, moreover, have a production capacity that is far lower than what Gulf claims, according to Glaucus.

Tianhe, Lumena, and Gulf Resources issued point-by-point rebuttals of the accusations levied at them. But even Tianhe's denials fell flat, despite the fact that it is backed by Morgan Stanley, a major investment bank

"China offers many opportunities to embellish facts."

CONFLICTING ACCOUNTS

What the companies and their critics claim

COMPANY	CRITIC	COMPANY CLAIMS	CRITIC CLAIMS	STOCK STATUS AT PRESS TIME
Tianhe Chemicals	Anonymous Analytics	■ Profit in 2013 of $425 million on sales of $820 million ■ Sales of anti-mar materials are growing strongly ■ Top five customers account for 38% of sales	■ Sales are only 15% of what is claimed ■ Company doesn't make anti-mar materials but rather their solvents ■ Main customers are straw men	Trading suspended since early September
China Lumena New Materials	Glaucus Research; Emerson Analytics	■ World's largest producer of polyphenylene sulfide (PPS) ■ Producing 250,000 metric tons of thenardite annually ■ Profit of $220 million on sales of $735 million in 2012	■ Company produces a small fraction of the PPS and thenardite it claims to make ■ One thenardite plant no longer operates ■ Financials grossly overstate sales, profits, and assets	Trading suspended since March
Gulf Resources	Glaucus Research	■ Owns the largest bromine producer in China ■ Enjoys a close relationship with its main customer, Shouguang City Rongyuan Chemical	■ Company does not own the assets it claims to own ■ Main customer is a related party ■ Company has paid contractors for fictitious work	Share price dropped from about $10.00 to $2.00 soon after Glaucus issued report in April 2011; has been trading between $1.00 and $4.00 since

that put its reputation behind the Chinese firm. Gulf Resources ended up paying a compensation to its shareholders, who sued the company in a class-action lawsuit.

It has always been hard to establish facts about Chinese firms, according to a chemical industry expert familiar with the recent stock implosions. He asked not to be identified to protect his business relationships.

The lack of transparency opens the door to both fraudsters and people who aim to destroy stock value by issuing negative reports on companies. "It's a very opaque environment, where, for example, distributors pass themselves off as manufacturers," he says. "China offers many opportunities to embellish facts."

In recent years, this expert says, the Hong Kong Stock Exchange has raised its listing requirements to reduce the likelihood of fraud. It is now harder for Chinese companies to list in Hong Kong than to do so in New York. And yet, the recent trading suspensions show that more needs to be done. "In terms of Chinese companies listing overseas, I think the system doesn't work," the expert says.

Investors are normally their own best safeguards against fraud because they have an incentive to closely watch their investments. But when a company based in China raises funds abroad, investors can be hard-pressed to learn what's really going on, according to Matthew Forney, a former *Time* magazine correspondent who now runs Fathom China, a Beijing-based firm that researches Chinese companies. Owing to capital controls, Chinese investors cannot buy stocks of firms listed outside China. As a result, "the people who are closest to those companies, and could check whether their story is true, don't have a reason to check."

The Hong Kong Stock Exchange does mandate that companies name directors to represent outside investors. But in practice, these so-called independent directors are close to the main owners of the companies, Forney says. Fathom does not do any work for short-sellers, he adds.

AN INDEPENDENT third party protecting investors should be companies' auditors. But again, that safeguard is not as sound as it seems. Companies hire the auditors that look at their statements, and the priority of these accounting firms, Forney contends, is to find new clients and pocket fees for their work.

The accounting firm Deloitte was the auditor for both Tianhe and Gulf Resources. But searching for fraud isn't the responsibility of external auditors, which detect it only in exceptional circumstances, Utley adds. "Most fraud is detected through whistle-blowers," he says.

Forney is surprised to see short-sellers targeting chemical companies because the industry's large-scale operations are hard to invent. "Unlike, say, an Internet company, a chemical company usually has assets you can see and trucks going in and out," he says.

Censere's Utley, though, is not surprised. In his 25 years as a financial investigator in China, he has come across all sorts of scams. One company that Utley and his team of forensic accountants was hired to investigate had 12 different sets of accounts that management used to show different groups.

One indication of the large scale of fraud is that an open market exists in China for "fapiao," which are official sales receipts. Contraband fapiao are easy to acquire and can be used to legitimize all sorts of illegal activities, from padding expense accounts to providing cash to bribe government officials, Utley says.

Everything can be faked in China, from management's credentials to actual locations of business, Utley claims. He is even aware of a company that took a foreign visitor on a tour of a facility it didn't own. "The plant workers were oblivious since foreigners are rarely challenged when touring plant facilities in China, and the foreigner just off the plane, and not speaking Chinese, just assumed they were inspecting a legitimate facility."

One way to guard against fraud and manage risk in China is to engage firms such as Censere that can verify claims and conduct due diligence into the business reality of a company. It's expensive, but Utley notes that the cost of not doing so can be even higher.

When it comes to the stock market, few people other than short-sellers have an incentive to test the claims that companies make, Forney says. "When a stock is high, the brokers profit, the auditors profit, and the investors profit too," he says. That is, until the music stops and it all implodes. ■

LAURA SCOTT

THE PROBLEM WITH LAVENDER OIL

An EU proposal to **LABEL THE ESSENTIAL OIL** as dangerous is meeting French resistance

ALL IS NOT WELL in the sun-drenched lavender fields of southern France. The mere mention of European chemical regulations to one of the 2,000 or so lavender growers in the Provence region is likely to elicit a roll of the eyes and a reach for a bottle of pastis, the local liquor.

The problem is that at least one company has notified the European Chemicals Agency that the essential oils in lavender can cause allergic reactions. As a result, ECHA is set to classify the oil as a "skin sensitizer." And that means that under European Union labeling and packaging rules, lavender-oil-based products will have to carry health warnings starting in 2018.

Although the final wording for the label has yet to be chosen, it could be along the lines of "May Be Fatal If Swallowed Or Inhaled." Arguing that this is the kind of label more often associated with bleach or lye, lavender farmers in Provence have organized a campaign to fight it.

The main application of lavender oil is as a fragrance although it also has antiseptic and anti-inflammatory properties. An example is the oil's ability to kill the parasite *Giardia*, which causes diarrhea and nausea. Key components in lavender oil include the terpene alcohol linalool and linalyl acetate, the acetate ester of linalool.

Farmers argue that lavender oil should be classified as an agricultural—not chemical—product. They say the proposed labeling would put off customers and harm their livelihoods. Many lavender farmers in Provence have peppered their fields with signs proclaiming that "lavender is not a chemical product" or pleading, "Help us: Save the lavender!"

"Everyone I know who sells lavender products at markets is against these plans," says René Galvin, who for years has grown lavender near Moustiers Sainte Marie in Provence. Amid his colorful fields, Galvin runs a tiny, intensely fragrant shop with pots of lavender flower honey, multicolored lavender soaps, and an array of bottles containing blends of lavender oil.

"Lavender extract isn't dangerous, you know. There's no chemical matter in the products," he says. "We obtain it by distilling the flower in steam. The essence comes out of the flower, and there's nothing else."

Marie France Bourjac, who runs two distilleries near Moustiers Sainte Marie, is another local who doesn't see the logic of lavender product labels. "We've been using essential oil for generations. For allergies, okay, maybe there was one person once who said he was allergic to it," she allows.

KICKING UP A STINK Farmers who grow lavender in Provence are pushing back against regulations requiring them to label lavender products as possibly dangerous.

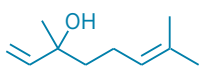
Bourjac claims that she would close her business out of principle rather than agree to labeling her products with health warnings. "We won't put the labels on," she declares.

PPAM de France, an industry association representing 1,500 growers of fragrant and medicinal plants in France, is also fighting the labeling of lavender products. It began a campaign in July.

The International Fragrance Association, a Switzerland-based body representing producers of natural oils, takes a more conciliatory tone. Commenting on its website about a meeting in April between the European Commission and fragrance industry groups from France, Italy, and Bulgaria, the association states that distillers are "willing to embrace their responsibility and comply with the new legislation, but that they require some guidelines specific to their sector."

TO THE NORTH in Brussels, where most EU bureaucrats are based, discussions are ongoing between regulators and industry groups about how the labels must be applied. The European Commission estimates the talks will conclude sometime next year.

So far, though, regulators show no sign of backing down. If the farmers of Provence refuse to apply the labels, the commission could impose sanctions.



Linalool

Doing so might seem ironic given that Europe's chemical regulations were conceived to combat pollution from synthetic—not natural—products. But ECHA makes no apologies. The basis for the regulations, the agency tells C&EN, "is to ensure a high level of protection of human health and the environment as well as the free movement of substances, mixtures, and articles, regardless of whether these come from natural sources, or are synthetic, or from big or smaller companies."

If French lavender farmers go through with threats to switch to other crops—an act that would change the identity of Provence—political pressure on EU legislators would no doubt intensify. Meanwhile, Bourjac, the lavender oil distiller, reiterates her threat. Rather than apply labels classifying her products as hazardous, "we'll just stop our production," she says.—ALEX SCOTT

OPTIMISM GROWS ON CHEMICAL SECURITY BILL

Odds are increasing that legislation to reauthorize the Department of Homeland Security's (DHS) chemical facility security program will be approved by Congress in the lame-duck session that will follow the Nov. 4 midterm elections. Rep. Patrick Meehan (R-Pa.) is the chief sponsor of a bill (H.R. 4007) the House of Representatives passed on July 8 to renew the Chemical Facility Anti-Terrorism Standards program for three years. He is willing to accept changes proposed by the Senate, says an aide to the congressman. Rep. Meehan is "hopeful that with more work we can get final chemical facility security legislation signed into law this year," the aide tells C&EN. The Senate's homeland security panel amended H.R. 4007 on July 30, extending the program for four years and creating a procedure for "expedited" approval of site security plans at many chemical facilities. The modified Senate version must still pass the full Senate and would then have to clear the House. Both the chemical industry and DHS have been strong supporters of the reauthorization effort.—GH

LOS ALAMOS BLAMED FOR REPOSITORY FIRE

Failure of Los Alamos National Laboratory operators to properly package waste may have caused a fire and radioactive release

DOE

A shipment of transuranic waste arrives at the Waste Isolation Pilot Plant.

early this year at the nation's only operating underground nuclear waste storage facility, concludes a recent report. The incident in February injured several workers and shut down the Department of Energy's Waste Isolation Pilot Plant (WIPP), a Carlsbad, N.M., repository for transuranic waste from DOE nuclear weapons facilities including the Los Alamos lab. The repository is not expected to reopen until 2016. In the report, DOE's independent inspector general finds that incompatible or potentially incompatible materials—cellulose-based kitty litter sorbent and liquid acid neutralizers—were placed in drums with radioactive nitrate salt waste. This may have resulted in a chemical reaction that led to the fire, the report says, adding that the exact cause has not been determined. WIPP stores large volumes of transuranic waste consisting mostly of radioactive clothing, rags, tools, and other material, some of which is combustible. The shutdown will delay cleanups at many DOE facilities and will cost tens of millions of dollars, the report says.—JJ

REFERENCE MATERIAL IS SMALLEST YET

The National Institute of Standards & Technology (NIST) has issued its smallest reference material for confirming measurements of synthetic nanoparticles. Reference Material (RM) 8027 contains silicon nanoparticles that are certified to be approximately 2 nm in diameter suspended in toluene. Created for validating measurements of particles between 1 and 100 nm, the new reference material is particularly useful "for anyone working with nanomaterials at dimensions 5 nm or less," says Vytas Reipa, leader of the team that developed RM 8027. The nanoparticles were made by etching nanocrystals from a silicon wafer, separating the crystals using ultrasound, and then stabilizing each within an organic shell. Analytical techniques including dynamic light-scattering electron microscopy and inductively coupled plasma mass spectrometry confirmed the size and chemical composition of the reference material, NIST says. Silicon nanoparticles are being studied for use in next-generation photovoltaic solar cells, solid-state lighting, and the cathodes of lithium batteries, the agency adds. The material can be ordered through nist.gov/srm.—JM

'NATURAL' FOODS MAY BE TRANSGENIC

An analysis of breakfast cereals, chips, soy infant formulas, and other popular packaged foods by *Consumer Reports* magazine has revealed genetically modified ingredients in many products, including several that are labeled as "natural." Some products that claim to be free of genetically modified organisms (GMOs) also turned out to contain the controversial ingredients, the analysis found. The investigation comes as some consumers and advocacy groups are ramping up calls for labeling foods that contain GMOs. "Federal law already requires labeling that lets consumers know whether foods have been previously frozen, made from concentrate, pasteurized, or irradiated, and we believe the label should also say if food is genetically engineered," says Jean Halloran, director of food policy initiatives at Consumers Union, the policy arm of *Consumer Reports*. At least 64 countries currently require manufacturers to label foods that contain GMOs, but the U.S. is not one of them. Because of the lack of a federal requirement, many states have introduced bills that would require labeling GMO food at the state level. This year, Vermont became the first to enact such a law.—BEE

USDA PROMOTES BIOBASED CHEMICALS

Biobased products, including chemicals, are a growing sector of the U.S. economy, concludes a contractor-prepared report released by the Department of Agriculture. Much of the growth has been fueled by government policies and industry sustainability initiatives, the analysis finds. The report explores emerging opportunities for combining agriculture and manufacturing to make products from sustainable biological materials and to create U.S. jobs. One of the studies cited by the report predicts that biobased chemicals will constitute more than 10% of the chemicals market by next year. Another cited study finds the potential to produce two-thirds of all chemicals from biobased materials, which in turn would go into more than 50,000 products and represent a $1 trillion global market. The analysis preludes a more in-depth economic study expected in coming months from USDA's BioPreferred program, which aims to increase federal agencies' use of biobased products.—BEE

PETER CUTTS PHOTOGRAPHY

NEW CAPTAIN FOR NSF

Astrophysicist **FRANCE CÓRDOVA** encourages advocacy for science

ANDREA WIDENER, C&EN WASHINGTON

FRANCE A. CÓRDOVA doesn't get worked up about every little crisis. That's one of the most important lessons she has learned in her years as a college president, government scientist, professor, and member of numerous corporate and nonprofit boards.

That attitude is one she's bringing to her new job as director of the National Science Foundation, she said when she sat down with C&EN for an interview last month.

"The expression 'Steady as she goes' is very important," explains Córdova, 67. "You have to just calmly sail the big waves and smile through it so that people know that you're on it but you're confident."

As NSF director—her six-year term in that job began on March 31—the astrophysicist oversees the government's only agency giving grants in all basic science disciplines. In 2014, NSF's budget was $7.2 billion. The majority of that money supports individual investigators in fields that include chemistry, computer science, and science education.

"NSF is a great agency with a very important mission: to further the progress of science," she says. "It's the opportunity of a lifetime, and I'm just thrilled it was offered to me."

The agency is facing challenges, however. Lean budgets across the government mean NSF can fund fewer grants. And in the past year, some members of Congress have attacked the agency's priorities and grant selection process.

"It's always a tumultuous time, right?" Córdova says. "There are all kinds of challenges. But nothing is a tsunami."

Córdova says she hasn't encountered many surprises in her new job so far, in part because of her previous experiences. "There are always challenges that are unique on the surface but then you go down a layer and they are really very similar challenges" to ones that have cropped up before, she says.

And she certainly faced challenges in roles that include chief scientist at the National Aeronautics & Space Administration and leader of two universities, the University of California, Riverside, and, more recently, Purdue University.

What makes NSF different from the other places she's worked is its mission, she says. Paying close attention to what the science community thinks will be game changers for the future is essential "so that you're out in front on the first wave rather than the last wave," she says.

Córdova spent the past six years on the National Science Board, which sets policy for NSF and advises the larger government on broad science policy issues. Most recently, she was chair of the board's committee on strategy and budget, which helped her understand how NSF works and its challenges and opportunities.

ONE MAJOR test facing NSF is that Congress is attempting to cut specific programs by slashing their budgets. Climate change programs are among those that have been in the crosshairs. For example, this year the House of Representatives proposed cuts to NSF's geosciences program, which funds climate change research. Those cuts haven't garnered Senate approval, however. Such political decisions are unfortunate, Córdova says. Collecting climate change data "should be a science question."

The social and behavioral sciences are another target of lawmakers' budget knives. Córdova says research in these fields is vital to understanding the larger questions facing science. "It's hard to imagine a human endeavor, it's hard to imagine a business or industry, it's hard to imagine an invention that doesn't have some social or behavioral science attached to it," she says.

NSF is also facing attacks on its heralded peer review system from House of Representatives Science, Space & Technology Committee Chairman Lamar Smith (R-Texas). In the past year, Smith has

"It's the opportunity of a lifetime, and I'm just thrilled it was offered to me."

called out specific grants for intense scrutiny and is asking the agency to affirm that each grant is in the "national interest."

Any executive branch agency is, by definition, in the public eye and subject to the oversight of Congress, Córdova says. "It's election season," she says with an eye to the November midterm races. "There may be more questions than some other times."

But similar attacks on the agency have happened before. "So it's episodic," she says. "I'm just the lucky one."

Despite the problems, Córdova has found that NSF and science in general have broad support in Congress. "I think we have done well given the circumstances and the overall budget constraints," she says.

SCIENTISTS AND RESEARCH organizations are doing their part to support research funding. But Córdova says that others who benefit from the outcomes of research need to step up too. "You can't just say this is somebody else's responsibility to advocate, to inform. It is everybody's responsibility," she says. "When only one group or one agency is going to Capitol Hill, that is really not giving our elected officials the impression that it matters to everybody."

Students should advocate because they are powerful messengers, she says, a lesson she learned as a college president. And businesses should make support for science a priority because they benefit from innovation, Córdova explains.

"It is just not at the top of people's lists. I don't think they realize what is happening, for the most part, in this country," she says. She cites the decline in U.S. science spending as a percentage of gross domestic product and other countries' increased investment in their domestic universities and research infrastructure.

Drawing people into that larger conversation is where Córdova says she can make the biggest difference as NSF director. "Where I think I can make a broader impact is spreading science and its importance more nation- and globalwide," she says, pointing to science and technology's role in economic health, prosperity, and national security.

Asking for more money from Congress isn't enough. "I don't think there is more money, period," she says. "But I do think there is more leverage potential.

"NSF has always thought of itself as an enabler," she says. "We catalyze good things, but we can't fund them forever."

Foundations, individuals, businesses, and even local and state governments are among those Córdova will encourage to take up the cause. The NSF director is still working out what she is going to do. But she says it will become clear over the next year as the agency proposes more partnerships, holds more workshops and idea labs, and issues more "Dear Colleague" letters asking for the science community's advice.

Córdova knows from experience that people can be drawn into science unexpectedly. She majored in English as an undergraduate at Stanford University. "I had a love of science, and in high school I took basic science and math, but I just didn't have any encouragement to be a scientist," she remembers.

It wasn't until she had graduated from college that she got excited about astronomy and physics through the first moon landing and a PBS television program she saw on neutron stars. "I found the ignition switch was my television dial because where were you going to meet a scientist except on TV in the culture that I grew up in?" she says. She recalls telling herself that 25 "may seem old but it's not. In five years I can go to graduate school and become a physicist. I can do this. That was a real revelation to me."

Soon after, Córdova walked onto the campus of Massachusetts Institute of Technology and knocked on a few doors. "People at the university were excited about my passion, and they decided to give me a chance," she remembers. They put her in the lab, asked her to write computer code, and told her to make some observations. She later went to California Institute of Technology, which allowed her to audit courses for a year before she became a full-time doctoral student. "In those days it was easier to look at people's talents and give them a test. It's a little harder nowadays. It's pretty bureaucratic to get into school."

Córdova has been taking chances ever since. It's a lesson she offers to anyone—but especially women—who ask her how she got ahead. "People are afraid to be what they want to be. That is the thing I see most when I talk to people or offer them an opportunity myself," she says.

Many have had opportunities but declined them because of their family, location, or some other factor. "People just throw up these chimerical roadblocks. You just have to be a little fearless and go after it."

However, she acknowledges that science isn't always the most welcoming place for women and minorities—or anyone else interested in doing research. In the U.S., "science and engineering careers are not as attractive as some other fields right now," she says. "We've just become very dependent on international talent, and that has served us very well. But I think it would be complacent to think that we will always be in that position."

That's why, as NSF director, Córdova wants to make sure the public is exposed to science in as many ways as possible.

"It's not a prescription we can write," she says. "We have to have science on TV. We have to have science in movies. We have to have science in books. We have to have science in the backyard, in the schoolyard, in every nook and cranny because you don't know at what age a person is going to be inspired to start thinking about scientific questions." ■

Meet France A. Córdova

Director, National Science Foundation
Appointed: March 31, 2014
Experience:
2007–12, President, Purdue University
2002–07, Chancellor, University of California, Riverside
1996–2002, Vice chancellor for research, University of California, Santa Barbara
1993–96, Chief scientist, National Aeronautics & Space Administration
1989–96, Professor, astronomy and astrophysics, Pennsylvania State University
1970–89, Scientist and group leader, space and astronomy group, Los Alamos National Laboratory
Education:
1979, Ph.D., Physics, California Institute of Technology
1969, B.A., English, Stanford University

NASA

IN THE WILD Feral hogs destroy crops and damage public lands to the tune of $1 billion a year.

COUNTERATTACKING THE WILD PIG INVASION

BACON PRESERVATIVE under study for controlling feral swine

FERAL PIGS that arrived with settlers in the New World in the early 1500s have overstayed their welcome, according to farmers and public land managers plagued by their destructive behavior. The animals gained popularity with big-game hunters in decades past, leading some states to stock the animals in the wild for sport. But feral swine, which breed abundantly, now number in the millions in the U.S. They cause more than $1 billion in damage nationwide to agricultural fields and native habitats each year with their aggressive rooting and roaming.

"Feral swine are a very intelligent, very strong animal," says Dale Nolte, who heads the U.S. Department of Agriculture federal feral swine management program. "I don't know of a crop they won't eat."

The average male wild pig weighs about 200 lb with some growing to be as heavy as 500 lb. Fences offer little protection against the massive beasts. Hunting and trapping, which once kept the population in check, can no longer keep up with the pigs' rapid reproduction.

In response, USDA is seeking to reduce the wild pig population that roams in at least 35 states. In January, it launched a national initiative that will attempt to stamp out the pervasive pigs by slipping them bait laced with a fatal dose of sodium nitrite.

Australian scientists pioneered the use of sodium nitrite to kill feral swine. USDA researchers are working in collaboration with the Australians to develop an effective, humane sodium nitrite bait for feral swine in the U.S., says Fred L. Cunningham, a federal scientist in charge of the research arm of the program.

In April, Congress gave USDA $20 million to begin bringing wild pigs under control. The pressure is on for USDA scientists to overcome challenges uncovered in early research and pilot programs that suggest feral swine won't go down without a fight.

"These things are the ultimate survivors. They can live pretty much anywhere, and they can eat pretty much anything," says Jack Mayer, a zoologist at Savannah River National Laboratory in Aiken, S.C., who is a technical consultant for the USDA program. But what they're not so interested in eating is sodium nitrite. The salty taste of the chemical is a turnoff to the pig's palate.

The curative properties of sodium nitrite are well established for preserving the taste and color of meat. But instead of making bacon, Cunningham and his team are working to develop toxic bait that encapsulates sodium nitrite in a tasty treat that pigs will eat.

Success in the research effort means registering a pesticide with the Environmental Protection Agency for controlling wild swine. But that can only happen after field studies have proven that the toxicant is safe for other animals and effective.

Animal welfare activists, however, are opposed altogether to using sodium nitrite to kill feral swine, calling the method "exceptionally cruel" and urging USDA to end the research.

"Lethal measures are not necessary, but if people insist on killing these animals, poisoning by sodium nitrite should never be an option," says Stephanie Bell, a casework director for People for the Ethical Treatment of Animals.

In the belly of a pig, sodium nitrite is absorbed into the bloodstream where it reduces oxygen. Without the oxygen it needs to function, the pig faints and dies much as it would through carbon monoxide poisoning, experts say. A lower concentration of an enzyme, methemoglobin reductase, in the pigs' blood makes them more susceptible to sodium nitrite toxicity than other animals.

"Basically, the animal gets kind of woozy and goes to sleep," Mayer says. If a wild pig gets a sufficient dose of the substance, he tells C&EN, "it doesn't wake up."

"RIGHT NOW, we do not have any chemical methods that are registered for use" to control wild hogs, Nolte says. He estimates that field studies to optimize use of the toxicant might take three to five years. In the meantime, researchers are developing feeding stations and working on a delivery system that keeps other wildlife from eating the salty bait. They are also investigating chemical contraceptives for controlling the feral swine population.

In response to critics, Nolte reiterates that the goal of the feral swine program is to reduce widespread damage to crops and natural lands.

"Our goal is to reduce damage. Unfortunately, the only way we can do it is to remove the animals," Nolte says.

"The U.S. has never really warmed up to the use of toxicants to control animals, but we have a national problem, and it's costing this country a lot of money," Mayer adds. "You and I are going to pay more money at the grocery store because of the damage that pigs do."—JESSICA MORRISON

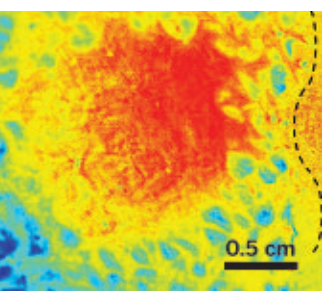
MANURE PROMOTES ANTIBIOTIC-RESISTANT SOIL BACTERIA

Manure from antibiotic-free cows can cause antibiotic-resistant bacteria in soil to bloom, Yale University researchers report (*Proc. Natl. Acad. Sci. USA* 2014, DOI: 10.1073/pnas.1409836111). Organic farmers commonly substitute manure for inorganic nitrogen and phosphorus fertilizers. Studies of soils fertilized with manure from pigs treated with sulfonamide antibiotics have shown transient increases in antibiotic-resistance genes of soil bacteria. Microbiologists are concerned that these genes could transfer through contaminated crops or groundwater to human pathogens. In the new work, a team led by Yale's Jo Handelsman found that manure from cows not treated with antibiotics caused population shifts in soil microbes so that bacteria resistant to β-lactam compounds such as cephalosporins became more abundant. Soil treated with an inorganic fertilizer did not show the same population shift. More research is needed to pinpoint the manure component responsible for promoting the antibiotic resistance, such as a nutrient, metal, or toxin to which nonresistant bacteria are vulnerable.—JK

PAINTING A DIAGNOSTIC WOUND DRESSING

Tracking oxygenation levels in a wound allows doctors to monitor a patient's healing. But dealing with damaged tissue requires a delicate touch. Many existing methods measure skin oxygenation; however, most of them are invasive. Researchers led by Conor L. Evans of Harvard Medical School and Massachusetts General Hospital have worked around that limitation by developing a bandage that can be painted atop a wound to map tissue oxygen content and consumption (*Biomed. Opt. Express* 2014, DOI: 10.1364/boe.5.003748). The team imbued a commercial liquid bandage solution with an oxygen-sensitive phosphorescent porphyrin dendrimer called Oxyphor R2. The porphyrin's dendritic arms helped the team control oxygen flux to the molecule's phosphorescent core and also kept the molecules dispersed throughout the liquid. The researchers painted bandages onto wounds, where they cured into flexible dressings. Measuring variations in the intensity or in the lifetime of the phosphorescent signal over a bandage's surface allows the team to map the oxygenation of the tissue underneath. Although the team says the sensitivity of its bandage can be improved, few existing oxygen monitors can be applied—or peeled off—so painlessly.—MD

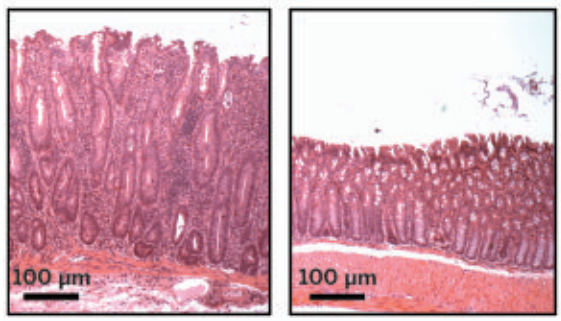
BIOMED. OPT. EXPRESS



A bandage painted over a burn shows damaged tissue (red) that consumes less oxygen than the healthier surrounding skin (blue and green). Dashed line indicates the bandage boundary.

PAIN-SIGNALING PROTEIN ACTIVATES T CELLS TOO

When T cells recognize a dangerous pathogen, they kick into gear and attack. One crucial step in the activation of these immune cells involves a protein receptor called CRAC opening and allowing calcium ions to rush inside the cells. Or so scientists thought. A research team led by Wilfred A. Jefferies of the University of British Columbia and Eyal Raz of the University of California, San Diego, has demonstrated that another receptor, TRPV1, also helps spur T cells into action (*Nat. Immunol.* 2014, DOI: 10.1038/ni.3009). Not normally associated with the immune system, TRPV1 is well-known for its role in pain sensing: The receptor becomes active and sends distress signals to the brain in response to heat and the chili pepper compound capsaicin. Using electrophysiology, genetic engineering, and other tools, Jefferies, Raz, and coworkers have shown that TRPV1 regulates T cell calcium ion influx. When the experimental cinnamide compound SB366791 blocked TRPV1 in mice afflicted by colitis, the inflammation in their gut walls declined. Because SB366791 worked at a low dose, Raz says the team's discovery might mean a second chance for TRPV1 blockers: as autoimmune disease therapies. Tested in humans as painkillers, some of these compounds have caused side effects such as fevers at high doses.—LKW



NAT. IMMUNOL.

A mouse with colitis has an inflamed gut lining (left). When genetically engineered to lack the receptor TRPV1, a colitis-afflicted mouse has a healthier gut (right).

TIN SULFIDE FILMS FROM SOLUTION

Owing to its low cost and potentially useful electronic properties, tin sulfide is a promising candidate for applications such as photovoltaic devices. Yet the semiconductor remains largely sidelined because methods used for making high-quality tin sulfide films, such as atomic layer deposition and thermal and electron beam evaporation, are laborious and costly. A team led by Richard L. Brutchey of the University of Southern California and Nathan S. Lewis of Caltech has now demonstrated that high-quality tin sulfide films can be prepared via a simple low-temperature solution-phase method (*Chem. Mater.* 2014, DOI: 10.1021/cm503124u). The researchers dissolved tin sulfide powder in a mixture of ethylenediamine and 1,2-ethanedithiol at 50 °C then spin-coated the solution onto glass plates or other supports. They briefly heated the films then conducted spectroscopic, photovoltaic, and X-ray analyses. Although tin and sulfur can form SnS_2, Sn_3S_4, Sn_4S_5, and other phases, the team reports that the simple solution method yields defect-free, phase-pure SnS films that generate stable

photocurrent values comparable with samples prepared by more complex deposition methods.—MJ

ALUMINA COATING TAMES NANOTUBE TOXICITY

Coating carbon nanotubes with a layer of aluminum oxide reduces the nanomaterial's propensity to induce pulmonary fibrosis in mice, new research shows (*PLOS One* 2014, DOI: 10.1371/journal.pone.0106870). Multiwalled carbon nanotubes (MWCNTs) can be long and fibrous and lodge in the lung tissue of animals when inhaled. This can cause pulmonary inflammation and fibrosis similar to that seen after exposure to asbestos. As industrial and biomedical applications for nanotubes increase, so will the potential for human exposure. Previous research has shown that attaching hydrophilic organic chains to carbon nanotubes reduces their toxicity, perhaps by breaking the tubes apart into shorter segments. James C. Bonner of North Carolina State University and colleagues have now used atomic layer deposition techniques to coat MWCNTs with Al_2O_3. Human cell cultures dosed with coated nanotubes produced lower levels of certain immune substances than the uncoated ones. The researchers also found that mice inhaling the coated nanotubes had lower rates of pulmonary fibrosis than their counterparts inhaling uncoated nanotubes. However, there were no differences in levels of pulmonary inflammation. "The aluminum oxide coating doesn't eliminate health risks related to MWCNTs," Bonner says, "but it does lower them."—EKW

ENHANCING BIORECEPTOR RESPONSIVENESS

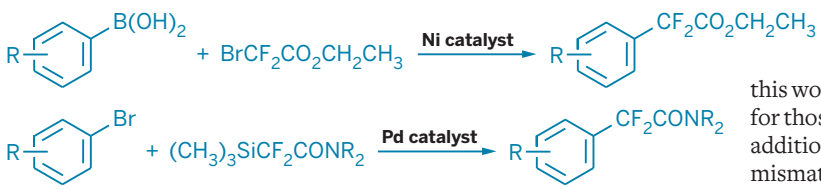
A generalizable way of boosting bioreceptor sensitivity to small changes in ligand concentration could lead to improved biosensors and more responsive biomaterials (*Proc. Natl. Acad. Sci. USA* 2014, DOI: 10.1073/pnas.1410796111). The sensitivity of most protein or DNA biosensors is physically limited in that it usually takes a large change in ligand concentration before binding-site occupancy changes significantly. A two-order-of-magnitude concentration increase is typically required to boost binding-site occupancy of a receptor by one order of magnitude. To deal with this problem, nature uses multisite receptors with positive cooperativity—in which an initial ligand such as a drug molecule binds with lower affinity than subsequent ligand molecules, enhancing sensitivity to small changes in ligand concentration. Kevin W. Plaxco of the University of California, Santa Barbara, and coworkers have now designed DNA-based receptors that are similarly cooperative. Their two-site receptors unfold in the absence of a ligand. Binding a first ligand initiates folding, forming a second binding site that is easier to occupy. This sequence increases ligand affinity and improves receptor sensitivity to small concentration changes. Next steps include adapting this mechanism to proteins, Plaxco says.—SB

COURTESY OF KEVIN PLAXCO

A designed DNA receptor is initially unfolded. Binding of a first ligand (star) initiates folding, creating a second binding site that is easier to occupy.

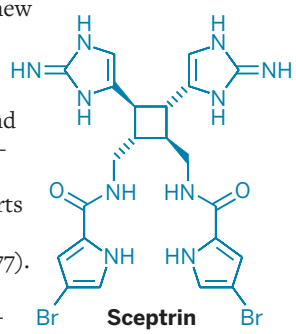
CROSS-COUPLING FLUORINATIONS RAMP UP

As organic chemists have continued to advance catalytic cross-coupling reactions in recent years, one of the biggest beneficiaries has been fluorinations. Incorporating fluorine into organic compounds has traditionally required hazardous stoichiometric reagents, but the new methods are ushering in gentler approaches. In one example, Xingang Zhang and coworkers of Shanghai Institute of Organic Chemistry have developed nickel- and palladium-catalyzed cross-coupling reactions between functionalized difluoromethylhalides and aryl boronic acids to make aryldifluoromethyl phosphonate, aryldifluoroacetic acid, and aryldifluoromethane derivatives (*Angew. Chem. Int. Ed.* 2014, DOI: 10.1002/anie.201309535 and 10.1002/anie.201405653). In another example, John F. Hartwig and coworkers of the University of California, Berkeley, have reported palladium-catalyzed cross-couplings of difluoroketones with aryl and heteroaryl halides and cross-couplings of trimethylsilylacetamides with aryl and heteroaryl bromides to make difluoromethylarenes and aryldifluoroacetamides (*J. Am. Chem. Soc.* 2014, DOI: 10.1021/ja501117v and 10.1021/ja508590k). These methods provide additional options for preparing building block molecules containing fluorine atoms at the metabolically labile benzylic position that is important for medicinal chemistry.—SR



SPONGE CHIRALITY SURPRISE

Ocean-dwelling sponges produce molecules complex enough to intimidate the boldest of organic chemists. And they may be even more skilled in synthesis than researchers thought: A new study demonstrates that three related sponge alkaloids—sceptrin, ageliferin, and massadine—have mismatched chirality, in contrast to prior reports (*Science* 2014, DOI: 10.1126/science.1255677). Most natural product families include members that all have the same chirality or are all mixtures, explains Chuo Chen of the University of Texas Southwestern Medical Center, who led the research. Chen made the mismatch discovery after synthesizing and crystallizing sceptrin and ageliferin in collaboration with Phil S. Baran of Scripps Research Institute California and Arnold L. Rheingold of the University of California, San Diego. The trio obtained the opposite stereochemistry compared with natural samples, which led them to conclude that sceptrin and ageliferin's absolute stereochemistry is different from massadine's and had originally been misassigned. It's not yet clear how the sponge achieves this divergence in chirality, Chen says. He notes that the team made sceptrin and ageliferin with oxidative reactions that other chemists have postulated are involved in their biosynthesis, including single-electron transfer, so this work provides more support for those biosynthesis pathways in addition to revealing the chirality mismatch.—CD



Sceptrin

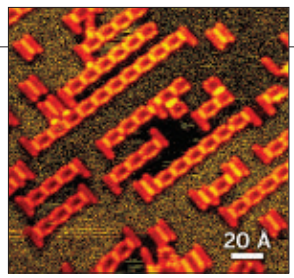
from the SCENEs

A selection of stories from C&EN's six online **TOPICAL NEWS CHANNELS**

FROM THE **ORGANIC SCENE**

COMBINATORIAL CHEMISTRY ON SURFACES

A team of British researchers has developed a combinatorial strategy for forming a diversity of macromolecules, such as porphyrin chains, directly on surfaces (*ACS Nano* 2014, DOI: 10.1021/nn502388u). The method provides a simple route to molecules that could serve as wires, switches, transistors, or other components in molecular electronics. A team led by Rasmita Raval of the University of Liverpool and David B. Amabilino of the University of Nottingham first adsorbed organic building blocks such as pentacene, perylene, and porphyrins onto a copper surface at room temperature. Heating the surface to between 560 and 650 K triggered bond formation and linked the monomers. By carefully tweaking the reaction conditions, the researchers produced a cornucopia of products, including long chains, branched structures, and even three-component oligomers that look like door keys. The team has begun to characterize the structures they have made for their potential use as organic semiconductors, light-harvesting materials, catalysts, or sensors.



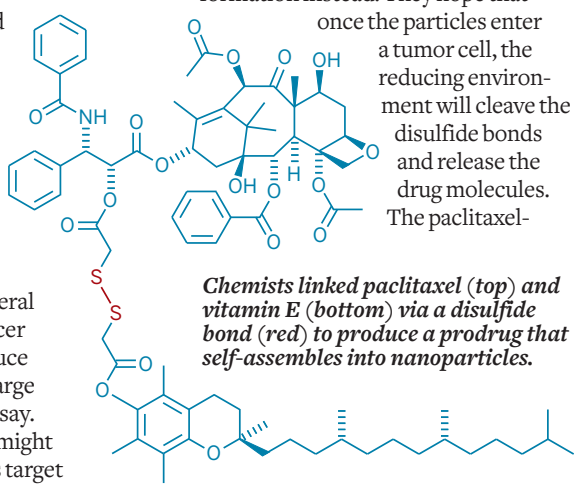
ACS NANO

A scanning tunneling micrograph shows H_2-porphyrins connected by bright copper atoms. Pentacene molecules cap the ends of the porphyrin chains.

FROM THE **NANO SCENE**

DISULFIDE BOND HELPS CANCER PRODRUGS ASSEMBLE INTO NANOPARTICLES

Chemists have coaxed anticancer prodrugs to form easy-to-deliver nanoparticles by inserting a single disulfide bond into the molecules (*Nano Lett.* 2014, DOI: 10.1021/nl502044x). The simple synthetic method works for several different kinds of cancer drugs and could produce nanomedicines on a large scale, the researchers say. Such nanomedicines might someday help doctors target tumors by infiltrating the leaky blood vessels that feed the cancerous tissue and then accumulating inside. Yongjun Wang of Shenyang Pharmaceutical University, in China, and colleagues made a collection of disulfide-linked prodrugs, including paclitaxel conjugated with vitamin E. They hypothesize that the disulfide bond prevents the prodrug molecules from forming crystals, favoring nanoparticle formation instead. They hope that once the particles enter a tumor cell, the reducing environment will cleave the disulfide bonds and release the drug molecules. The paclitaxel-vitamin E particles pack in more drug than commercially available paclitaxel formulations: The 113-nm-wide particles are 60% paclitaxel by weight, compared with 10% for an approved nanodrug version called Abraxane.



Chemists linked paclitaxel (top) and vitamin E (bottom) via a disulfide bond (red) to produce a prodrug that self-assembles into nanoparticles.

FROM THE **BIOLOGICAL SCENE**

SMELL RECEPTORS SNIFF OUT HYDRATED ALDEHYDES

How mammalian olfactory receptors bind aldehydes—common odorant molecules in foods and fragrances—is something of a mystery. But now scientists have sniffed out one important detail: Some odorant receptors recognize an aldehyde via its hydrated, double hydroxyl form (*ACS Chem. Biol.* 2014, DOI: 10.1021/cb400290u). In water, such as in a moist nasal environment, an odorous aldehyde equilibrates between its carbonyl form and its double hydroxyl form, otherwise known as a geminal diol. So Kevin Ryan of the City College of New York wondered if any of the numerous known aldehyde receptors detected the hydrated form. He and his colleagues decided to look at octanal, a citrusy aldehyde found in butter, oranges, and rice. They made a fluorinated version, 2,2-difluorooctanal, which strongly favors the diol form when in water. Then they tested the fluorinated compound on cells expressing one of 24 odorant receptors activated only by aldehydes. About 40% of those receptors responded to 2,2-difluorooctanal, demonstrating that some olfactory receptors can bind *gem*-diols. The finding will help chemists build better computational models of these protein-ligand interactions, says Hanns Hatt of Ruhr University Bochum, in Germany.

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NEWSCOM

SUCCESS Scientists at the Indian Space Research Organisation celebrate MOM's successful insertion into orbit around Mars.

U.S., INDIAN SPACE AGENCIES LINK

Success Of India's **MARS PROBE** Spurs Collaboration With NASA On Mars, Earth Observation

ELIZABETH K. WILSON, C&EN WEST COAST NEWS BUREAU

A MERE FOUR DAYS after India's first Mars spacecraft successfully entered orbit around the Red Planet on Sept. 24, the National Aeronautics & Space Administration (NASA) and the Indian Space Research Organisation (ISRO) announced they were going to be collaborators.

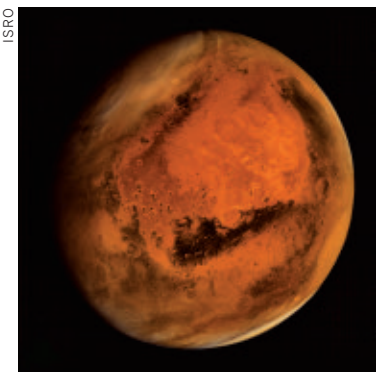
IRSO is now the fourth space agency with a presence at Mars, a feat it achieved for the remarkably cheap price tag of around $74 million. The craft is named *Mangalyaan*—Hindi for "Mars craft"—but is also known as MOM, for Mars Orbiter Mission.

In the past year, NASA, the world's space exploration leader, and ISRO, which had never before sent a craft to Mars, had been exploring the possibility of partnering, but the decision was put on hold to see how things played out for India. India's success was enough for NASA to invite ISRO into a club of Mars explorers that also includes the European Space Agency and the Russian Federal Space Agency.

On Sept. 30, NASA Director Charles F. Bolden Jr. and ISRO Chairman K. Radhakrishnan formalized a NASA-ISRO Mars Working Group. They also announced a collaborative project, the NASA-ISRO Synthetic Aperture Radar (NISAR) mission. Scheduled to launch in 2020, NISAR will orbit Earth, measuring the movements of surfaces such as ice and land.

"The signing of these two documents reflects the strong commitment NASA and ISRO have to advancing science and improving life on Earth," Bolden said. "This partnership will yield tangible benefits to both our countries and the world."

ISRO



FIRST SHOT MOM's camera snapped this picture of Mars as the spacecraft began its orbit around the Red Planet.

Though MOM was designed primarily as a vehicle to test ISRO's ability to send a craft to orbit Mars, it carries five instruments, including a camera, infrared imaging spectrometer, and methane sensor. It is scheduled to spend 300 days making measurements.

Three days before MOM entered into Mars orbit, NASA's *Mars Atmosphere & Volatile EvolutioN* (*MAVEN*) spacecraft also reached Mars, to begin a mission to study the planet's upper atmosphere.

Much has been made of the fact that the ISRO mission is so inexpensive. By comparison, the MAVEN mission's price tag is approximately $671 million.

The two missions have vastly different goals, and the spacecraft are also very different, says Bruce M. Jakosky, principal investigator for the MAVEN mission and geological sciences professor at the University of Colorado, Boulder. For example, *MAVEN*'s payload is four times as large as MOM's, and the NASA craft is performing more complex maneuvers, which require more fuel.

However, the missions potentially overlap. The agencies are still in the early stages of planning their collaboration, but Jakosky notes that both craft are carrying Lyman-α photometers that will measure the structure of the extended corona—data that are relevant to understanding how hydrogen escapes from Mars's atmosphere.

MAVEN will be studying the upper portion of the corona; MOM will be making the same observations but at a lower altitude. It would then be ideal to combine the two data sets, which should yield a more complete picture, Jakosky says. Merging data from the two spacecraft will "require some effort but hopefully not a lot," Jakosky says.

ISRO has launched more than 70 spacecraft in the past 40 years, including Earth- and moon-orbiting satellites. ■

"This partnership will yield tangible benefits to both our countries and the world."

A CONFOUNDING CRYSTAL FORM

Researchers identify CARBONIC ACID'S α POLYMORPH as the compound's monomethyl ester

JYLLIAN KEMSLEY, C&EN WEST COAST NEWS BUREAU

CARBONIC ACID, H_2CO_3, is a key molecule in both biology and geology. In your body, it plays an intermediate role in transporting carbon dioxide, and the equilibrium between carbonic acid and bicarbonate buffers your blood to keep it at about pH 7.4. In the environment, CO_2 taken up by water forms carbonic acid, which is then responsible for dissolution of carbonate minerals and ocean acidification. Astrochemists expect that carbonic acid exists in solar system ices, such as those on Mars, and in interstellar regions.

But despite being ubiquitous, carbonic acid has been difficult to study as a pure substance because it readily dissociates into CO_2 and H_2O. Researchers in the 1990s identified two crystalline polymorphs, christened the α and β forms, thought to differ by how the molecules hydrogen bond to each other. The substances, however, eluded precise structural determination. Now, new infrared spectra of carbonic acid trapped from the gas phase demonstrate that so-called α-H_2CO_3 is likely the monomethyl ester, or methyl hydrogen carbonate, CH_3OCO_2H (*Angew. Chem. Int. Ed.* 2014, DOI: 10.1002/anie.201406969)

These results will help researchers monitor carbonic acid and understand its roles in the chemistry of Earth's atmosphere and interstellar space, says Markku Räsänen, a chemistry professor at Finland's University of Helsinki. The findings also show "the power of the combination of computational and matrix isolation spectroscopy in finding essential species," Räsänen adds, noting that he has also tried—unsuccessfully—to make carbonic acid.

"The work highlights that it's very, very important to avoid misidentification by doing experiments under well-defined and clean conditions to avoid artifacts," adds Ralf I. Kaiser, a chemistry professor at the University of Hawaii, Manoa, who has also worked on carbonic acid.

PREVIOUSLY, β-H_2CO_3 was typically prepared by irradiating cryogenic ice mixtures of CO_2 and H_2O or by protonating bicarbonate or carbonate in aqueous solution also under cryogenic conditions. α-H_2CO_3 was prepared via protonation in methanolic solution. But studies of α- and β-H_2CO_3 in which the substances were sublimated and then trapped in a noble-gas matrix

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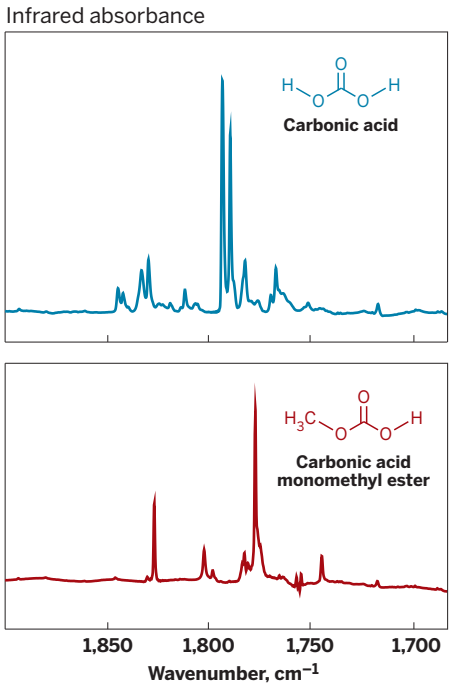
showed differences in the IR spectra of molecules from the two materials (*J. Am. Chem. Soc.* 2013, DOI: 10.1021/ja4020925). That work was done by a team in Austria led by graduate student Jürgen Bernard and chemistry professor Thomas Loerting of the University of Innsbruck and Hinrich Grothe of Vienna University of Technology. The researchers also asserted that α-H_2CO_3 sublimes and recrystallizes as α while β-H_2CO_3 sublimes and recrystallizes as β.

Those results piqued the interest of Peter R. Schreiner, a professor of chemistry at Justus Liebig University, in Giessen, Germany. "You'd expect the infrared spectra of two polymorphs to be identical, yet they show two different carbonyl absorptions," Schreiner says. "And then, if they're condensed in the same way, they should wind up in the same form. When I saw this paper, I said that we have to get on this, we have to make carbonic acid in an independent way."

Schreiner, senior scientist Hans Peter Reisenauer, and graduate student J. Philipp Wagner designed an approach to prepare carbonic acid through pyrolysis of alkyl carbonates followed by trapping the products in a noble-gas matrix for spectroscopic study. The researchers found that the IR spectrum of carbonic acid prepared through pyrolysis matched that of β-H_2CO_3. They could only reproduce the spectrum of α-H_2CO_3, however, by pyrolysis of *tert*-butyl methyl carbonate to form CH_3OCO_2H.

Loerting agrees that IR spectra indicate the presence of a methyl group in both his group's α-H_2CO_3 and the pyrolysis samples. Bernard's thesis, published earlier this year, also acknowledges the possibility of the monomethyl ester. But Loerting questions whether the monomethyl ester is the primary product or a side product. For a definitive answer, he would like to see mass spectrometry experiments show CH_3OCO_2H in solid α samples, but he acknowledges the difficulty of such studies, because both species tend to fragment upon ionization. ■

BANDS DEFINED The infrared spectra of carbonic acid and its monomethyl ester differ in the carbonyl region (1,750–1,800 cm^{-1}).



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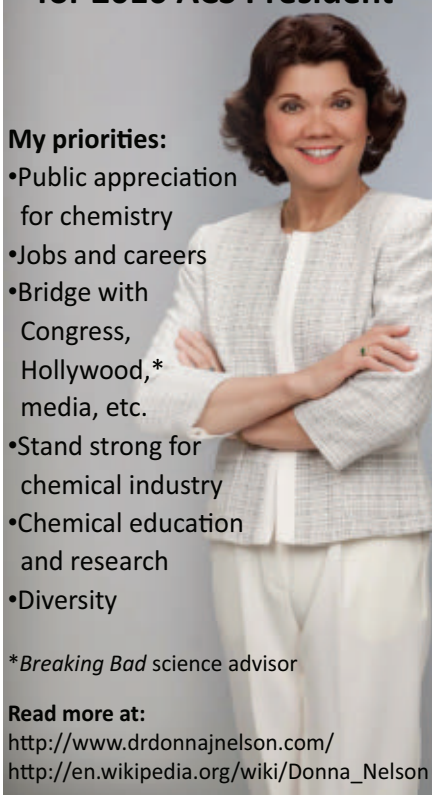
Donna J. Nelson, Ph.D. for 2016 ACS President



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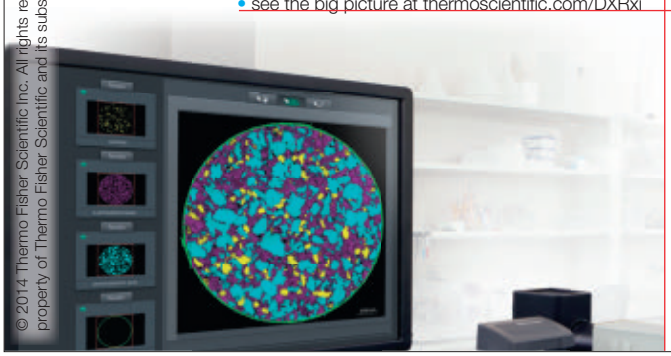

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Science And Human Rights: A Call To Action

DOROTHY J. PHILLIPS, DIRECTOR-AT-LARGE, ACS BOARD OF DIRECTORS, AND LIAISON FOR ACS SCIENCE & HUMAN RIGHTS INITIATIVES

THINK OF ALL of the reasons you became a scientist. Although the prospect of an exciting and rewarding career was likely one of the primary motivations, did you also consider how human rights could play a part in your work? Did you know that it already does?

As a member of the American Chemical Society, you are already supporting the society's work at the intersection of science and human rights. Our efforts—which include writing letters to key government stakeholders and visiting at-risk scientists in their home countries—have long been a model in the scientific community. In fact, the society has been involved in dozens of cases of persecuted chemists, chemical engineers, and related scientists since the early 1980s.

PORTRAIT SIMPLE

When you practice science, your work is tied to the progress of humanity and the general betterment of the quality of life for all.

A current case that ACS is closely monitoring is that of professor Kemal Gürüz, a chemical engineer and former president of the Turkish Council of Higher Education. Professor Gürüz was originally jailed in 2012 as part of the Ergenekon conspiracy, which targeted academics, journalists, and other individuals as members in a fabricated coup against the Turkish government.

In addition to sending letters to officials in both the U.S. and Turkey, ACS brought the case to the attention of the U.S. Department of State. This meeting had a meaningful outcome: the inclusion of Gürüz's case in the Turkey section of the "2013 Country Reports on Human Rights Practices," published by the Department of State.

As a result of this and other efforts, Gürüz has been released from prison pending the appeal of his case. Bradley Miller, director of the ACS Office of International Activities, connected with Gürüz this August while in Turkey to inquire about his welfare and the status of his case. Gürüz still faces challenges and expressed his gratitude for the efforts of ACS and its members.

ACS is also a founding member of the American Association for the Advancement of Science (AAAS) Science & Human Rights Coalition. The coalition brings together participants from a variety of organizations that recognize the role that scientists and engineers can play in human rights. ACS sends representatives to the biannual meetings of the coalition and contributes to many of its efforts. As an example, ACS helped produce a primer on scientific freedom and human rights to help guide scientific and engineering societies on how to begin addressing human rights issues within their respective disciplines.

ACS will step up its support of science and human rights with a symposium on this topic at the spring 2015 ACS national meeting in Denver. Also in Denver, during the open session of the ACS Board of Directors meeting, the board will honor the 2013 Nobel Peace Prize recipient, the Organisation for the Prohibition of Chemical Weapons, for its work to find peaceful applications of chemical sciences worldwide (C&EN, Aug. 25, page 21).

Although ACS is proud of its long history of assisting chemists and allied scientists in distress, one area that could use improvement is member engagement with human rights issues. To that end, please consider this a call to action.

Are you a chemistry teacher? I invite you to think of ways to incorporate human rights into your lesson plans.

Are you a researcher? Explore the possibility of assisting human rights organizations that need technical expertise by becoming an on-call scientist for AAAS.

Student? ACS has exciting plans to work with human rights organizations such as Amnesty International that would help you to engage.

IT'S IMPORTANT to emphasize that there is no need to reinvent the wheel when you become involved in ACS science and human rights initiatives. A number of mechanisms are already in place for ACS members, including participating in our webinar series, following the science and human rights section of *Global Chemistry* (ACS's international e-newsletter), and attending related symposia at ACS national meetings. There are also opportunities through signing petitions as well as incorporating the tenets of human rights into your work.

If you need inspiration, or if you already have the passion for science and human rights but need guidance on where to begin, please feel free to reach out to Miller or Lori Brown in the ACS Office of International Activities to see what you can do. Additionally, if you have ideas or initiatives that involve chemistry and human rights, the office might be able to assist you in developing them. You can contact the office at intlacts@acs.org. I also encourage you to visit the ACS webpage dedicated to this topic: www.acs.org/scienceandhumanrights.

When you practice science, your work is tied to the progress of humanity and the general betterment of the quality of life for all. Providing access to science and its benefits, as well as ensuring the freedom for scientists to pursue their work, is where chemistry and human rights meet. Now that you know ACS has a direct connection to human rights work, I encourage you to see how you can get more involved in this area of the society.

Views expressed on this page are those of the author and not necessarily those of ACS.

2014 MIDWEST REGIONAL MEETING

THE UNIVERSITY OF MISSOURI Section will host the 49th Midwest Regional Meeting of the American Chemical Society (MWRM 2014) at the Memorial Union on the University of Missouri (MU) campus, in Columbia, from Wednesday, Nov. 12, through Saturday, Nov. 15.

The general chair of the meeting is Michael Greenlief and the program chair is Timothy Glass, both of MU. Please visit the MWRM 2014 website, mwrm2014.org, for evolving program details as well as registration and hotel information.

TECHNICAL PROGRAM. The technical program will include more than 500 presentations.

The meeting will begin on Wednesday evening with an opening Sci-Mix poster session and reception.

The meeting will include general oral sessions in analytical, inorganic, organic and medicinal, physical, and polymer chemistry; biochemistry; chemical education; and materials science, along with poster sessions throughout the day on Thursday and Friday.

A number of symposia are scheduled. These include "Chemical Education," "Chemistry Outreach Programs & Activities," "Computational Chemistry," "Green Nanochemistry," "Inorganic Radiochemistry," "Mass Spectrometry & Targeted Proteomics," "Organic Synthesis in the Southeastern Conference (SEC)," "Policy & Science Communication," and "Supramolecular Chemistry."

The University of Iowa's Vicki H. Grassian—winner of this year's Midwest Award, sponsored by the St. Louis Section—will present the Midwest Award address on Thursday afternoon.

WORKSHOPS. Three different workshops are scheduled for Friday. "Essential Information & Training for the Chemical Hygiene Officer" is planned as an all-day event. ACS Career Services will offer "Finding Your Pathway" in the morning and "Résumé Review" in the afternoon. See the meeting website to find more details about these workshops and to register; please note that space may be limited.

Saturday's workshop and program will focus on high school chemistry teachers. Donna Malkmus of St. Charles, Mo., this year's recipient of the ACS Division of Chemical Education Midwest Region Award for Excellence in High School Teaching, will give a presentation. And a session featuring Craig T. Gabler and Joseph Krajcik, who are both part of the writing team for the Next Generation Science Standards, will include a discussion of national science education standards.

SOCIAL EVENTS. Several social events are planned for MWRM 2014. An opening social and Sci-Mix session will take place on Wednesday evening. Thursday evening will include the awards social hour followed by the awards banquet at Reynolds Alumni Center on the MU campus. Friday will feature an ice cream social with ACS governance.

EXHIBITS. The vendor exhibition show will open on Wednesday evening with the Sci-Mix social. The show will also be open from 9 AM to 5 PM on Thursday and 9 AM to noon on Friday. It will be held in Stotler Lounge in the Memorial Union. The exhibition area will include poster sessions. Coffee breaks will be held in the lounge Thursday morning and afternoon and again on Friday morning.

Sponsorships of meeting sessions, coffee breaks, and social events are available for purchase to financially support MWRM 2014. To reserve exhibit space or to obtain further information on sponsorships, visit mwrm2014.org and click on the "Exhibition" tab.

LODGING & TRAVEL. A block of rooms is being held at the Stoney Creek Hotel & Conference Center in Columbia for conference attendees. Please identify yourself as an ACS member when making your reservation so you can obtain the reduced conference rate.

Columbia is located in the middle of Missouri. It is about halfway between Kansas City and St. Louis along I-70. The Columbia Regional Airport is located 12 miles from both MU and the Stoney Creek Hotel. Rental cars and taxis are available at the airport.

More information on lodging, directions, and parking can be found on the meeting website.

REGISTRATION. Registration is available through the MWRM 2014 website. Advance registration at a discounted rate ends at 11:59 PM CDT on Oct. 21; however, online registration will remain open at the on-site registration rate until Nov. 5. After that date, participants must register on-site.

On-site registration will take place in the Memorial Union from 6 to 9 PM on Wednesday, Nov. 12; from 7:30 AM to 5 PM on Thursday, Nov. 13, and Friday, Nov. 14; and from 7:30 to 10 AM on Saturday, Nov. 15. ■

WIKIMEDIA COMMONS

STRIKING SETTING MWRM will be held at the University of Missouri, Columbia.

MWRM 2014 At A Glance

Dates: Nov. 12–15

Location: Memorial Union, University of Missouri, Columbia

Information contacts: Michael Greenlief, general chair, greenliefm@missouri.edu; Timothy Glass, program chair, glasst@missouri.edu; and Kimberly Savage, regional meeting planner, ACS, k_savage@acs.org

Website: mwrm2014.org

2014 SOUTHWEST REGIONAL MEETING

COWBOYS, CULTURE, and chemistry—Fort Worth will bring the best of the West and more to the American Chemical Society's Southwest Regional Meeting (SWRM 2014).

Join the society's Dallas-Fort Worth Section on Wednesday, Nov. 19, through Saturday, Nov. 22, at the Worthington Renaissance Fort Worth Hotel for the meeting. Whether you're in academia, industry, or a nontraditional chemistry job, or you're in transition, SWRM 2014 has something for you. Details can be found at the meeting website, swrm2014.org.

TECHNICAL PROGRAM. One of the highlights of the meeting will be a keynote symposium on Thursday. Speakers from several federal agencies, including the Department of Agriculture, the Environmental Protection Agency, and the National Aeronautics & Space Administration, will discuss innovation and the intersections between the federal labs, academia, and industry.

If environmental topics pique your interest, you can attend SWRM 2014's entire day of programming focused on sustainability, climate change, and water purification.

And if you're interested in starting a business, growing your business, or even selling your business, you'll gain plenty of insight at SWRM 2014, where experts in financing, patenting, and other areas of business will be presenting. In addition, a pro bono patent assistance panel on Wednesday will offer tips on where independent inventors can gain patent assistance when they may not otherwise be able to afford it.

Abstracts are being accepted for symposia including, but not limited to, "Biochemistry, Cell Signaling & Drug Discovery"; "Bioinorganic Chemistry"; "Chemical Education"; "Computational Chemistry"; "Functional Polymers: Synthesis, Characterization & Applications"; "Main-Group Chemistry"; "Natural Product Discovery & Biosynthesis"; "New Advances in Mass Spectroscopy Research"; "New Methods in Forensic Chemistry"; and "Women in Chemistry." General session submissions are also being accepted. The deadline to submit an abstract through the ACS Program & Abstract Creation System (abstracts.acs.org) is Oct. 17.

Other opportunities to present research will include the general poster sessions and the undergraduate poster session.

WORKSHOPS. If you're interested in safety issues, the meeting will offer a workshop on Wednesday on "Essential Information & Training for the Chemical Hygiene Officer." It will cover relevant regulatory requirements as well as best management practices and the development of chemical hygiene plans. It will also cover essential resource materials, fundamental risk assessment and management, fundamental exposure assessment, and basic emergency response.

For graduate students and postdocs, the "Preparing for Life After Graduate School" workshop on Thursday and Friday will serve as an opportunity to learn about various career options and how to prepare for them. In addition to the workshop, two expert consultants will be available on Friday and Saturday for students to schedule one-on-one résumé and curriculum vitae reviews.

SWRM 2014 also will offer the ACS career workshop "Finding Your Pathway" on Thursday morning. This workshop is ideal not only for graduate and undergraduate students but also recent grads and experienced professionals considering a career change.

UNDERGRADUATE PROGRAMMING. If you're considering what to do after you complete your undergraduate degree, SWRM 2014 has programming that could provide you with some guidance. Various sessions on career path options will be available, including the "Finding Your Pathway" workshop and a graduate school fair that will take place on Friday evening. Applications for schools that want to participate in the fair can be found on the meeting website. Undergraduates can also participate in an undergraduate ice cream social on Friday between the undergraduate poster session and the graduate school fair.

EXPOSITION. A reception on Wednesday evening will help kick off the exposition, which will run through Friday. The expo will offer a great opportunity to learn about the latest products on the market. Applications for exhibitors are available on the meeting's website.

AWARDS. Several awards will be presented at the meeting. These include the Stanley C. Israel Regional Award for Advancing Diversity in the Chemical Sciences, the ACS Division of Chemical Education Southwest Region Award for Excellence in High School Teaching, the E. Ann Nalley Regional Award for Volunteer Service to ACS, and the Southwest Regional ACS Award. The awards luncheon will take place on Friday.

SOCIAL EVENTS. Among the social highlights of SWRM 2014 will be a gala reception on Thursday evening, sponsored by intellectual property law firm Klemchuk Kubasta LLP. At the event, you'll mingle with fellow attendees and enjoy a taste of the West. Participants are also invited to attend the Women Chemists Luncheon on Thursday. And a new social event called Networking Dine Around will take place in the evening on Wednesday and Friday. Attendees can sign up to join other attendees at local restaurants, network with one another, and experience all that Fort Worth has to offer.

SWRM 2014 At A Glance

Dates: Nov. 19–22

Location: Worthington Renaissance Fort Worth Hotel, Fort Worth

Information contacts: Kirby Drake, general chair, kirby.drake@kk-llp.com; Beatriz Rios-McKee, program chair, berios@smu.edu; Michelle Stevenson, ACS Department of Meetings & Exposition Services, m_stevenson@acs.org

Website: swrm2014.org

LODGING & REGISTRATION. Early-bird registration for the meeting ends at 11:59 PM CDT on Oct. 31, but you can register at the on-site rate through the end of the meeting. However, your opportunity to reserve a room at a reduced rate at the beautiful Worthington Renaissance Fort Worth Hotel—which is in the middle of downtown Fort Worth on Sundance Square—ends at 11:59 PM CDT on Oct. 28. ■

MICHELLE POWELL/NOVO NORDISK

FAMILY FRIENDLY Novo Nordisk employees and their families participate in the Juvenile Diabetes Research Foundation Walk to Cure Diabetes.

COMPANIES THAT CARE

Three **TOP FIRMS** with ties to chemistry prove that large doesn't have to mean impersonal

LAURA CASSIDAY, CONTRIBUTING EDITOR

WHO SAYS BIG companies are cold, heartless behemoths, where employees are numbers and every decision is based on the bottom line? The three companies highlighted in this year's C&EN profile of top companies for chemists are out to dispel this perception. Although large, these companies foster collaboration and the building of communities within the larger corporate community, making every employee feel like a valued member of a team striving for a common goal. The companies recognize that employees are more than just their job titles, giving them the flexibility to fulfill personal as well as professional obligations.

C&EN has selected three companies—Genentech, Novo Nordisk, and AstraZeneca—from chemistry-related firms that made *Fortune*'s "100 Best Companies to Work For" or *Working Mother*'s "100 Best Companies" in 2014. Because they are large, each of these companies offers many job opportunities for chemists. Like other companies on these two lists, they aim to attract and retain bright, passionate scientists by offering stimulating work environments and excellent benefits packages.

GENENTECH, a biotech company with headquarters in South San Francisco, is a perennial favorite of "top companies" lists, making both the *Fortune* and *Working Mother* lists for the 16th time in 2014. Genentech was founded in 1976 by venture capitalist Robert A. Swanson and biochemist Herbert W. Boyer, a pioneer in the field of recombinant DNA technology.

The firm, which became a subsidiary of Roche in 2009, now has 35 medicines on the market and 44 therapies in the pipeline for the treatment of conditions as diverse as cancer and schizophrenia.

Genentech has about 12,000 employees, with 1,200 scientists (bachelor's, master's, and Ph.D. degrees) and 100 postdocs in the research and early-development arm of the organization. Additional opportunities exist for chemists in technical operations such as drug manufacturing and quality control.

For Mary Cromwell, a biophysical chemist, the opportunity to merge her interests in biology and physical chemistry was what initially attracted her to the pharmaceutical research and development group at Genentech. "When you're a biophysical chemist, you're interested in a lot of scientific disciplines," she says. "I read a job de-

scription that looked like it fit my interests perfectly. I was intrigued that there was a company doing this kind of work, where I could take what I had learned in grad school and apply it to a real-life situation."

Now, 25 years later, Cromwell works in a management role as head of global biomanufacturing sciences and technology and packaging development. Throughout her career at Genentech, she has enjoyed the cross-disciplinary approach of the company. "I've worked with biologists, engineers, organic chemists, physical chemists, analytical chemists, even food chemists," she says. "At Genentech, we look across various disciplines and maybe even other industries for the expertise that we need." Cromwell notes that one of her current group members came from the paint industry, where he had expertise in materials science that was relevant to product packaging.

Although the biotech company encourages teamwork, each member of the team is "highly self-motivated," Cromwell says. "The people tend to want to solve puzzles on their own, not because somebody's asking them to solve a problem." Micromanagement by supervisors "doesn't go over well," she laughs.

In addition to the scientific stimulation, Genentech's benefits package "plays a key role in attracting and retaining talent," says Nadine Pinell, senior manager of external communications. "Genentech is recognized for providing our employees with some of the most competitive and comprehensive benefits in the country. Our benefits and programs are convenient and easy to use so that employees can focus on the science and the patients."

The package includes family-friendly benefits, such as on-site child care. Seventy-five percent of employees use a flextime schedule, and 50% telecommute. Opportunities for job sharing also exist. Although Cromwell's children are now grown, she remembers how helpful these benefits were to her family. "I attended many meetings via teleconference so that I could take care of my kids' needs," she says. "There was a lot of flexibility about how I could meet the demands of my work schedule while also meeting the demands of being a mother."

The company also offers activities and groups to build camaraderie among employees and connect those with similar interests. Some groups, such as a biking club, are recreational, whereas others foster professional or personal development. For example, a group called NextGen, primarily for younger people entering the workforce, offers professional development seminars, mentoring and leadership programs, and networking opportunities.

Each year during Genentech Gives Back Week, employees have the opportunity to raise money for charities and volunteer with local and national nonprofit groups of their choice during working hours. In 2014, 5,300 employees volunteered for more than 250 community projects and raised more than $236,000 for local charities.

NOVO NORDISK, the world's largest diabetes care company and leading producer of insulin, traces its roots back to Denmark in the 1920s. In 1923, August Krogh, a Nobel Prize-winning professor at the University of Copenhagen, decided to start producing a revolutionary new medicine called insulin. Inspired by his wife's type 2 diabetes, a condition often fatal at the time, Krogh founded Nordisk Insulinlaboratorium. The firm initially extracted insulin from bovine pancreas, then pig pancreas, and in 1987 began producing the human hormone from genetically engineered yeast cells. In 1989, Nordisk merged with a competing Danish firm established in 1925, Novo Terapeutisk Laboratorium, to create Novo Nordisk.

In addition to selling modern long-lasting insulin and other diabetes drugs, Novo Nordisk markets glucose-monitoring devices and insulin injection pens and pumps. It also offers products for growth hormone therapy, hormone replacement therapy, and hemophilia treatment. Novo Nordisk currently has 31 products on the market, with 17 drugs in the pipeline.

The company's world headquarters are in Bagsværd, Denmark, and its 40,700 employees work in 75 countries. U.S. headquarters are in Plainsboro, N.J., with a R&D center in Seattle and an insulin production facility in Clayton, N.C. Total U.S. employees number 5,143.

With a company so large and diverse, establishing a global company culture seems daunting, if not impossible. To help meet this challenge, management has issued a booklet called "The Novo Nordisk Way," which is intended to guide the decisions and actions of employees. Essential to the Novo Nordisk way is the triple bottom line,

STANDOUTS

Top Chemistry-Related Companies To Work For

100 BEST COMPANIES TO WORK FOR (*FORTUNE,* JAN. 16, 2014)

6. Genentech, South San Francisco
22. W. L. Gore & Associates, Newark, Del.
26. NuStar Energy, San Antonio
30. St. Jude Children's Research Hospital, Memphis
42. Stryker, Kalamazoo, Mich.
51. Chesapeake Energy, Oklahoma City
53. Mayo Clinic, Rochester, Minn.
56. Devon Energy, Oklahoma City
64. General Mills, Minneapolis
68. Roche Diagnostics, Indianapolis
72. Novo Nordisk, Plainsboro, N.J.
76. Mars, McLean, Va.
97. EOG Resources, Houston

100 BEST COMPANIES FOR WORKING MOTHERS (*WORKING MOTHER,* SEPT. 16, 2014)

Abbott, Abbott Park, Ill.
AbbVie, North Chicago
AstraZeneca, Wilmington, Del.
Boehringer Ingelheim USA, Ridgefield, Conn.
Bristol-Myers Squibb, New York City
Colgate-Palmolive, New York City
Dow Corning, Midland, Mich.
DuPont, Wilmington, Del.
Eli Lilly & Co., Indianapolis
General Electric, Fairfield, Conn.
Genentech, South San Francisco
General Mills, Minneapolis
Johnson & Johnson, New Brunswick, N.J.
Kellogg, Battle Creek, Mich.
Merck & Co., Whitehouse Station, N.J.
Novartis Pharmaceuticals, East Hanover, N.J.
Procter & Gamble, Cincinnati
Roche Diagnostics, Indianapolis
S. C. Johnson, Racine, Wis.
Takeda, Deerfield, Ill.
Yale University, New Haven
Zoetis, Florham Park, N.J.

which involves balancing financial, social, and environmental considerations. Facilitators conduct visits to company sites to highlight best practices, as well as identify areas that need improvement.

Raymond Couch is a quality-control chemist at the Novo Nordisk production facility in Clayton. He analyzes the stability and other parameters of insulin manufactured at the plant, and he also helps calibrate the high-performance liquid chromatography systems. "The quality-control department is very well organized and utilizes a standard [that is] set across the whole company," says Couch. "Process improvement is a daily thought."

Couch says that the reputation and stability of the company are what attracted him to Novo Nordisk, which he describes as a family-friendly workplace. "The facility is recognized for its parental leave—which includes fathers—and the promotion of family-focused activities such as the Juvenile Diabetes Research Foundation Walk to Cure Diabetes, the American Diabetes Association Tour de Cure family bicycle ride, and occasional family fun days," he says.

According to Anthony Daniels, human resources business partner at Novo Nordisk, the North Carolina facility currently employs 10 chemists, with a new chemist position added about once a year. "We typically look for candidates with a B.S. or M.S. in chemistry or microbiology," Daniels says. "Strong analytical skills, good manufacturing practices, process improvement skills, and team collaboration are all important."

The Novo Nordisk research site in Seattle includes a type 1 diabetes R&D center and a newly forming obesity research unit, announced late last month. The obesity research unit will initially employ 10 people, growing to an estimated 60 employees by the end of 2016. It will be headed by Kevin Grove, an expert in endocrinology and obesity at Oregon Health & Science University.

Like Genentech, Novo Nordisk provides opportunities for employees to volunteer for causes they care about during working hours. The TakeAction employee volunteer program coordinates efforts such as raising money for summer camps for children with diabetes and hemophilia, building homes for Habitat for Humanity, and cleaning up the Gulf after the Deepwater Horizon spill.

The company's benefits package includes flextime, job sharing, an on-site fitness center, in-home backup care for dependents and ill family members, and adoption assistance. In addition, Novo Nordisk automatically contributes 8% of employees' salaries to their 401(k) plans and pays 95% of health insurance premiums. A program called College Coach helps employees plan and save for their children's college tuition.

All of these aspects contribute to making Novo Nordisk an enjoyable place to work, Couch says. In addition, he appreciates the company's culture of supportiveness. "All jobs are stressful at times," he says. "However, everyone at Novo Nordisk is always willing to help."

ASTRAZENECA, like Novo Nordisk, is a global pharmaceutical company, operating in more than 100 countries and employing 51,500 people worldwide (including 9,000 in R&D). The firm was created in 1999 through the merger of a Swedish pharmaceutical group, Astra, and a British company, Zeneca Group. Today, it focuses on developing medicines to treat three major areas: cardiovascular and metabolic disease, oncology, and respiratory and autoimmunity disease and inflammation.

AstraZeneca currently has 43 medicines on the U.S. market, with 99 pipeline projects listed in its 2013 annual report. The company, with U.S. headquarters in Wilmington, Del., develops both small-molecule and biologic therapies.

"All jobs are stressful at times."

In 2013, the company announced a restructuring, which will concentrate R&D operations at three strategic centers: Cambridge, England; Gaithersburg, Md.; and Mölndal, Sweden. As AstraZeneca's primary location for biologics R&D in the U.S., the Gaithersburg site currently employs about 2,000 people. The company also has research centers in California and Massachusetts.

Dean Brown, director of infection chemistry for AstraZeneca, leads a medicinal chemistry team at the company's Waltham, Mass., research center that strives to find new treatments for drug-resistant bacterial infections and respiratory viral infections. Brown's team identifies and optimizes test compounds that are evaluated for biological effects and druglike properties.

From Brown's perspective, the company's culture and science make AstraZeneca a great place to work. "I am surrounded by phenomenal scientists who are eager to collaborate," he says. "I love being able to walk down the hall and brainstorm an idea with a chemist, biologist, or drug development scientist." Brown says that researchers are encouraged to bring their ideas to the table in an environment where all contributions are valued.

"I knew that at AstraZeneca I would have a tremendous opportunity to be mentored by some of the best experts in the field of medicinal chemistry," Brown says.

The company recruits across various areas of chemistry expertise, including synthetic, medicinal, analytical, and computational chemistry, as well as biochemistry, chemical engineering, and biochemical engineering. Opportunities exist for education levels ranging from B.S. to Ph.D. AstraZeneca also offers a postdoctoral training program. "Each postdoctoral scientist receives a tailored training and development program," says Linette Grey, human resources partner at AstraZeneca. "This includes core training on drug discovery and development, as well as on key skills such as presentation delivery and publication writing."

Like Genentech and Novo Nordisk, AstraZeneca offers policies and programs to help employees maintain a healthy work-life balance. Sixty-six percent of U.S. employees use a flextime schedule, and 80% have the opportunity to telecommute on occasion. Unlike some workplaces where such practices, while allowed, are frowned upon by supervisors, at AstraZeneca "senior leaders serve as role models, taking advantage of the resources and benefits the company makes available and encouraging all employees to do so as well," Brown says.

The company also offers family-friendly benefits like on-site child care, summer day camp, and backup dependent care. A free coaching service helps employees' children select colleges, complete essays and interviews, and apply for financial aid. Networking groups, such as groups for women, caregivers, working parents, mature workers, and adoptive parents, help employees connect with each other. And the AstraZeneca Nobel Medicine Initiative brings Nobel Laureates within the fields of physiology and medicine to research centers to present lectures to employees and members of the local community.

For Brown, the vibrant, collaborative culture at AstraZeneca makes for an exciting workplace. "It's an incredible feeling to watch a new idea leap beyond the team's wildest expectations and grow into something really significant," Brown says. "Having been part of that, I can tell you that it's highly contagious and makes you want to try to do it again." ■

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http://chemistryjobs.acs.org/profiles/808472/shenzhenuniversity

ACADEMIC POSITION

THE CHEMISTRY DEPARTMENT of Johns Hopkins University, Baltimore, Maryland (www.chemistry.jhu.edu) invites applications for a faculty position in the general area of theoretical chemistry. The search will focus on Assistant Professor candidates from entry level to candidates who would be considered for tenure in the near term. The position has an anticipated starting date of July 1, 2015. Applicants should submit a curriculum vita, a teaching statement, and description of research plans, and arrange to have three letters of recommendation submitted through Interfolio. Please apply at **http://apply.interfolio.com/26935.** Consideration of applications will begin on November 1, 2014, and will continue until the position is filled. Johns Hopkins University is an Affirmative Action/Equal Opportunity employer and actively encourages interest from minorities and women.

ACADEMIC POSITIONS

FACULTY POSITIONS IN THE DEPARTMENT OF CHEMICAL ENGINEERING

Columbia Engineering is pleased to invite applications for faculty positions in the Department of Chemical Engineering at **Columbia University** in the City of **New York.** Applications at the Assistant professor, and in exceptional cases, at the Associate professor and Full professor levels, will be considered.

Applications are specifically sought in the areas of Systems/Synthetic Biology and Materials Discovery. Candidates must have a Ph.D. or its professional equivalent by the starting date of the appointment. Applicants for the position at the Assistant Professor and Associate Professor without tenure must demonstrate the potential to do pioneering research and to teach effectively. Applicants for this position at the tenured level (Associate or Full Professor) must have a demonstrated record of outstanding research accomplishments, excellent teaching credentials and established leadership in the field.

The successful candidate is expected to contribute to the advancement of their field and the department by developing an original and leading externally funded research program, and contributing to the undergraduate and graduate educational missions of the Department. Columbia fosters multidisciplinary research and encourages collaborations with academic departments and units across Columbia University. These positions particularly seek candidates whose research focus intersects with the field of data science and can take full advantage of the Institute for Data Science and Engineering at Columbia. The Department is especially interested in qualified candidates who can contribute, through their research, teaching, and/or service, to the diversity and excellence of the academic community.

For additional information and to apply, please see **http://engineering.columbia.edu/faculty-job-opportunities.** Applications should be submitted electronically and include the following: curriculum-vitae including a publication list, a description of research accomplishments, a statement of research and teaching interests and plans, contact information for three experts who can provide letters of recommendation, and up to three pre/reprints of scholarly work. All applications received by November 30, 2014, will receive full consideration.

Applicants can consult **www.cheme.columbia.edu** for more information about the department.

Columbia is an affirmative action/equal opportunity employer with a strong commitment to the quality of faculty life.

THE NEW MEXICO INSTITUTE of Mining and Technology (New Mexico Tech) seeks applicants for a tenure-track faculty position at the Assistant Professor level to start Spring 2015 or Fall 2015. Candidates with research interests and experience in the areas of explosives and energetic materials are preferred. Teaching experience at the undergraduate and graduate level in "explosives" chemistry is desired. This is a joint position involving the Department of Chemistry and the Energetic Materials Research and Testing Center (EMRTC) of New Mexico Tech.

The successful candidate will serve as a faculty member in the Department of Chemistry and will have access to the world-class laboratory and testing facilities of EMRTC, an internationally recognized facility with over 60 years of history in explosives research and testing.

The Department of Chemistry is home to M.S. and Ph.D. degree programs. Candidates are expected to develop an active, externally funded research program, leading to publications credited both to the Department of Chemistry and to EMRTC.

A Ph.D. in Chemistry or a related discipline is required, and postdoctoral experience is preferred. Applicants must submit a cover letter, resume, research plan, teaching philosophy, evidence of experience and/or interest in teaching General Chemistry, and three letters of reference to **Chemistry Search Committee, Human Resources, 801 Leroy Place, Box 099, New Mexico Tech, Socorro, NM 87801.** Application materials may also be submitted by e-mail to **jsalome@admin.nmt.edu.** The review of applications will begin on October 15, 2014, and will continue until the position is filled. New Mexico Tech is an equal opportunity employer.

ACADEMIC POSITIONS

ASSISTANT/ASSOCIATE PROFESSOR
Department of Chemistry
University of Miami

The Department of Chemistry in the College of Arts and Sciences at the **University of Miami** seeks applicants for a tenure-track appointment at the level of Assistant or Associate Professor starting in the 2015-16 academic year. Minimal qualifications include a Ph.D. in Chemistry and significant postdoctoral experience. To be considered at the Associate professor level, the candidate must have independent teaching and research experience. Preference will be given to candidates with strong research interests in the area of materials/energy. The successful candidate will be expected to teach at both undergraduate and graduate levels and to develop and/or maintain a nationally and internationally recognized research program. Applicants should forward electronic copies of their CV, research plans, and a statement of teaching philosophy, as well as arrange to have three letters of recommendation sent to **Chair of Search Committee, Department of Chemistry, Cox Science Center, Room #315, University of Miami, Coral Gables, FL 33146-0431.** All materials should be sent electronically to **chemistry@miami.edu** with Subject "Materials/Energy." Review of applications will begin November 17, 2014, and will continue until the position is filled. Information about the Department can be found at **http://www.as.miami.edu/chemistry/.** The University of Miami is an Equal Opportunity Employer — Females/Minorities/Protected Veterans/Individuals with Disabilities are encouraged to apply. Applicants and employees are protected from discrimination based on certain categories protected by Federal law.

FACULTY POSITION IN INORGANIC CHEMISTRY
Department of Chemistry
Syracuse University

The Department of Chemistry at **Syracuse University** invites applications for a tenure-track faculty position at the Assistant Professor level in inorganic chemistry with specialization in materials chemistry (broadly defined). The Department of Chemistry is located in the Syracuse University College of Arts & Sciences, an institution committed to exceptional core education in the liberal arts and excellence in research and scholarship. Successful candidates will have a PhD in Chemistry, postdoctoral experience, and the capability of establishing a high quality, externally funded research program. The candidate must also have a strong commitment to teaching excellence at both the undergraduate and graduate level.

Candidates must submit a full CV, a detailed research plan (up to 5 pages), a statement of teaching philosophy, and should arrange for at least three reference letters to be submitted. To apply, go to **www.sujobopps.com, job #071373.** Review of applications will begin November 17, 2014. Please direct questions to Professor **Mathew Maye (mmmaye@syr.edu).** Syracuse University is an ADVANCE institution, and is an AA/EOE employer fully committed to achieving a diverse workforce.

CLARKSON UNIVERSITY. The Department of Chemistry and Biomolecular Science invites applications for a **Full Professor faculty position**, with research expertise in the broadly defined materials/colloids/nanoscience areas, to start Fall 2015. Highly qualified candidates at the Associate Professor level may also be considered. The successful candidate will have a PhD, a demonstrated record of research excellence, and is expected to develop a vigorous, creative, externally funded research program that compliments that of current faculty and builds on departmental strengths. Teaching will be in support of the department's undergraduate programs in Chemistry and Biomolecular Science as well as the graduate MS and PhD programs. Review of applications will begin immediately and continue until position is filled. **Clarkson University** is **New York State's** highest ranked small research institution. Applications must be submitted through the web site, **www.clarkson.edu/hr** by clicking "Career Opportunities" on the left hand navigation bar. An equal opportunity/affirmative action employer, Clarkson University actively seeks and encourages applications from minorities, women and people with disabilities.

EAST TENNESSEE STATE UNIVERSITY (ETSU)— Department of Chemistry **(Johnson City, TN)** invites applications for two Analytical Chemist positions. Both positions are tenure-track positions to begin August 2015. Please visit **http://jobs.etsu.edu** to apply. ETSU is an AA/EEOE. Women and minorities are encouraged to apply.

ACADEMIC POSITIONS

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

THE DEPARTMENT OF CHEMICAL & BIOLOGICAL ENGINEERING, **University of Wisconsin-Madison** invites applications for two tenure-track/tenured faculty positions at the assistant, associate or full professor level. Successful candidates are expected to maintain world-class graduate research programs, participate in undergraduate and graduate instruction and engage in university service. Candidates with a Ph.D. and a strong background in chemical or biological engineering or related field with truly outstanding accomplishments in any area of research of importance to chemical and biological engineering will be considered. For more information, please visit **http://www.ohr.wisc.edu/WebListing/Unclassified/PVLSummary.aspx?pvl_num=80445.**

Apply online at **www.facsearch.cbe.wisc.edu.** Applications received by December 1, 2014, will receive full consideration. Women and candidates from groups traditionally underrepresented in engineering are strongly encouraged to apply.

ASSISTANT PROFESSOR
(Tenure-Track/Multiple Positions)
Cain Department of Chemical Engineering
College of Engineering
Louisiana State University

The Cain Department of Chemical Engineering at **Louisiana State University** is seeking to fill new tenure-track, Assistant Professor positions in the research areas of "Energy" and the "Environment", with a preferred start date of Fall 2015. We invite outstanding applicants with a doctoral degree in chemical engineering (or closely related field) from a recognized institution, and a proven record of academic accomplishment.
Required Qualifications: Ph.D. or equivalent degree in Chemical Engineering or related field; must be committed to excellence in research and undergraduate and graduate teaching. Salary will be commensurate with qualifications and experience. An offer of employment is contingent on a satisfactory pre-employment background check. Application deadline is January 1, 2015, or until candidates are selected. Apply online and view a more detailed ad at **www.lsusystemcareers.lsu.edu.** Position #multipleCHE.
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A POSTDOCTORAL POSITION is available starting January 1, 2015, in Department of Chemistry of the College of Arts and Sciences at **American University** in **Washington, D.C.** The qualified candidate will work predominantly with Dr. Douglas Fox's research group at the **NIST in Gaithersburg, MD,** on the flammability of materials. Applicants must have a PhD in chemistry or a related field and be qualified to work at a national laboratory. Preference will be given to those with prior experience in fire science or colloidal chemistry. Please submit applications via **http://apply.interfolio.com/26714.** Review of applications will begin November 1, 2014, and continue until the position is filled. American University is an Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability, or protected Veteran status.

ST. EDWARD'S UNIVERSITY invites applications for a tenure-track assistant professor position in analytical or inorganic chemistry to begin Fall 2015. A Ph.D. in Chemistry is required. Successful candidates will be expected to teach both introductory and upper division courses in either **analytical or inorganic** chemistry and establish a research program involving undergraduates. Located in **Austin, Texas,** St. Edward's University is a community that values diversity and different worldviews offering an academically challenging, globally informed education to a diverse student body. Application review will begin November 1, 2014. See full ad at **https://stedwards.applicantpro.com/jobs/142978.html.**

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NANYANG TECHNOLOGICAL UNIVERSITY

Faculty Positions at School of Chemical and Biomedical Engineering [SCBE]

The School of Chemical and Biomedical Engineering (**http://www.scbe.ntu.edu.sg**), Nanyang Technological University of Singapore invites applicants to apply for tenure-track faculty positions at the Associate/Assistant Professor level. Applicants should hold a Ph.D. in Chemical Engineering, Bioengineering, Biomedical Engineering, Food Science Technology and Engineering or a related field by the beginning of the appointment period. Candidates with post-doctoral training would be preferred.

The School is particularly interested in:

1) Chemical Engineering candidates with interests in Biochemical Engineering, Synthetic Biology, Food Engineering, Chemical Engineering Process, and Fluids and Colloids.
2) Bioengineering candidates with research interests in Biomaterials, Bioimaging, Biosensors, Biodevices, Bionanotechnologies, Tissue Engineering (musculoskeletal, neuron regeneration, etc), Rehabilitation Neuro-Biomechanics and Translational Biomedical Engineering.

The candidate should have a demonstrated excellence in original research, with good publication records and the ability to teach core Chemical/Food Engineering and Bioengineering courses. Entrepreneurial qualities are also sought after.

Responses received by 30th November 2014 would be given priority.

Emoluments and General Terms and Conditions of Service
The commencing salary will depend on the candidate's qualifications, experience and the level of appointment offered. Information on emoluments and general terms and conditions of service is available at: **http://www.ntu.edu.sg/ohr/CareerOpportunities/TermsandConditions/Pages/FacultyPositions.aspx**.

Application Procedure
Qualified candidates are invited to submit an application. Guidelines for Submitting an Application for Faculty Appointment are available at: **http://www.ntu.edu.sg/ohr/CareerOpportunities/SubmitanApplication/Pages/FacultyPositions.aspx**.
The post applied for should be clearly stated. Electronic submission of application is encouraged and can be forwarded to:

Chairman, Search Committee, School of Chemical and Biomedical Engineering
NANYANG TECHNOLOGICAL UNIVERSITY
E-mail: scbe_recruit@ntu.edu.sg

www.scbe.ntu.edu.sg

FACULTY POSITION
Chemistry
NYU ABU DHABI

New York University Abu Dhabi invites applications for a tenure track faculty position in inorganic chemistry, preferably with interests in materials science and solid state chemistry. Candidates with a strong background in energy and environmental science, electrical and magnetic characterization of materials, and catalysis are also welcome to apply. Candidates at all ranks will be considered, but applications from highly qualified candidates at the rank of Associate or Full Professor are encouraged. We are seeking individuals with a history of outstanding accomplishments in research and scholarship with an interest in teaching and guiding undergraduate research and advising graduate students.

Successful candidates will find a vibrant research and teaching environment that includes state-of-the-art facilities; a competitive startup package and employment terms; including housing and educational subsidies for children; and broad opportunities for collaborative research across the science and engineering areas at NYU Abu Dhabi and the NYU system. Successful candidates will have the opportunity to compete for research support from US funding agencies. The appointment begins September 1, 2015, but candidates may elect to start as late as September 1, 2016.

Applications are due by ***November 15, 2014****; applications received later will be reviewed until the position is filled.* We will consider senior candidates on a rolling basis. Candidates should submit a cover letter, curriculum vitae, statements of research and teaching interests, three representative publications, and three letters of reference in PDF format to be considered. See **http://nyuad.nyu.edu/en/about/careers/faculty-positions.html** for application instructions. Send questions to **nyuad.science@nyu.edu**.

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ACADEMIC POSITION

TENURE-TRACK ASSISTANT PROFESSOR IN MATERIALS CHEMISTRY

The Department of Chemistry of **The University of West Georgia (UWG) (http://www.westga.edu/chemistry/)** invites applications for a tenure-track position in Materials Chemistry at the rank of assistant professor that will begin August 2015. The applicant is expected to develop a rigorous undergraduate research program in materials development. Teaching responsibilities will include introductory and upper level undergraduate courses. A doctorate in materials chemistry or another closely related field is required. Review of applications will begin on October 20, 2014. To apply, e-mail a cover letter, CV, research plan, statement of teaching philosophy, and transcripts in a single PDF file to **Dr. Megumi Fujita (mfujita@westga.edu)** and have three letters of recommendation e-mailed. UWG is an equal opportunity employer.

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newscripts

REDEFINING A PLANET, RAT MASSAGE IS GOLDEN

DAVID A. AGUILAR

Planetlike: Pluto (left) and its moon Charon.

Once upon a time, a planet was one of the nine balls of rock or gas that orbited our sun. But then some astronomers started finding planetoids orbiting the sun between Mars and Jupiter and out beyond Neptune. And then they started finding what look like planets orbiting other suns throughout the galaxy.

These observations created a problem for the International Astronomical Union (IAU), which is in charge of naming things in space. Some scientists started splitting hairs over **WHAT CAN BE CALLED A PLANET,** going so far as to question whether Pluto still qualified. IAU thus tried to tackle the question at its 2006 annual meeting.

Alas, the astronomers couldn't come up with a definition that everyone could agree on. In the end, they voted and were left with this: A planet is a celestial body that is in orbit around the sun, is round or nearly round, and has cleared the neighborhood around its orbit.

But this definition remains unsatisfying. For one thing, it only applies to planets in our solar system. And it booted Pluto from the planet club, because it doesn't meet the last requirement. Pluto is now called a dwarf planet—an object the size of a planet but that is "neither a planet nor a moon or other natural satellite." So dwarf planets aren't real planets (even if a miniature schnauzer is still a dog).

However, the Harvard-Smithsonian Center for Astrophysics has come to Pluto's rescue. On Sept. 18, the center hosted a public debate among planetary science experts as to what a planet is or isn't. One scientist argued that "planet" is a culturally defined word that changes over time and that Pluto is a planet. Another defended the IAU definition. Others tendered different options. Then the audience got to vote.

The winning definition is that a planet is "the smallest spherical lump of matter that formed around stars or stellar remnants." Although that is perfectly vague, it unofficially brings Pluto back into the planetary family fold. IAU is being coy about considering a re-redefinition.

What can you learn from massaging baby rats? Answer: how to improve the health outcome for premature human babies. Research on the topic by Duke University neuroscientist Saul Schanberg and his team just received a **GOLDEN GOOSE AWARD.**

These awards are given by a consortium of scientific societies and nonprofit institutes to honor scientists whose taxpayer-funded research may not have seemed significant at the time it was carried out but resulted in a significant societal benefit. The award is a countermeasure to the Golden Fleece Award, given to call out wasteful federal spending.

In 1979, Schanberg and his group were studying an enzyme and a growth hormone that are biomarkers for fetal and newborn development. They had to separate rat babies from their moms and in doing so found that, although the babies were kept fed and warm, they did not thrive and the biomarker levels dropped.

SHUTTERSTOCK

Rat rub: Massaging babies does good.

To make a long story short, they noticed that rat moms spend a great deal of time grooming and licking their newborns. Wondering if the tactile attention was important, they started using a small brush to stroke the separated babies. That was the missing link—the enzyme and hormone levels rose and the kids turned out okay.

In the 1980s, neonatal specialists read about Schanberg's work and started trying it with premature infants, with good effect. Today, massaging premature infants is becoming common practice.

STEVE RITTER *wrote this week's column. Please send comments and suggestions to newscripts@acs.org.*

C&EN WEBINARS

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Finding the Balance: Setting Up Data Independent Acquisition on a Q Exactive HF MS Using Spectronaut and Application to a Hepatotoxicity Study

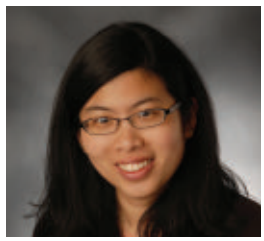
OCTOBER 30, 2014 8:00 a.m. PDT / 11:00 a.m. EDT / 16:00 BST

SPEAKERS

Dr. Lukas Reiter,
Head of Research & Development
BiognoSYS AG

Dr. Yue Xuan,
Product Specialist FT-MS
Thermo Fisher Scientific

MODERATOR



Linda Wang,
Senior Editor
C&EN

OVERVIEW

This webinar, in two parts, will cover the development of an optimized Data Independent Acquisition (DIA) workflow for a proteomics study using the Thermo Scientific™ Q Exactive™ HF mass spectrometer and Spectronaut™ software.

In the first part, Yue Xuan will introduce the Q Exactive HF hybrid quadrupole-Orbitrap mass spectrometer featuring an ultra-high-field Orbitrap analyzer, which doubles its speed and resolution. The benefits of fast scan speed, high mass accuracy, and excellent HCD MS/MS spectra quality of QE HF MS for DIA applications are reviewed along with a demonstration of the workflow strategy using data from analysis of various samples.

In the second part, Lukas Reiter will present DIA for protein profiling of human 3D liver microtissues on a Q Exactive HF MS and using the Spectronaut™ software. The microtissues were exposed to biologically relevant concentrations of Acetaminophen and measured in triplicates. With the instrumentation and software advancements it became feasible to robustly profile thousands of proteins across dozens of conditions with reasonable time, cost and very limited starting material.

KEY LEARNING OBJECTIVES:

- The prerequisites, including both hardware and software, for the data independent acquisition (DIA) current workflow
- The DIA workflows based on Q Exactive HF MS platform
- High Resolution Accurate Mass information for both MS/MS and MS to confident identify and quantify samples
- A study of DIA protein profiling of human 3D liver microtissues on a Q Exactive HF MS and using the Spectronaut™ software

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