FEBRUARY 1, 2010

C&EN

CHEMICAL & ENGINEERING NEWS

LAB ACCIDENTS
Safety board to investigate cases in academia **P.25**

SCIENCE IN ORBIT
Challenges for the space station **P.32**

SUSTAINABLE FLUOROCHEMICALS

Alternatives to protect humans, wildlife **P.12**

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C&EN
CHEMICAL & ENGINEERING NEWS

Serving the chemical, life sciences, and laboratory worlds

COVER STORY

LONG-CHAIN PHASEOUT

Chemical firms work to replace lengthy perfluoroalkyl compounds with shorter, non-bioaccumulative versions. PAGE 12

QUOTE OF THE WEEK

"Scientists live or die by the funding they get."

JULIE ROBINSON, INTERNATIONAL SPACE STATION PROGRAM SCIENTIST, NASA PAGE 32

NEWS OF THE WEEK

BUSINESS

GOVERNMENT & POLICY

SCIENCE & TECHNOLOGY

Funding, personnel, and logistical challenges threaten scientific research in unique facility.

ACS NATIONAL AWARDS

THE DEPARTMENTS

COVER: *Guillemot eggs from a remote part of Sweden help scientists understand how persistent perfluorochemicals bioaccumulate in guillemots and other species at the top of the food chain. It is not yet known how high levels of the chemicals affect the long-lived seabirds. Anna-Karin Johansson, Stockholm University*

& THIS WEEK ONLINE
WWW.CEN-ONLINE.ORG

REEL SCIENCE

A father goes through "Extraordinary Measures" to save his kids from a rare disease.

PLUS: Check out which states are trading CO_2.

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Science And Public Policy

CRITICS OF THIS PAGE frequently argue that C&EN's editor-in-chief should comment only on matters concerning chemistry or the chemical industry. There is no place, they argue, in the American Chemical Society's newsmagazine for commentary on public policies about which ACS members might disagree. The magazine, in fact, should stay out of public policy issues altogether, in the view of some of these critics.

The stories in this week's issue of C&EN illustrate why this criticism is unrealistic in today's world. The first seven department stories—from the cover story to both stories in the Business Department, both stories in the Government & Policy Department, the single story in the Science & Technology Department, and even the first story in the ACS News Department—all deal with issues that have a public policy component to them. Science and technology and public policy are inextricably linked in modern societies.

For example, the cover story, "Fluorochemicals Go Short" by Senior Correspondent Steve Ritter, is a comprehensive examination of the development of a policy for dealing with two particularly persistent long-chain perfluoroalkyl compounds: PFOS and PFOA (see page 12). As an interim measure, chemical companies, with EPA's blessing, are replacing PFOS and PFOA with compounds with shorter perfluoroalkyl chain groups that impart the same functional properties as the longer chain compounds. "Although the alternatives are just as persistent, they aren't as bioaccumulative and appear to have a better toxicity profile—which is still being confirmed by testing—and are thus considered sound replacements," Ritter writes.

This is not a trivial public policy issue. Fluorocarbons are extremely useful. Ritter quotes David W. Boothe, global business manager for DuPont Fluoroproducts, who says: "The societal benefits of fluoroproducts—boosting gas mileage in cars while cutting air emissions, adding durability to clothing, improving semiconductor and communications cable performance, and increasing fire-fighting speed—help consumers save money and make products safer, last longer, and environmentally friendlier."

Nevertheless, in January 2006, DuPont and seven other major PFOA producers and users agreed with EPA that PFOA had to go. What Ritter chronicles is the scientific, technological, and public policy challenges that stemmed from this decision. This is a success story that should be applauded. A regulatory agency and chemical producers and users can work together to protect the environment.

The second story in the Business Department (see page 23), by Senior Correspondent Marc Reisch, is also a success story, but perhaps a bit more controversial than Ritter's. Reisch examines the Regional Greenhouse Gas Initiative (RGGI), a CO_2 cap-and-trade program that has operated for more than a year in the northeastern U.S., generating $500 million in 2009 for energy-saving projects in the 10 states involved.

The program has its critics, Reisch notes, quoting one who calls cap-and-trade "a standard-of-living killer." Nevertheless, the Western Climate Initiative (seven states and four Canadian provinces) and the Midwestern Greenhouse Gas Reduction Accord (six states) are adopting the RGGI model. When implemented, the programs will create a trading area covering more than 50% of the U.S population and more than 50% of U.S. emissions.

Any mention of climate change in C&EN stirs up some people. RGGI is happening, however, and it shows that cap-and-trade can work.

Finally, the first ACS News story by Associate Editor Linda Wang looks at the ACS policy statement on endocrine disruption adopted by the ACS Board of Directors at their December 2009 meeting (see page 34). ACS has policy statements on a variety of topics. Statements are developed by ACS committees with expertise in the area covered by the statement, and they are reviewed every three years to determine if they should be retired, renewed, revised, or replaced. The ACS Standing Board Committee on Public Affairs & Public Relations has responsibility for the review. One of the policy statements up for review in 2010, in fact, is the society's position on global climate change.

Thanks for reading

Editor-in-chief

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

ACTINOMYCIN QUADRUPLEX

I WAS INTRIGUED to learn that actinomycin D is a quadruplex agent inhibiting the c-myc promoter (C&EN, Nov. 2, 2009, page 28). This nicely addresses the findings presented by K. Nishikura and J. M. Murray in their paper "The mechanism of inactivation of the normal c-myc gene locus in human Burkitt lymphoma cells" (*Oncogene* **1988,** *2,* 493). As pointed out in your article, c-myc mutations occur in many malignancies, with Burkitt lymphoma being the prototype. Actinomycin D is not in our therapeutic repertoire for Burkitt lymphoma and is worth invesigating in relapsed patients.

Thomas Reid
Conway, Ark.

MISSING THE TARGET

I READ "Missing the Target" with great interest, and I could not agree more with those who call for "moving beyond targeted therapies when tackling cancer" (C&EN, Oct. 26, 2009, page 20). I disagree, however, with their suggestion that "the time is right to devote resources to approaches that might change cancer into a manageable disease." Common wisdom calls on prevention over cure, so it is imperative to identify the underlying broad causes of cancers and other diseases and worry less about tackling symptoms.

In his book "Freedom from Disease" (St. Martin's Press, 2008), Peter Kash contends that controlled insulin levels are key to a balanced and healthy life. Considering our emotional makeup and the highly varied acute and chronic stresses we experience, I'm not sure how this control can be achieved.

Although humans have built-in evolutionary mechanisms to manage acute stress, we are ill-prepared to handle chronic stress. From a psychoneuroimmunological perspective, Edna M. V. Reiche et al. (*Lancet Oncol.* **2004,** *5,* 617) have proposed "that the persistent activation of the hypothalamic-pituitary-adrenal (HPA) axis in the chronic stress response and depression probably impairs the immune response and contributes to the development and progression of some types of cancer." They propose that "consecutive stages of the multistep immune reactions are either inhibited or enhanced as a result of previous or parallel stress experiences, depending on the type and intensity of the stressor" and on other factors.

They assert that, in general, stress and depression "are associated with the decreased cytotoxic T-cell and natural-killer-cell activities that affect processes such as immune surveillance of tumors, and with the events that modulate development and accumulation of somatic mutations and genomic instability. A better understanding of bidirectional communication between the neuroendocrine and immune systems could contribute to new clinical and treatment strategies," they say.

Years ago, my colleagues and I described the characterization of corticotropin-releasing factor/hormone (CRF or CRH), the stress hormone. Soon thereafter, we described the first CRF antagonists. I propose that the latest generations of the potent, long-acting peptidic CRF antagonists may be good drug candidates to reinstate homeostasis. This approach would address the causes rather than the symptoms of conditions prone to remissions and stress-related relapses, including some cancers.

Would nurturing cellular (immune) homeostasis be more effective than inducing cancer cell death through chemotherapy, radiation, or starvation? Can this be achieved? There is emerging evidence that the answers may be, "yes."

Jean E. Rivier
La Jolla, Calif.

SAFETY IS WORTH THE WORRY

PERHAPS it's just my style, but when I first agreed to hire a high school student as a lab assistant, I spent several uneasy nights wondering how I could possibly make the lab safe enough so that I would not find myself at some future point explaining to her parents that she had been seriously injured or killed while working for me.

My past experiences with fires and explosions reminded me that a working organic lab is never a safe environment. I came up with some policy guidelines for myself: never allowing assistants to work

alone; developing an overengineered, multitiered safety system of shields and barriers for running reactions; installing a heavy-duty fire extinguisher right next to the hood; and so forth. But I also realized that I was unable to guarantee everything, and as a result, I was very honest with that student and all the subsequent students who came to work for me.

I told them all that safety was as much their responsibility as it was mine, and that the very nature of what they would be doing precluded absolute foreknowledge of the safety risks. I generally started out their time in the lab by reminding them that all the explosives and toxins out in the world are chemicals, and most are organic chemicals.

I tried to include everything I knew about the reagents' dangers in the prep for any experiment and explained the safety measures we would be using in the setup. I also encouraged them to think about containment if problems developed. I still worried excessively over their presence, but it was manageable, and I'm glad to say we never had an incident that wasn't well contained by our precautions.

I realize a fair amount of luck was involved, but I think the worrying beforehand led to some good defensive measures that contributed to the unblemished safety record. It may be more difficult to implement in a large research group, but designating someone to act as an overseer for any younger members of a lab is what I would suggest. It is good training for the overseer (it certainly was for me), and it may make an unsafe environment just a little less unsafe.

Bill Glassco
Tiverton, R.I.

STIMULATING THE METRIC SYSTEM

LET'S USE SOME of the stimulus money to convert to the metric system in the U.S. This will bring us in line with most of the rest of the world, simplify our commerce, and employ people in a broad spectrum of trades over the next 10 to 20 years. It will also stimulate our brain cells, especially in some of us seniors, as we learn to think in metric terms.

Vic Smith
Kennewick, Wash.

RUNAWAY REACTIONS

SIN RESPONSE to the article "Runaway Reaction," I agree that chemical engineering curricula should include reactive chemical education (C&EN, Sept. 21, 2009, page 8). I'm a chemical engineering major in my senior year at Rutgers University, and I'm also a member of the American Institute of Chemical Engineers (AIChE).

Even though we study chemical kinetics, we don't really understand the impact of kinetics until we see an accident such as the one at T2 Laboratories, which killed four people. AIChE, in cooperation with the Safety & Chemical Engineering Education Program, is offering several certificate programs that focus on safety. Two of these are "Runaway Reactions" and "Hazards of Chemical Reactivity." They are extremely informative and show how quickly chemical reactions can get out of hand when scaled up.

Brian Pizza
Forked River, N.J.

INTELLIGENT DESIGN AND CURIOSITY

RICHARD S. GREELEY invokes a common fallacy in his argument against intelligent design or creation; namely, that they put an end to investigation (C&EN, Sept. 28, 2009, page 4). History could not disagree more.

Until the past century, the majority of scientists ardently believed in a designer and found their curiosity continually stimulated to understand the genius behind the design. I daresay many of us still approach our science with this perspective and find it immensely motivating and satisfying.

One who believes in a creator accepts and assumes that successful living organisms are amazingly complex and well suited for their environment. We seek to understand how we are made, why it works, and what we can do to fix it. When it comes to dealing with disease (my particular business), these questions are interesting and relevant. Determining what random sequence of events may have led to the current state has done little to inform that quest. In fact, after 30 years, I am still waiting.

Lane Sattler
Warminster, Pa.

SCIENCE & ART PROVIDE INSIGHT

THE COVER STORY "Science from Art" was both timely and stimulating (C&EN, Oct. 19, 2009, page 12). As the co-organizer of the ACS Rochester Section's ChemLuminary Award-winning lecture series on "Chemistry and the Arts," I concur with Karen Trentelman of Getty Conservation Institute that the subject is of inherent interest to both professionals and the general public. Our lecture series was very well attended by the general public but was also quite effective in bringing together chemists, materials scientists, and scholars in the humanities, bridging the gap between C. P. Snow's "Two Cultures."

There is more to science and art than authentication and conservation. In his 1953 essay, "The Creative Mind," philosopher Jacob Bronowski pointed to a deeper connection. He observed that the sciences and the arts have always flourished together: A culture that excelled in one typically also excelled in the other. Studying our cultural heritage from the twin perspectives of the history of science (chemistry) and the history of art could thus give us clearer insight into the meaning of being human.

Nicholas Zumbulyadis
Rochester, N.Y.

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C&EN news of the week

FEBRUARY 1, 2010 EDITED BY WILLIAM G. SCHULZ & LAUREN K. WOLF

FLUORINASE SUCCESS

BIOSYNTHESIS: In a chemical first, an engineered microbe yields a bioactive fluorinated compound

BY REPROGRAMMING a deep-sea microbe to make a fluorinated version of the anticancer drug candidate salinosporamide A, scientists have for the first time achieved gene cloning of the fluorinase enzyme into a host organism to generate a fluorinated metabolite (*J. Nat. Prod.*, DOI: 10.1021/np900719u). Although the efficiency of the biosynthesis is low, the achievement is a major step toward practical fermentation production of fluorinated drugs.

Organofluorine compounds play an important role in medicinal chemistry—about 15% of all pharmaceuticals include at least one fluorine atom to improve bioavailability and efficacy. Although halogenated natural products are common, natural organofluorine compounds are rare, with only five examples reliably known. In 2002, the fluorinase enzyme that gives rise to these fluorinated compounds was first isolated from the soil bacterium *Streptomyces cattleya*, in which fluorinase uses fluoride ion to generate C–F bonds.

David O'Hagan of Scotland's University of St. Andrews and colleagues accomplished the original work to isolate and decipher the function of fluorinase. Now, O'Hagan, in collaboration with Alessandra S. Eustáquio and Bradley S. Moore of Scripps Institution of Oceanography at the University of California, San Diego, has coaxed the bacterium *Salinospora tropica* to accept the fluorinase gene and put it to work.

In 2007, Moore and coworkers sequenced the genome of *S. tropica*, one of many *Salinospora* species found in ocean sediments that are producers of anticancer and antibiotic compounds. Salinosporamide A, a key chlorinated natural product made by *S. tropica*, is in clinical trials as an anticancer drug. To make fluorosalinosporamide, O'Hagan, Eustáquio, and Moore replaced the chlorinase gene in *S. tropica* with the corresponding sequence from fluorinase. This switch enables the engineered microbe to convert *S*-adenosyl-L-methionine to 5′-fluorodeoxyadenosine, the lead step in the fluorosalinosporamide biosynthesis.

"For salinosporamides, fluorine substitution has the potential to alter the cytotoxic potency of the compound because the halogen is involved in the drug's mechanism of action," notes Guy T. Carter, assistant vice president of chemical technologies at Pfizer. "One can now envision creating other fluorine-containing precursors through mechanisms linked to the metabolism of intermediate fluorosugars and hence broaden the array of fluorinated products."

The efficiency of fluorosalinosporamide production is currently hampered because the engineered microbe is sensitive to fluoride ions, O'Hagan notes. "We still need to work out how to engineer fluoride-ion resistance into the host organism," O'Hagan says. "We have some clues how this can be done from the relevant gene cluster in *S. cattleya*, which is where we are going in the next phase of our research."

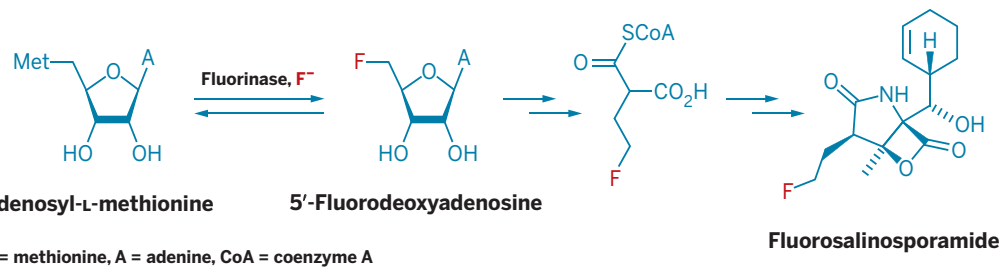
"Introducing the halide is just the first step in a remarkable sequence of some 15 transformations initiated by the halogenase enzyme," Moore notes. "Some of the intermediates, including fluorosugars, have the potential to be shunted off in different directions to make other types of fluorochemicals and expand the utility of the engineered bacterium."

Many obstacles hamper the use of combinatorial biosynthesis in drug manufacturing, says Iwao Ojima, director of the Institute of Chemical Biology & Drug Discovery at the State University of New York, Stony Brook. "The fluorosalinosporamide synthesis is a beginning to possible production of fluorinated natural products by genetic engineering, but it has a long way to go to reach a practical level," Ojima says. "We can be cautiously optimistic for this approach to eventually become synthetically useful."—STEVE RITTER

"We can be cautiously optimistic for this approach to eventually become synthetically useful."
—IWAO OJIMA

FERMENTED FLUORINE

By replacing a gene in the bacterium *S. tropica* with one for the fluorinase enzyme, researchers have biosynthesized a fluorinated version of salinosporamide.



S-Adenosyl-L-methionine

5′-Fluorodeoxyadenosine

Fluorosalinosporamide

Met = methionine, A = adenine, CoA = coenzyme A

OBAMA TAKES ON THE ECONOMY

POLICY: State of the Union address focuses on jobs and innovation to further recovery

Obama delivers his State of the Union address to a joint session of Congress as Vice President Joseph Biden and House Speaker Nancy Pelosi (D-Calif.) applaud.

TIM SLOAN/UPI/POOL/NEWSCOM

IN HIS FIRST State of the Union address, President Barack Obama focused on stabilizing and growing the nation's economy by investing in people and innovation.

"We need to invest in the skills and education of our people," the President said during his 70-minute speech on Jan. 27. This investment is needed to ensure the U.S.'s global competitiveness, which Obama tied to innovation, jobs, and education—particularly in the area of energy and clean technology infrastructure.

"There's no reason Europe or China should have the fastest trains or the new factories that manufacture clean energy products," he said, promising to further federal energy incentives to "put more Americans to work building clean energy facilities."

The President also stressed China's and Germany's emphasis on math and science education and their willingness to spend for infrastructure improvements. "They're making serious investments in clean energy because they want jobs. Well, I do not accept second place for the United States of America," he said.

This Administration has made the largest investment in basic research funding in history—investments, Obama said, that could lead to the "world's cheapest solar cells or treatment that kills cancer cells but leaves healthy ones untouched."

"No area," he continued, "is more ripe for innovation than energy." The President singled out his Administration's support for research and manufacture of advanced batteries, biofuels, clean-coal technologies, and solar panels, but he also called for greater development of nuclear power and offshore oil and gas resources.

His speech made no mention of carbon dioxide cap and trade. Instead, Obama urged passage of a comprehensive energy and climate bill with "incentives that will finally make clean energy the profitable kind of energy in America."

"I know that there are those who disagree with the overwhelming scientific evidence on climate change," Obama continued. "But here's the thing: Even if you doubt the evidence, providing incentives for energy efficiency and clean energy are the right thing to do for our future because the nation that leads the clean energy economy will be the nation that leads the global economy. And America must be that nation." —JEFF JOHNSON AND SUSAN MORRISSEY

DUPONT PLANT INVESTIGATION

FATAL ACCIDENT: Safety board begins probe of phosgene leak

After a series of accidents and toxic releases, CSB has opened an investigation of DuPont's Belle, W.Va., complex.

JEFF GENTNER/AP

THE CHEMICAL SAFETY & Hazard Investigation Board (CSB) will investigate a deadly accident that occurred on Jan. 23 at the DuPont chemical complex in Belle, W.Va., located south of Charleston on the Kanawha River.

The board made the announcement on Jan. 25, the day after a 58-year-old worker died from exposure to phosgene, which leaked when a braided steel hose attached to a 1-ton-capacity tank ruptured. The plant can legally store up to 44,000 lb of phosgene.

The accident follows two others at the plant over a one-week period, according to CSB. One involved a release of chloromethane from the plant's unit for producing hexazinone, a broad-spectrum herbicide, that went undetected for several days, the board says. The other was a sulfur dioxide release from a spent sulfuric acid unit. CSB also notes that six other releases have occurred at the plant since December 2006.

In a statement, DuPont announced that it was temporarily shutting down several process units immediately for safety checks. "The purpose of the safety stand-down is to reinforce the seriousness of this situation and maintain the site's focus on safe work, consistent with DuPont's core values. The site is undergoing a thorough investigation of the units involved in the incidents," DuPont says.

CSB is currently two members shy of its full five-member complement, and speaking for the board, CSB member William E. Wright cautioned that the new investigation is likely to delay efforts to complete other investigations, including another fatal accident at a Bayer CropScience plant in nearby Institute, W.Va. (C&EN, May 11, 2009, page 25).

Wright notes that with the new DuPont investigation, the board now has 17 open investigations, the largest number in its 11-year history.

The investigation was requested by local and federal elected officials. The federal Occupational Safety & Health Administration also says it intends to investigate the accident.—JEFF JOHNSON

STRONGER DEMAND IN FOURTH QUARTER

EARNINGS: Chemical firms say sales volumes in most segments are rebounding

EARLY REPORTS of fourth-quarter earnings in the chemical industry suggest that demand for a wide variety of products has improved noticeably, giving executives reason to be optimistic about 2010.

The year-over-year results are almost guaranteed to look good because the last quarter of 2008 was horrible for chemical firms. For example, DuPont earned $402 million for the quarter, compared with a loss of $249 million in 2008.

In a conference call with analysts, DuPont CEO Ellen J. Kullman struck a triumphant note. "We delivered 10% sales growth in the quarter, with volume increases in every region," she said.

David Begleiter, a research analyst with Deutsche Bank, points out in a report to investors that DuPont's earnings per share of 44 cents beat consensus expectations by 4 cents and observes that "the upside was driven by better-than-expected volume growth."

DuPont's $6.4 billion in sales reflected growth in five of six segments, including a 22% increase in electronic chemicals and a 20% boost in performance materials. Only the safety and protection business saw a decrease in the quarter. The company raised its earnings-per-share guidance for 2010 by 5 cents to $2.15–$2.45.

DuPont also enjoyed strong growth in its agriculture business, selling 25% more seeds than in the fourth quarter of 2008. In contrast, fertilizer maker Mosaic continues to confront low selling prices for potash and phosphate, which took a big bite out of its profits.

Specialty chemical maker Albemarle saw an improvement in sales and a significant rise in quarterly earnings to $62 million from $13 million in 2008. Earnings were powered by increased sales of brominated flame retardants. Meanwhile, Ashland, which acquired Hercules in November 2008, earned $86 million on $2.0 billion in sales in the fourth quarter of 2009.

At industrial gas firms Air Products & Chemicals and Praxair, sales in the quarter were essentially flat compared with last year's fourth quarter because the companies were forced to lower prices to reflect decreases in energy and raw material costs. But sales volumes are on their way up. Specifically, Air Products saw an increase in demand for tonnage gases and electronics and performance materials. Productivity gains and favorable exchange rates helped Air Products increase quarterly earnings to $252 million from $69 million in 2008. Praxair's earnings rose 70.0% to $340 million.

The earnings reports also show that the strength of the upturn was not universal. Emerging economies, especially China's, drove improved volumes, with those of the U.S. and Europe lagging behind. Praxair CEO Stephen F. Angel forecasts that the pattern will continue. "For 2010, we are cautiously optimistic that growth in the U.S. and Europe will continue to improve," he says, "but we expect the climb to be slow and deliberate."—MELODY VOITH

FOURTH-QUARTER CHEMICAL RESULTS

One year after the economic crisis hit the chemical industry, earnings start to climb

	SALES	EARNINGS[a]	CHANGE FROM 2008		PROFIT MARGIN[b]	
	($ MILLIONS)		SALES	EARNINGS	2009	2008
Air Products	$2,174	$252	-1.0%	265.2%	11.6%	3.1%
Albemarle	558	62	7.7	376.9	11.1	2.5
Ashland[c]	2,020	86	-9.5	na	4.3	na
DuPont	6,419	402	10.3	nm	6.3	def
Mosaic	1,710	108	-43.1	-88.8	6.3	31.9
Praxair	2,407	340	0.2	70.0	14.1	8.3

a After-tax earnings from continuing operations, excluding significant extraordinary and nonrecurring items. **b** After-tax earnings as a percentage of sales. **c** Data are pro forma and reflect acquisition of Hercules. **def** = deficit. **na** = not available. **nm** = not meaningful.

MEDICAL ISOTOPES DOE provides grants to relieve shortage of critical diagnostics aid

As the global shortage of radioactive isotopes used for medical imaging diagnostics worsens, the Department of Energy has given grants to two firms to further develop new sources for the materials.

The National Nuclear Security Administration, an arm of DOE, awarded $9 million to engineering firm Babcock & Wilcox and $2.3 million to nuclear reactor maker GE Hitachi Nuclear Energy. Both firms say they will match the awards to develop domestic sources for the isotopes, which are used in 20 million U.S. procedures, such as heart-stress scans and blood-flow monitoring, each year.

Two aging reactors, one in Canada and one in the Netherlands, currently supply the bulk of the U.S.'s demand for molybdenum-99, the raw material for medical isotope technetium-99m. Supply from these reactors has been severely constrained recently (C&EN, Aug. 24, 2009, page 9).

Ross Thomas, chief technical officer for Babcock & Wilcox, says the firm is adapting a decades-old reactor design that will use low-enriched uranium to generate ^{99}Mo. The firm plans to fulfill half of the U.S.'s needs by late 2013.

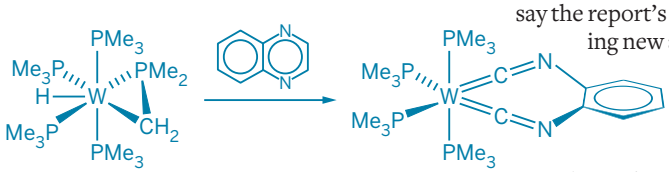
GE Hitachi plans to make use of nuclear reactors it has built to convert naturally occurring ^{98}Mo to the isotope ^{99}Mo. Commercial-scale production aimed at supplying half of the U.S.'s demand should be ready by 2013, a GE Hitachi spokesman says.

In the meantime, shortages of ^{99}Mo are expected to continue, according to Covidien, a major pharmaceutical isotope supplier.—MARC REISCH

TUNGSTEN BREAKS TOUGH BOND

ORGANOMETALLICS: Rare carbon-carbon bond scission could lead to new route for functionalizing aromatics

Tungsten complex breaks C–C bond in quinoxaline.



Me = methyl

A STRONG AROMATIC carbon-carbon bond can be cleaved with ease by a tungsten complex that inserts the metal between the two carbon atoms, report chemists at Columbia University (*Nature* **2010,** *463,* 523). The mechanism of this unusual bond breaking, which was observed in quinoxaline under mild conditions, could be extended to other systems, say the report's authors, opening new avenues for functionalizing aromatic molecules.

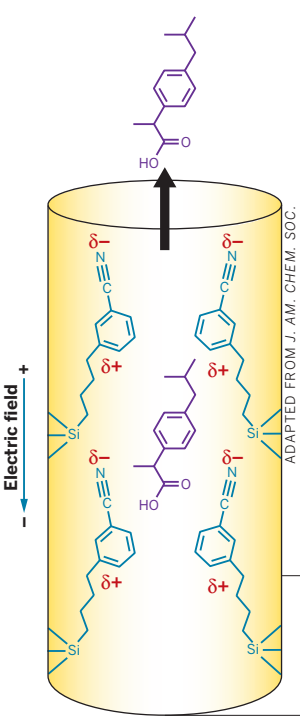
Aaron Sattler and Gerard Parkin discovered the tungsten complex's bond-breaking ability while searching for a compound that would cleave C–N aromatic bonds. They had been working with molybdenum complexes but decided to switch to tungsten, which is a more aggressive metal. Sattler and Parkin were surprised to find that in the presence of the N-heterocyclic molecule quinoxaline, the tungsten complex breaks the aromatic C–C bond adjacent to the aromatic C–N bond, even though the C–N bond is typically more reactive.

"Carbon-carbon bond cleavage reactions are uncommon and are typically only observed when the C–C bond is held in close proximity to the metal center, or when the cleavage is accompanied by relief of strain energy or the formation of an aromatic system," Parkin explains. "The most promising aspect of the study is, therefore, that this type of cleavage could be extended to other transition-metal compounds and other substrates, and thereby ultimately leads to a new way of functionalizing organic molecules." The researchers have examined the reactivity of the tungsten complex with a few other aromatic compounds but have not observed the same C–C bond cleavage.

"Sattler and Parkin's reaction is a molecular tour de force, although it is probably a long way from seeing any useful applications," writes Rutgers University chemistry professor Alan Goldman in a commentary that accompanies the paper. Even so, he notes, "the unusual mechanism may inspire new routes to a more general cleavage of C–C bonds, applications of which can be envisaged, ranging from the syntheses of pharmaceutical compounds to the development of new catalysts for the hydrodenitrogenation of fossil fuels."—BETHANY HALFORD

MEDICATION ON DEMAND

DRUG DELIVERY: Electric field spurs nanoscale device to release cargo



SWING SHIFT An electric field prompts dipolar molecules attached to the walls of a silica pore to eject a cargo of ibuprofen molecules (purple).

OVER THE PAST decade, scientists have devised several miniature controlled-release devices that respond to external stimuli such as a change in pH or exposure to light. Now, researchers have created the first such system that can be controlled with an electric field (*J. Am. Chem. Soc.*, DOI: 10.1021/ja907560y). The new device could be used for in vivo treatment of tumors, among other applications.

Yingchun Zhu, a professor at China's Shanghai Institute of Ceramics, and his colleagues constructed the system by fastening one end of dipolar 4-(3-cyanophenyl)butylene molecules to the inner walls of nanoscale silica pores. The researchers then loaded the pores of the derivatized silica with ibuprofen molecules and submerged the material in simulated extracellular fluid. When they placed the system in an alternating electric field, the tethered dipolar molecules swept back and forth like windshield wipers. This motion pushed the ibuprofen out of the pores and into the fluid at a rate controlled by the frequency of the alternating field.

Such a system could be particularly useful for organic compounds that won't diffuse without assistance because of poor solubility in body fluids, Zhu says. For example, porous silica loaded with a chemotherapeutic agent could be incorporated in a microchip and implanted in a tumor, he notes. The chip would release the agent in response to an external field or, if the chip had its own tiny power supply, a local field controlled by the chip's programming.

"Releasing cargos from mesoporous silica in response to an electric field is both neat and clever," says J. Fraser Stoddart, a Northwestern University chemistry professor known for his work with nanomachines, including controlled-release devices. "I am sure that the idea has passed through quite a few minds in the drug-delivery field. It's implementing it that matters, however, and Dr. Zhu and his collaborators have done just that both convincingly and elegantly."—SOPHIE ROVNER

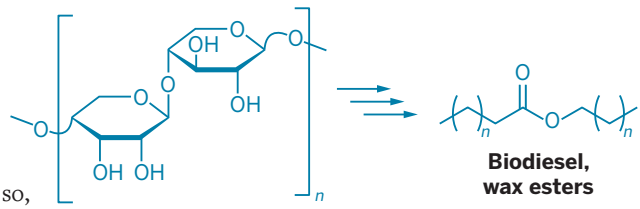
ONE-POT BIODIESEL

SYNTHETIC BIOLOGY: Bacteria make biodiesel directly from glucose and hemicellulose

A BIOENGINEERING development could lead to a cheaper route to products derived from plant biomass. Researchers have redirected fatty acid metabolic pathways in the bacterium *Escherichia coli* to produce biodiesel and other chemicals such as fatty alcohols, aldehydes, and wax esters directly from glucose (*Nature* **2010**, *463*, 559).

"My goal has been to produce the kinds of fuels that will work with our existing transportation infrastructure," says Jay D. Keasling of the University of California, Berkeley, who carried out the work with Stephen B. del Cardayre of the industrial biotech company LS9, located in South San Francisco, and coworkers. "We're at the point with biology where we can engineer the biology to work with our existing infrastructure rather than vice versa," Keasling adds.

To do that, his team engineered bacteria to produce long-chain fatty acid esters that can be used as biodiesel. The researchers increased the amount of free fatty acid by engineering the bacteria to express a thioesterase enzyme that releases the fatty acid from the carrier protein to which it's normally tethered. By doing so, and by suppressing other enzymes that compete with the formation of fatty acids, the researchers boosted the bacteria's output of the acids three- to fourfold.



A hemicellulose

Engineered bacteria produce biodiesel from hemicellulose.

Making fatty acid ethyl ester, which can be used as biodiesel or as a precursor to other chemical products, requires the simultaneous expression of an ethanol-producing metabolic pathway. The fatty acids and the ethanol need to be made in the right ratios, Keasling says. "If either one of them is limiting, then it's going to limit the production of the final product," he says.

They were able to efficiently produce the esters with glucose as the sole carbon source. By adding a pathway to produce enzymes that degrade hemicellulose, a structural material found in plant cell walls, the researchers demonstrated the production of biodiesel using hemicellulose as a feedstock.

"If feedstock availability, large-scale production, economics, and product properties are favorable, this approach may have the potential of significantly increasing the supply of biofuel," says Gerhard H. Knothe, a biodiesel researcher with USDA's Agricultural Research Service in Peoria, Ill.—CELIA ARNAUD

BRASKEM TO BUY DOMESTIC RIVAL

LATIN AMERICA: Acquisition of Quattor will advance firm's position in commodity plastics

I N A MOVE that will allow it to stand shoulder to shoulder with the likes of Dow Chemical and ExxonMobil, Brazil's Braskem is buying a 60% stake in rival Quattor for $380 million plus its $3.6 billion in debt.

The purchase, from the local conglomerate Unipar, aims to combine Brazil's only producers of polyethylene and polypropylene into a company with about $13.9 billion in annual sales. Braskem will become the number one overall producer of polyethylene, polypropylene, and polyvinyl chloride in the Americas.

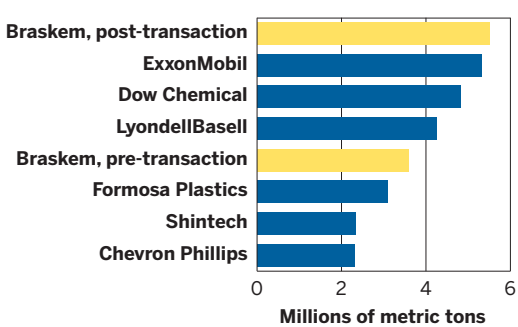
Antitrust authorities in Brazil will review the transaction, but Braskem's chief financial officer, Carlos Fadigas, is confident regulators will look beyond Brazil. "Although we are going to have important market share in Latin America and Brazil, Braskem will have a share of the global market of only 3 to 4%," he told investors on a conference call.

As part of the deal, Brazilian state oil company Petrobras, which has a 30% stake in Braskem, will merge its 40% interest in Quattor into Braskem.

Petrobras and Braskem's major shareholder, the construction materials firm Odebrecht, will together inject $1.9 billion of additional capital into Braskem by participating in a stock offering that Braskem hopes will raise about $2.7 billion.

NUMBER ONE

Acquisition of Quattor gives Braskem more annual PE, PP, and PVC capacity in the Americas than any other company



NOTE: PE = polyethylene, **PP** = polypropylene, **PVC** = polyvinyl chloride. **SOURCES:** Braskem, CMAI, Barclays, Parpinelli Tecnon

Though Braskem is taking on more debt as part of the transaction, debt analysts aren't worried. They cite the cash injection from its major shareholders and Braskem's track record with previous acquisitions. "The company's proven ability to integrate and turn around acquired assets mitigates the integration risk involved in the acquisition of Quattor," wrote Moody's analyst Richard Sippli to clients.—ALEX TULLO

FLUOROCHEMICALS GO SHORT

Shorter perfluoroalkyl chain lengths improve **ENVIRONMENTAL PROFILE** of versatile stain-, grease-, and water-repelling chemicals

STEPHEN K. RITTER, C&EN WASHINGTON

NEARLY ALL HUMANS, and a large proportion of wildlife, are contaminated with environmentally persistent long-chain perfluoroalkyl compounds. That revelation, around for a decade now, has brought dramatic change to the fluorochemicals industry.

Spurred on by academic researchers and concerns from environmental and consumer advocacy groups, chemical companies have worked with the Environmental Protection Agency to phase out perfluorooctane sulfonate (PFOS) and are in the process of phasing out perfluorooctanoic acid (PFOA). The companies are replacing PFOS, PFOA, and their associated compounds with shorter perfluoroalkyl chain compounds that impart the same functional properties as the longer chain compounds. Although the alternatives are just as persistent, they aren't as bioaccumulative and appear to have a better toxicity profile—which is still being confirmed by testing—and are thus considered sound replacements.

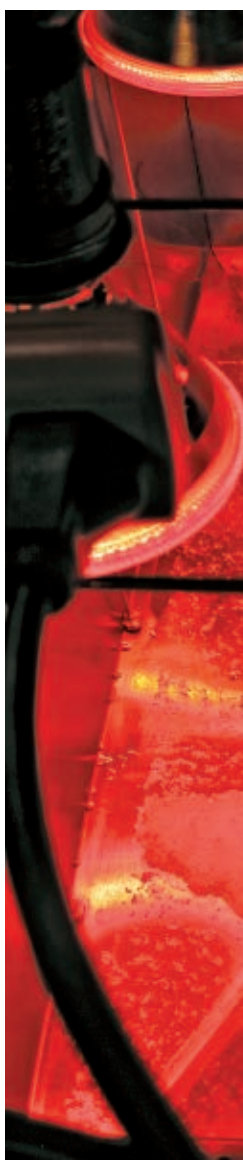
The chemical inertness of these fluorocarbons and their simultaneous hydrophobic and lipophobic character make them useful for manufacturing a variety of plastics and as surface treatments for industrial and consumer products, explains David W. Boothe, global business manager for DuPont Fluoroproducts. He says people have come to take such products for granted: nonstick cookware, grease-proof fast-food wrappers, stain-resistant carpet, and water-repellent clothing. Less visible are critical applications such as components of fuel hoses for cars, hydraulic fluids for airplanes, insulation for telecommunications wiring, and as surfactants to aid application of pesticides, enhance wetting properties of paints and coatings, and improve flowability of fire-fighting foams.

"The societal benefits of fluoroproducts—boosting gas mileage in cars while cutting air emissions, adding durability to clothing, improving semiconductor and communications cable performance, and increasing fire-fighting speed—help consumers save money and make products safer, last longer, and environmentally friendlier," Boothe emphasizes.

THE DOWNSIDE is that, over time, emissions from the manufacture and use of PFOS and PFOA have meant that they are ubiquitous in the environment, where they have no natural analogs. The compounds are found in places ranging from pristine areas of the Arctic to sludge in municipal wastewater treatment plants. And they've infiltrated nearly every corner of the food chain, from herring to humans.

PFOS and PFOA are known to exhibit toxicity in lab animals, but so far their toxicity to people is uncertain, says Toni Krasnic, coordinator for perfluorochemicals in EPA's Office of Pollution Prevention & Toxics. EPA has yet to make a full judgment of whether these compounds pose an unreasonable risk to the public, Krasnic says. One holdup is that to effectively deal with PFOS and PFOA, the research community has to scrutinize the compounds' associated precursors and derivatives, too. "It makes the whole risk-management issue more complicated," Krasnic says.

Scientists studying the fluorochemicals agree that, given the persistence, long-term exposure to PFOS and PFOA and their associated compounds can reasonably be anticipated to result in adverse health effects. But at the same time, the fluorochemicals are too useful to society and are too large of a market for chemical companies to abandon. Those realizations prompted EPA and chemical firms to start working toward finding sustainable solutions.



The PFOS and PFOA families of compounds have been produced since the late 1940s. PFOS is a degradation product of perfluorooctane sulfonamide derivatives, including perfluoroalkyl sulfonamidoethanols (PFASEs), that were originally the key components used to make 3M's Scotchgard brand of stain-protection products.

PFOA's ammonium salt and, to a lesser extent, its longer perfluorononanoic homolog have been used in small amounts as surfactants to help solubilize fluorinated monomers in the industrial emulsion polymerization of tetrafluoroethylene to produce DuPont's Teflon and other fluoropolymers. PFOA and other perfluoroalkyl carboxylic acids (PFCAs) are also inadvertent degradation products of long-chain fluorotelomer alcohols (FTOHs), a set of oligomeric compounds built up from tetrafluoroethylene by a free-radical telomer-

Fluorochemicals are too useful to society and are too large of a market for chemical companies to abandon.

ization process. Chemical companies use PFASEs and FTOHs to add fluorinated pendant groups to polymers and surfactants that are then used to coat metals, paper, carpet, and fabrics.

Fluorinated compounds were first noted in human blood in the late 1960s, and by 2000, PFOS and PFOA were specifically identified and discovered to be virtually anywhere scientists checked. PFOS currently is found at higher concentrations in blood than PFOA, about 20 ppb versus 4 ppb on average in the U.S. Chemical production workers tend to have levels about 100 times higher, according to EPA data.

Animal studies indicate that when the chemicals are at moderate to high levels—mostly above 1,000 ppb—they cause developmental problems, liver toxicity, immune system problems, and benign tumors. In some people, higher levels of PFOS and PFOA correlate with higher cholesterol levels and a higher incidence of thyroid disease, as noted in studies based on data from the National Health & Nutrition Examination Survey conducted by the Centers for Disease Control & Prevention. But other studies by academics, EPA and other federal agencies, and the companies themselves indicate that the chemicals so far are not firmly associated with any increased risk for cancer or other adverse health effects in people.

Nevertheless, when it became clear that PFOS was accumulating in people and the environment, 3M took a proactive step and, in cooperation with EPA, voluntarily began phasing out production of PFOS, PFOA, and PFOS-related products in May 2000. It was a daring move for 3M, the leading global producer and only U.S. maker of the PFOS family of compounds. The company decided to take a chance on reworking its product line to sustain its $300 million business.

TAINTED SNOW Stockholm University graduate student Merle Plassmann melts large quantities of snow to determine how PFOS, PFOA, and polyfluorinated alkane pollutants from ski waxes are distributed in meltwater.

In 2003, 3M unveiled a new version of Scotchgard, reformulated with chemistry based on perfluorobutane sulfonamide and its related alcohol in place of PFOS chemicals. The ultimate degradation product, perfluorobutane sulfonate, has a much shorter half-life in people: about one month versus 5.4 years for PFOS and 3.8 years for PFOA.

EPA went on to use provisions of the Toxic Substances Control Act to limit future U.S. manufacturing and import of PFOS and its related chemicals, Krasnic notes. As a follow-up, EPA expanded its investigation of PFOA.

As a result, in January 2006, EPA and the eight major companies that make or use PFOA launched the 2010/2015 PFOA Stewardship Program to formally put a stop to environmental release of PFOA and its related compounds. The companies—Arkema, Asahi, Ciba, Clariant, Daikin, DuPont, 3M/Dyneon, and Solvay Solexis—committed to reducing global facility emissions and product content of PFOA and its associated compounds by 95% relative to 2000 levels by the end of this year. The companies also committed to working toward fully eliminating PFOA emissions and product content by 2015, leading the firms to start switching over to shorter chain replacements.

& MORE ONLINE

The impact of the 3M phaseout and the PFOA stewardship program is already evident, Krasnic says. PFOS levels in U.S. adult blood donors dropped by 60% and PFOA levels by 25% from 2000 to 2006, according to a study by 3M scientists (*Environ. Sci. Technol.* **2008,** *42,* 4989).

"On the one hand, this study shows that what we are doing is effective," Krasnic says. "On the other hand, we see a trend that as we phase out these chemicals in the U.S., they are being picked up in other parts of the world, such as China." If manufactured goods containing these chemicals are imported, there will still be a source of exposure in the U.S., which could undermine the transition to the short-chain alternatives, he points out.

INDUSTRY EFFORTS to phase out the problematic long-chain fluorochemicals have stimulated an evolution in the scientific understanding of PFOS and PFOA. These developments have required the efforts of many academic scientists around the world—in some cases, working side by side with EPA and company scientists—to paint a clearer picture of how perfluorochemicals have infiltrated the environment and our bodies.

In 2006, a landmark study by Konstantinos Prevedouros and Ian T. Cousins of Stockholm University, in collaboration with DuPont's Robert C. Buck and Stephen H. Korzeniowski, provided the first detailed account of the global production history, direct and indirect emissions, and fate of PFOA and its homologs (*Environ. Sci. Technol.* **2006,** *40,* 32). Prevedouros and coworkers estimated the global historical emissions of PFOA from 1951 to 2004 for direct manufacture and use, plus indirect sources such as residuals in finished products.

They determined that up to 6,900 metric tons of PFOA, or around 10% of total production, was directly emitted from chemical plants. Most of the material was

COURTESY OF ROBIN VESTERGREN

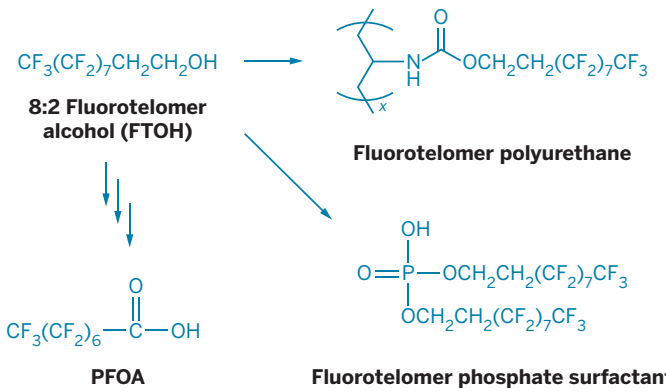
released in process wastewater prior to 2000, before companies significantly tightened their emissions controls. An additional 350 metric tons was indirectly emitted. The team also determined that ocean surface waters contain a majority of the compounds and that ocean transport is responsible for most of the distribution around the globe.

But the ocean transport mechanism can't fully explain how PFCAs have ended up on land in remote locations away from water. Scott A. Mabury of the University of Toronto, a leading PFOS/PFOA researcher, reasoned that there must be an atmospheric transport component in addition to the oceanic transport mechanism described by the Stockholm researchers.

As laid out in a series of papers over the past decade, Mabury and coworkers studied the physical properties of PFOA, FTOHs, and related compounds independently of available chemical company data and showed that the compounds can be found in the atmosphere and in indoor air. Mabury's group, in collaboration with Derek C. G. Muir of Environment Canada, also conducted monitoring studies to show that PFCAs with chain lengths up to C_{15} are in the Great Lakes and in the water and snow across remote regions of the Canadian Arctic. In these locations, the fluorochemicals exist at concentrations that match the researchers' model predictions for atmospheric transport of small amounts of the compounds.

In other modeling studies, James M. Armitage in Cousins' group at Stockholm evaluated the global transport and projected future trends in PFCA distribution in the environment out to 2050 (*Environ. Sci. Technol.* **2006,** *40,* 6969, and **2009,** *43,* 5830). The team's key observation is that although PFCA concentrations near chemical plants should decline as producers phase out the chemicals, concentrations in the Arctic marine environment will continue to increase until about 2030, as PFCAs are globally distributed. The group

FLUORINE FAMILY FTOHs are versatile precursors for functionalized polymers and surfactants, but residual amounts of the compounds degrade to the environmentally problematic PFOA.



has also explored the transport and fate of PFOS, but that effort has been hampered by lack of complete data on global emissions (*Environ. Sci. Technol.* **2009,** *43,* 9274).

Robin Vestergren in Cousins' group has additionally tracked pathways of exposure to PFCAs, finding that human exposure is fundamentally different from that of wildlife (*Environ. Sci. Technol.* **2009,** *43,* 5565). For example, PFOA is more prevalent in people, but the longer perfluorononanoic acid tends to be more common in animals, Vestergren notes.

FOOD IS NOW the likely dominant pathway of PFOA exposure for most people, Vestergren says. However, for those living in areas near chemical plants that make or use the chemicals, drinking water is likely the more dominant source. Inhalation or other exposure to residual compounds such as FTOHs in consumer materials followed by metabolism is another source, he notes. So even with the PFOA phaseout slated to take place by 2015, "people and wildlife will still continue to receive a fairly constant low-dose exposure far into the future," Vestergren adds.

Because PFOS and PFOA are the ultimate degradation products for the perfluoroalkyl compounds, they might be the least troublesome of the fluorochemicals in the environment, Mabury believes. His group has been piecing together the chemistry of the sulfonamido and fluorotelomer alcohols in the global environment. Taking into account that PFOS has largely been phased out globally, Mabury has focused more on FTOHs, although most of his observations are relevant to PFASEs as well, he says.

In smog-chamber studies carried out with atmospheric chemist Timothy J. Wallington of Ford Motor Co., Mabury and his colleagues unraveled a degradation pathway between FTOHs and the corresponding PFCAs. They determined that for most of a sample tested, the long perfluoroalkyl chain "unzips" to eventually form carbon dioxide and fluoride ion. But in 1–10% of the sample, the chains remain intact and react with chlorine and hydroxyl radicals, leading to a photochemical chain of events that convert FTOHs to aldehyde and then other intermediates. Ultimately, PFOA and other PFCAs are produced.

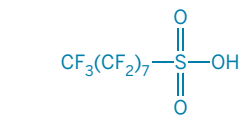
Mabury's research led to a couple of key findings about the perfluoroalkyl chemicals. "The acids bioaccumulate only if there are at least seven perfluorinated carbons in the chain," Mabury says. "And for each additional carbon, the rate of bioaccumulation goes up by a factor of seven." Mabury attributes this phenomenon to the hydrophobicity of the compounds, which have a tipping point between six and seven fluorinated carbons. That property is the basis for the C_6 and shorter chain replacements, he notes.

In one of the Mabury group's latest discoveries, Jessica C. D'eon found that fluoroalkyl phosphoric acid diesters used as surfactants on grease-proof food wrappers and pizza box liners occur in high concentrations in human blood bank serum (*Environ. Sci. Technol.* **2009,** *43,* 4589). This study marks the first time that a commercial product, rather than PFOS or a PFCA, has been found in human blood, Mabury notes. "No one thought that these chemi-

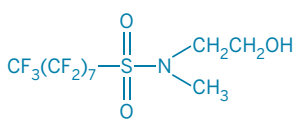
cals came off the paper," he says. "It seems to confirm that the fluorosurfactants, not just residual PFASEs or FTOHs, can be metabolized and be a significant source of PFOS and PFOA in humans."

All that research has finally led Mabury to what he thinks is the key point of the PFOS/PFOA story. Some of the intermediates in the FTOH-to-PFCA pathway are 10,000 times more toxic than PFOA to *Daphnia*, a freshwater planktonic crustacean used as a "canary" for studying toxicity of chemicals in aqueous systems, Mabury says.

One unique aspect of the PFOS and PFOA compounds is that they are not lipophilic like other persistent organic pollutants. So instead of binding to lipids and being stored away in fat, the electrophilic intermediates might form covalent adducts with proteins and nucleic acids, Mabury says. That has several implications in the hunt for more sustainable replacements, he notes.



PFOS



A perfluoroalkyl sulfonamidoethanol (PFASE)

The new shorter chain compounds have less steric hindrance than the longer chain analogs and thus a higher potential to interact with biomolecules, Mabury believes. "It may be that the longer chain compounds are less toxic because of steric hindrance," he says. "But it also is possible that if the shorter chain compounds are more reactive, then their half-lives are so short that their toxicity is less important. That is something we still need to find out."

IN ADDITION, an important difference between the PFOS and PFOA groups of chemicals is that the sulfonamide group in PFASEs acts like a wall between the reactive functional group and the nonreactive perfluoroalkyl chain, limiting further reactivity. FTOHs don't have that wall, Mabury points out, meaning they are more likely to form electrophilic intermediates and potentially be more toxic.

Either way, Mabury is convinced that all perfluoroalkyl compounds with reactive end functional groups—regardless of chain length—will ultimately end up as stable perfluoro acids in the environment. He agrees that removing residuals such as FTOHs and going with the shorter chains is a start toward reducing exposure. But to fully resolve the perfluorochemical problem, chemical makers will need to alter the basic chemistry so the molecules can degrade to innocuous compounds in the environment, Mabury suggests.

Currently, there are no U.S. standards for PFOS or PFOA in food or drinking water. But now that PFOS and PFOA are becoming better understood, federal agencies are edging toward stronger regulatory control (see page 24). Several states have already set their own drinking water guidance in the range of 0.04 to 2.00 ppb. In January 2009, EPA announced nonbinding provisional health advisories for drinking water of 0.2 ppb for PFOS and 0.4 ppb for PFOA.

And DuPont and 3M joined forces to fund a study led by former EPA toxicologist Robert G. Tardiff of the Sapphire Group consulting firm to determine a "drinking water equivalent level" (*Food Chem. Toxicol.* **2009,** *47,* 2557). The study concluded that a safe level of lifetime exposure to PFOA in drinking water is up to 6.5 ppb; average levels of PFOA in drinking water are below 1 ppb, with the exception of water found near some industrial sites,

where the average level is 3.5 ppb, according to the study.

In May of last year, PFOS and its associated chemicals were among nine new sets of chemicals added to the original "dirty dozen" list of persistent and bioaccumulative chemicals under the Stockholm Convention on Persistent Organic Pollutants (C&EN, May 18, 2009, page 9). And last month, EPA established the first "chemical action plans" for certain chemicals, including PFOS and PFOA, which could extend the reach of the PFOA stewardship program to include a ban on some chemicals (C&EN, Jan. 11, page 9).

"We now have a lot of the pieces to understand PFOS and PFOA—we know about exposures from water, air, and food—but we still are not certain how important each of them is," EPA's Krasnic says. EPA is working to determine if revised drinking water health advisories are needed for PFOS and PFOA. That assessment, scheduled to be completed by the end of this year, "will in part drive whatever additional action we will need to take," he adds.

Like other companies in the stewardship program, DuPont has been busy introducing new technologies as it eliminates PFOA and long-chain FTOHs. For example, the company's new Echelon technology removes 99% of residual PFOA from metal, fabrics, architectural materials, and electronics coated with fluorotelomer polymers. The company also developed short-chain PFOA replacement technology for fluoropolymer production and has used it in global manufacturing facilities to make product test materials for its customers and for regulatory approval.

"OUR REPLACEMENT technologies aren't just a drop-in solution," Boothe says. "We are talking about hundreds to thousands of variations of these products that each have to be qualified with our customers and their customers all the way down the value chain in order for them to be viable. We took a risk in committing significant resources to address this issue, and that risk paid off—this was a big transformation."

EPA is taking a more active role in working with companies as they develop the short-chain replacements, Krasnic says. "To date, we have seen more than 100 chemical replacements for the PFOS and PFOA chemicals," he notes.

As the new chemicals are evaluated and go on the market, they are accompanied by a binding agreement that puts limits on the production and use, Krasnic adds. If data in the future show that there is a concern for these chemicals, the agreements serve as a mechanism for dealing with them without having to take regulatory action.

Looking further down the road at possible nonfluorinated alternatives or compounds that are fluorinated differently, "we are seeing some of those as well," Krasnic notes. "But so far that is confidential business information that EPA can't disclose. A lot of companies have made it clear that the shorter chain fluorochemicals are not the final PFOS or PFOA replacements but are intermediate chemicals until better alternatives can be developed.

"We realize we have to be really careful in how we deal with any new compounds that come in because the problems with PFOS and PFOA were a surprise to us in 2000," Krasnic adds. "We don't want to be surprised again." ■

CHEMTURA TO SHUTTER SOME ARKANSAS ASSETS

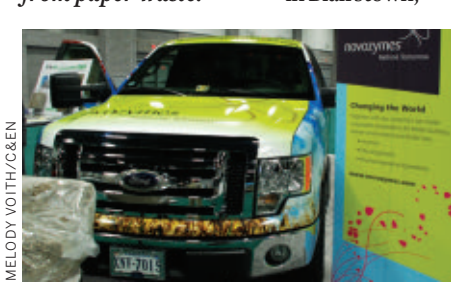
Chemtura is restructuring operations at its El Dorado, Ark., facility that makes bromine and its derivatives. The company will idle its South plant to free up assets to make new brominated flame retardants. In addition, the company will consolidate its Central plant into its West plant. Chemtura recently signed an agreement to acquire the remaining 17% interest in certain Arkansas bromine assets from Albemarle and have that company manufacture flame retardants and other brominated products for it under contract (C&EN, Jan. 25, page 9). Chemtura says the restructuring plan will cost it about $40 million.—AHT

BUNGE SELLS OUT TO BRAZIL'S VALE

White Plains, N.Y.-based agricultural giant Bunge is selling its Brazilian fertilizer manufacturing assets to Brazilian mining group Vale for $3.8 billion. In the deal, Vale will get Bunge's two phosphate rock mines and four phosphate fertilizer processing plants in the country. It is also buying Bunge's 42% stake in Fosfertil, a major Brazilian producer of phosphate rock, phosphate fertilizers, and nitrogen fertilizers. Bunge's retail fertilizer business was not included in the sale. Vale has large phosphate and potash assets and wants to grow its business.—AHT

GOVERNMENT WASTE FUELS TRUCK

Danish enzyme maker Novozymes demonstrated vehicles powered by ethanol derived from government waste paper at the Washington Auto Show, in Washington, D.C., last week. Fiberight, which makes ethanol from municipal solid wastes at a demonstration plant in Blairstown, Iowa, created the fuel from paper trash provided by the National Security Agency. Novozymes supplied a specialized cocktail of enzymes to break down the paper into sugars before being fermented into ethanol.—MV



MELODY VOITH/C&EN

Ford F-150 pickup truck fueled with ethanol from paper waste.

CLARIANT TO CUT 500 JOBS

Swiss specialty chemical firm Clariant plans to cut an additional 500 jobs during the first half of this year. According to a Clariant spokesman, CEO Hariolf Kottmann revealed the cutbacks at a recent investor conference. The new layoffs will come on top of 3,200 layoffs revealed last year. The firm will provide details when it announces fourth-quarter earnings on Feb. 16. According to the spokesman, the cutbacks are a continuation of the firm's production optimization strategy. In November 2009, the firm said it was weighing closure of sites in Huningue, France; Pontypridd, Wales; Cuernavaca, Mexico; Onsan, South Korea; and parts of plants in Gendorf and Frankfurt, Germany (C&EN, Nov. 30, 2009, page 18). The spokesman says the firm is still reviewing assets for closure and it expects to "nominate" additional plants for closure in mid-February.—MSR

FUJIFILM, IBM CRAFT DATA STORAGE TAPE

Fujifilm and IBM have developed a high-density data storage tape cartridge capable of holding 35 terabytes of data, which is more than 40 times the capacity of current cartridges, the companies say. A terabyte is 1,000 gigabytes. The new magnetic tape is made with a technology that uniformly disperses a coating of barium ferrite microparticles onto a tape. Because of a surge in worldwide data storage volume, Fujifilm says, customers need tapes capable of storing more information than previously possible.—JFT

ENERDEL TO BUILD INDIANA BATTERY PLANT

Lithium-ion battery maker EnerDel says it will invest $237 million in a new plant near its Indianapolis headquarters. The firm will manufacture batteries for all-electric and hybrid cars and will also make large batteries for stationary smart-grid applications. EnerDel plans to pay for the plant in large part with public dollars. The company has received $70 million in state and local awards and $118.5 million in a grant from the American Recovery & Reinvestment Act of 2009. The plant will employ 1,400 people and have the capacity to produce batteries for 600,000 hybrid electric or 60,000 all-electric vehicles.—MV

LANXESS BUILDS MEMBRANE PLANT

Lanxess is building a $40 million water filtration membrane production facility in Bitterfeld, Germany, where it already manufactures ion-exchange resins for water filtration. Sites in Singapore and Spain were also considered, but Bitterfeld won because of access to researchers at nearby universities. Work on the 43,000-sq-ft facility marks Lanxess' entry into the market for membrane water filtration based on new proprietary technology.—MSR

LANXESS

A rendition of the new membrane facility.

PARTNERS IMPROVE FIRE-FIGHTING SUITS

Fiber producer Teijin and materials maker Hosokawa Micron have created a new *para*-aramid-based fabric for use in fire-fighting suits. Suits made with the material will reduce the risk of second- and third-degree burns by 40% compared with *p*-aramid fabrics now in use, tests by the two companies show. The new suits are also 15% lighter than current versions, reducing firefighter fatigue and the likelihood of heatstroke. Teijin made the fabric using a new process that kneads Hosokawa-invented nanosized

carbon particles into the fabric. The two Japanese firms say they plan to commercialize the fabric soon.—JFT

ASTRAZENECA TO CONSOLIDATE R&D

AstraZeneca plans to cut 8,000 jobs across the firm by 2014. The new cuts, about 12% of the workforce, come on top of 15,000 job cuts previously announced, 12,600 of which were already eliminated over the past two years. Within R&D, the firm plans to cut as many as 3,500 positions to realize annual savings of $1 billion. AstraZeneca also said it would restructure R&D by reducing the number of disease-area targets, expanding contract research, and consolidating research sites.—MSR

INVESTORS REVIVE DECODE GENETICS

A consortium of investors have revived Icelandic biotech firm deCode Genetics as a private company with fresh financing after its parent company declared bankruptcy in November 2009. Saga Investments, which includes Polaris Ventures and Arch Venture Partners, bought the firm from its publicly held parent company, which has changed its name to DGI Resolution while it liquidates remaining assets. With Earl M. Collier Jr., former executive vice president at Genzyme, at the helm and deCode's former CEO Kári Stefánsson as president of research, the new deCode will continue to sell diagnostic tests, offer personal genome scans, and provide a range of contract services. deCode was started in 1996 to tap into the homogeneity of the Icelandic population in order to determine the genetic underpinnings of disease. Although the company found endless "links" to diseases, it failed to translate those data into products.—LJ

IPSEN, INSPIRATION JOIN ON HEMOPHILIA DRUGS

France's Ipsen and California-based Inspiration Biopharmaceuticals have formed a partnership for recombinant-protein-based hemophilia drugs. Ipsen will acquire a 20% stake in Inspiration for $85 million, with the potential to increase ownership to 47% through $174 million in additional funding. Inspiration will get a license to Ipsen's OBI-1, a hemophilia drug set to enter Phase III clinical testing this year. Inspiration is developing IB1001, also set to start Phase III trials this year. The partners say Inspiration's enlarged hemophilia portfolio could have $1 billion in sales by 2020.—MM

PFIZER INKS INFORMATICS DEALS

Pfizer has inked a licensing agreement with Tripos under which it will use the software firm's Discovery 360 drug discovery informatics platform at Pfizer research facilities worldwide. As part of the deal, Pfizer has licensed Tripos the rights to certain of its in-house laboratory informatics systems. Pfizer also signed an agreement with ChemAxon to use the Hungarian company's Markush structure enumeration cheminformatics platform. Separately, Pfizer said that after its October 2009 merger with Wyeth, combined R&D assets comprise 133 programs in clinical trials and 500 projects ranging from discovery through registration. Before the merger, the two firms had a total of 600 projects under way.—RM

VASELLA STEPS DOWN, JIMENEZ UP AT NOVARTIS

NOVARTIS

Vasella

Daniel Vasella, 56, Novartis' CEO, has stepped down after 14 years. Joe Jimenez, 50, head of Novartis' pharmaceuticals division, replaces Vasella, who will remain chairman, a position he has held for the past 11 years. Novartis' board selected Jimenez over Chief Operating Officer Joerg Reinhardt, a German researcher who was instrumental in the development of Novartis' vaccines business. Reinhardt will leave the company.—RM

BUSINESS ROUNDUP

AIR LIQUIDE will invest $42 million to increase production of oxygen, nitrogen, and argon in Panipat and Jhagadia, India. The firm will also invest $8 million in a new facility in Chennai, India, to produce cryogenic storage tanks.

THE SECURITIES & Exchange Commission has issued interpretive guidance regarding how companies are to treat the impact of climate change in their financial disclosure forms. SEC says climate-related factors that might make a material impact on companies' businesses include legislation, regulation, international treaties, interruption of business operations, and the positive or negative consequences of business trends.

NALCO will enter the $400 million water treatment market in and around South Africa by forming a jointly owned firm, Nalco Africa, with Johannesburg-based Protea Chemicals. The firms see a market not only for water and process treatment but also for air quality control.

PERSTORP will build a calcium formate plant at its site in Arnsberg, Germany. The Swedish firm says the plant will complement a potassium formate facility it opened in the summer of 2009. Calcium formate is used in feed additives and tile manufacture.

MERCK & CO. and Envoy Therapeutics will work together to find new targets for metabolic diseases. In exchange for research funding and an up-front fee, Envoy will use its technology that allows the identification of proteins produced by certain cell types without having to isolate the cells. Merck will develop compounds to modulate those protein targets.

MOMENTIVE Performance Materials has established a tire R&D lab in Charlotte, N.C., by purchasing assets from Continental Tire, which was ending R&D at the site. Momentive, a provider of silanes to the tire industry, says it has hired five former Continental researchers with a combined 160 years of tire development experience.

THE SANFORD-Burnham Medical Research Institute, in La Jolla, Calif., has secured a $50 million donation from philanthropist T. Denny Sanford to help the organization translate basic ideas into diagnostics and treatments. The gift follows a previous donation of $20 million from Sanford that enabled the creation of the Sanford Children's Health Research Center at Burnham's San Diego campus.

PMC BIOGENIX has opened the Center for Renewable Chemistry at its oleochemicals plant in Memphis. The firm says the center includes R&D labs and a pilot plant devoted to developing new products from renewable resources.

SOLAR MILLENNIUM

LOTS OF MIRRORS Solar Millennium is completing its Andasol project in Spain, which will have capacity for 150 MW of solar thermal power.

THE OTHER SOLAR

Chemical makers see a new alternative-energy market in CONCENTRATING SOLAR POWER

ALEXANDER H. TULLO, C&EN NORTHEAST NEWS BUREAU

ANYBODY WHO has burned leaves with a magnifying glass understands the idea behind concentrating solar thermal power. But the technology is more than just child's play. For many companies, including the chemical firms that sell the heat-transfer fluids that are the lifeblood of the concentrating solar plant, it's becoming a serious business.

Concentrating solar power (CSP) couldn't be more different from its better known cousin, photovoltaic power, which takes advantage of the photoelectric effect. When photons hit cells made of polycrystalline silicon or other materials, they set electrons into motion, electrifying a circuit.

CSP works under a much more primitive principle: using the sun's rays to heat something up. Under the dominant form of CSP technology today, parabolic mirrors focus sunlight on a glass tube. Heat-transfer fluids running through a steel pipe inside the glass tube warm up to nearly 400 °C and heat water to produce steam for a conventional turbine generator.

The two technologies are used in different ways. The emphasis of photovoltaic power is generating electricity at the end-use location. CSP, especially parabolic trough technology, is meant to be operated at an industrial scale.

The heat-transfer fluids of choice for parabolic troughs are blends of diphenyl oxide and biphenyl supplied by Dow Chemical and Solutia. These molecules have a long history. Dow has been making diphenyl oxide commercially since 1924. Biphenyl was chlorinated to make polychlorinated biphenyls (PCBs), coolant and insulating liquids that were banned about 30 years ago.

Because they are stable molecules that remain liquid under low pressures from ambient temperatures up to about 400 °C, diphenyl oxide and biphenyl lend themselves to CSP, according to Ravi Prakash, market development manager for specialty fluids at Solutia. "There are few other fluids out there that can do the same things," he says.

After a 20-year hiatus, CSP is coming back into vogue, with new plants starting up in the southwestern U.S., Spain, and North Africa. But the temperature limits of diphenyl oxide-biphenyl blends are a barrier to making CSP more efficient, and scientists are looking for alternatives that can perform at higher temperatures.

At a December alternative-energy conference organized by the Chemical Development & Marketing Association and held at the University of Pennsylvania, Gilbert E. Cohen, president of the Morrisville, N.C.-based consultancy Eliasol Energy, profiled CSP's history. In 1912, the U.S. inventor Frank Shuman built the world's first parabolic trough plant to power an irrigation system in Egypt. But the technology didn't catch on. Although Shuman's concentrator design was not much different from today's, "the apparition of 'quasi-inexhaustible' fossil fuels came out to be a more attractive and cheaper fuel supply," Cohen told conference attendees.

In the wake of the late-1970s energy crisis, the Israeli firm Luz International collaborated with the U.S. Department of Energy to build nine parabolic trough plants in California's Mojave Desert from

& MORE ONLINE **See a schematic of a concentrating solar plant with thermal storage by clicking on this story at www.cen-online.org.**

1985 through 1991. Still in operation today, they have a combined capacity of 354 MW. The first of these plants is based on a mineral oil heat-transfer fluid. The rest use diphenyl oxide and biphenyl supplied by Solutia's predecessor, Monsanto.

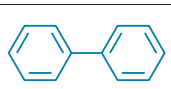
It wasn't until 2007 that another large-scale CSP plant was completed in the U.S. Spain's Acciona Energy built the 64-MW Nevada Solar One parabolic trough complex at a cost of $266 million. Spain itself has been another hotbed for CSP development. The most ambitious project in the country was initiated by the German firm Solar Millennium and consists of three plants, named Andasol 1 to 3, each with a capacity of 50 MW. The first one opened in 2008. Unlike the Mojave Desert units, which use natural gas to supplement solar production, the Andasol plants include tanks of molten nitrate salts to store energy so they can run at night.

THESE PLANTS might be just the first few flakes of a coming blizzard. In California alone, the Federal Bureau of Land Management has received right-of-way requests for 34 CSP plants, largely parabolic trough setups with more than 50 MW of capacity apiece. In Spain, more than 30 trough plants are planned. According to a report compiled by the market research firms CSP Today and Altran, about 680 MW of CSP capacity is operating today around the world; capacity for another 2 GW is under construction.

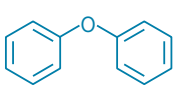
For Dow and Solutia, business in diphenyl oxide-biphenyl blends for CSP has been brisk. Dow fluids are used in six Spanish projects with a total of 300 MW of capacity, including 2,000 metric tons of fluid that Dow delivered to each of two of the Andasol plants. It also delivered 1,500 metric tons to fill Nevada Solar One.

Dow won another eight contracts for 2010, according to Christoph Lang, a technical service and development specialist for the firm's heat-transfer fluids business. Among the various industrial sectors that the business serves, CSP has the greatest growth potential, he notes.

Solutia fluids are used in a 50-MW plant in Spain and in natural gas/solar hybrid plants in Algeria, Egypt, and Morocco with capacities of 170, 150, and 470 MW, respectively. "This is an exciting market," says Richard Altice, vice president of commercial services at Solutia's technical specialties business. "And our belief is that it will have more staying power than the initial installations in the 1980s. Climate change and energy security are different types of drivers than we saw then."



Biphenyl



Diphenyl oxide

Diphenyl oxide-biphenyl blends may be a good fit with CSP, but developers of the technology hope someday to have fluids that offer even better performance. Greg Glatzmaier is a senior engineer overseeing heat-transfer-fluid and thermal-storage research at the National Renewable Energy Laboratory (NREL) in Golden, Colo. He points out that at temperatures above 390 °C, biphenyl polymerizes, whereas diphenyl oxide undergoes a reaction that forms a bond between two phenyl groups of the same molecule.

Both reactions give off hydrogen, which dissipates through the metal pipe and into the glass tube, disturbing a vacuum that prevents heat loss by conduction. Because of this problem, the operating temperature of CSP plants that use diphenyl oxide-biphenyl blends must be kept below 400 °C.

The temperature limitation restricts the efficiency of converting heat into electricity at the plant's steam turbine to about 38%,

Glatzmaier says. Unencumbered by diphenyl oxide and biphenyl, CSP plants could in principle run at up to 500 °C. "If you can go higher, that conversion temperature goes up," he notes. In addition, hotter heat-transfer fluids would raise the temperature of the molten salt storage medium, increasing the amount of energy the salts can store.

Better heat-transfer fluids would improve the overall economics of CSP plants. Right now, parabolic trough CSP incurs a cost of about 18 cents per KWh. NREL's goal for the industry is to reduce that to 12 cents, bringing CSP closer to the 7 to 9 cents per KWh that natural gas power costs to generate.

Earlier in the decade, scientists investigated ionic liquids as alternative heat-transfer fluids, but they also ran into thermal stability barriers at higher temperatures, Glatzmaier says. Another alternative is molten salts. They can run at temperatures as high as 600 °C, but their freezing point of 120 °C or more poses a problem in plants that have miles of pipe, Glatzmaier points out.

SCIENTISTS CAN reduce the freezing point of salts by mixing different ones together. For example, Robert W. Bradshaw at Sandia National Laboratories has used calcium and lithium nitrate to decrease the melting point of sodium and potassium nitrate mixtures.

Last April, DOE awarded Sunnyvale, Calif.-based Symyx Technologies $1.5 million for a three-year project to come up with CSP heat-transfer fluids with an operating temperature range of 80 to 500 °C. However, at the end of the year, the company elected not to continue the project.

Symyx used high-throughput experimentation to test 5,000 different salt combinations, says Justin Raade, who was the principal investigator for the program. Although he won't say how close to the target melting point the research group came, he notes, "We did make progress."

Dow has been working to find heat-transfer fluids that can tolerate higher heat. Lang won't reveal more details, although he does note that the company markets Syltherm 800, a polydimethylsiloxane fluid made by Dow Corning that doesn't produce hydrogen at high temperatures. It also has a lower freezing point than diphenyl oxide-biphenyl blends' 12 °C, which might make it suitable for colder climates.

However, Syltherm 800 doesn't have the heat capacity or the density of the organic fluids. And it has yet to be used in a CSP installation.

Manufacturers of diphenyl oxide-biphenyl blends aren't standing still, either. According to Solutia's Altice, research shows that impurities exacerbate the instability of the mixture at high temperatures. Improving product purity could improve the fluid's already good performance. "The aromatic ring structure is one of the most thermally stable structures that are out there," he says.

Dow's Lang agrees, noting that CSP plants will continue to use diphenyl oxide-biphenyl for the foreseeable future. "After more than 80 years, there is still no other organic fluid that we have found with a higher thermal stability," he says. "It is really suitable for this solar application." ■

LIMITED CAP-AND-TRADE PROGRAM

Mandatory **CARBON DIOXIDE TRADING SYSTEM** for power producers thrives in 10 northeastern states

A CARBON DIOXIDE cap-and-trade program has operated for more than a year in the northeastern U.S., generating $494 million in 2008 and 2009 for energy-saving projects in the 10 states involved. Many say the auction process has been a success so far, but others caution that it is too soon to call it a viable means to limit emissions of climate-changing gases.

In the program, called the Regional Greenhouse Gas Initiative (RGGI), operators of fossil-fuel-fired electric power plants must buy rights to emit carbon dioxide from an interstate agency. Excess rights can be traded or sold on exchanges, but the amount participants can buy each year is capped and gradually ratcheted down.

Operators and participants in the trading program say it works and proves that a national cap-and-trade scheme can function without significantly increasing energy costs. In fact, admirers call RGGI a model for a national cap-and-trade program. However, RGGI has operated only since September 2008 and does not cover emissions from industrial facilities, as is the case under proposed federal legislation.

Moreover, RGGI's goals are modest: a 10% reduction in carbon dioxide from regional power generators by 2018 from the average emissions from 2003 to 2005. Pending cap-and-trade legislation in the Senate calls for a 20% reduction in greenhouse gases from many sources, including chemical makers, by 2020 based on 2005 emission levels (C&EN, Oct. 5, 2009, page 10).

Critics contend that a national cap-and-trade program covering both power plants and industrial facilities could kill jobs and prosperity. "Cap and trade is a standard-of-living killer," says Bob D. McTeer, former Dallas Federal Reserve Bank president and now a distinguished fellow at the National Center for Policy Analysis, a Dallas-based think tank. "Perhaps it will mean a better standard of living down the road. But countries that adopt it now will be at a disadvantage to those that don't."

Chemical firms acknowledge that they need to lower carbon emissions, but many are concerned that taxes or cap-and-trade programs would increase their operating costs. "The chemical industry, being an energy-intensive industry, faces significant trade exposure," Calvin M. Dooley, president and chief executive officer of the American Chemistry Council, a chemical industry trade group, warned during a December press conference. "We need to have transition time to allow us to respond to what might be a higher price on emissions, as well as the higher price for energy supplies."

ALTHOUGH RGGI hasn't been around long, it has inspired the governments of other states to forge ahead with their own plans to set up carbon trading. These states also plan to cooperate together if the federal government doesn't act. Using RGGI as its model, the Western Climate Initiative, consisting of seven western states and four Canadian provinces, aims for a mandatory cap-and-trade scheme in 2012 covering utilities and large industrial installations.

The Midwestern Greenhouse Gas Reduction Accord, covering six states, hasn't set a date for its trading initiative yet. But it plans an RGGI-like cap-and-trade program covering all major pollution sources, says Douglas P. Scott, director of the Illinois Environmental Protection Agency.

Jonathan E. Schrag, executive director of RGGI, says the auctions "have been a huge success." Power generators, banks, industrial companies, environmental groups, and individuals can register to participate in three-hour Internet auctions for emission rights, each of which represents an authorization to emit 1 ton of carbon dioxide in RGGI states. The states require that power generators hold allowances equivalent to their emissions over a three-year period.

Because of reduced electricity demand during the economic downturn, emission rights sold at RGGI's quarterly auctions and subsequently traded in venues such as the Chicago Climate Futures Exchange have been plentiful and cheap. The price paid at auction for each emission allowance got as high as $3.50 but was about $2.00 at the December 2009 auction. Schrag says early studies suggested that emission purchases would raise the average consumer electric bill by about $1.50 per month based on a carbon price of $3.00 to $5.00 per ton.

But even if the economy revs up and emission credits become more expensive, Schrag argues that they will encourage power generators to invest in efficiency programs to generate more power with less fuel. Likewise, customers will conserve and install more fuel-efficient appliances. States, meanwhile, will use money raised at auction to fund fuel-efficiency projects and to aid poor consumers.

NATIONAL GRID

UP IN THE AIR National Grid's gas-fired power plant in Northport, N.Y., is subject to carbon emissions trading regulations.

Cap and trade, he says, will thus have a "self-regulating" effect.

Many other regulators are also convinced of the self-regulating effect of cap and trade. And even if federal legislation doesn't become a reality, Illinois regulator Scott points out, linking RGGI with the two other multistate greenhouse gas reduction efforts will create a trading area "covering more than 50% of the U.S. population and more than 50% of U.S. greenhouse gas emissions."—MARC REISCH

& MORE ONLINE For a map locating carbon-trading states and provinces, click on this story at www.cen-online.org.

TIGHTER STANDARD FOR NO_2 AIR POLLUTION

EPA has set a new one-hour air quality standard for nitrogen dioxide of 100 ppb, while retaining the existing annual average standard of 53 ppb. State and local regulators will have to use more monitors to track emissions of the pollutant. "For the first time ever, we are working to prevent short-term exposures in high-risk NO_2 zones such as urban communities and areas near roadways," EPA Administrator Lisa P. Jackson says. NO_2 is formed from vehicle, power plant, and other industrial emissions and contributes to the formation of fine-particle pollution and smog. Industry groups say the new air standard is unnecessary and will not significantly improve public health. The American Petroleum Institute, the main trade group for the oil and natural gas industry, says the standard is "bad public policy and does not justify the additional economic burdens placed on consumers, states, and industry." Public health advocates, such as the American Lung Association, call the one-hour limit "a step forward in the fight for cleaner, healthier air" but are disappointed a stricter standard was not adopted.—GH

KAFATOS EXITS EUROPEAN RESEARCH POST

The founding president of the European Research Council, Fotis C. Kafatos, announced he will give up his position at the agency. Established in 2005, ERC currently has a $10 billion budget from 2007 to 2013 for supporting research and investigators in Europe based solely on scientific merit, not on politics, economics, or geography. Kafatos, who was previously director-general of the European Molecular Biology Laboratory, in Heidelberg, Germany, will return to Imperial College London to "devote more time to my research laboratory," where he studies immunogenetics, he wrote in a statement. Kafatos will be remembered for "really getting ERC going" and for "defending and explaining" the need for ERC to the European Commission and other stakeholders, says Ernst-Ludwig Winnacker, former secretary-general for ERC and currently secretary-general of the Human Frontier Science Program, an international support program for research and training at the frontier of the life sciences.—SE

ERC

Kafatos

EPA TARGETS PERFLUORINATED POLYMERS

EPA is strengthening regulation of certain perfluorinated polymers that the agency said may degrade into compounds expected to persist in the environment, may bioaccumulate, and may be toxic (see page 12). Affected are polymers that contain perfluoroalkyl sulfonates, perfluoroalkyl carboxylates, fluorinated alcohols called telomers, and perfluoroalkyl moieties that are covalently bonded to a carbon or sulfur atom that is an integral part of the polymer molecule. These polymers are used to impart stain, oil, and water resistance, as well as reduced flammability in carpets and in coatings on paper and fabrics. Since 1995, EPA has allowed companies to produce or import most new polymers—including perfluorinated ones—without submitting premanufacture notices to the agency. These notices are required for most other new chemicals before they can enter the marketplace. Under a rule finalized on Jan. 27, EPA is eliminating that exemption for the affected perfluorinated polymers. Companies now must submit premanufacture notices for these polymers, stop making them, or ask EPA for an exemption applicable to substances produced in low volumes or to compounds expected to have low rates of release and exposure.—CH

HELIUM SELL-OFF NOT WORKING

The mandatory selling of helium from the government's stockpile required by the 1996 Helium Privatization Act is not in the best interests of the U.S., according to a report from the National Research Council. The Federal Helium Reserve is the only long-term storage facility for helium in the world, and it plays a crucial role in satisfying the world's helium needs. But the highly prescriptive law has created artificially high prices for the element and will cause the U.S. to become an importer of helium within the next 10 to 15 years. To help the situation, NRC recommends that Congress change the method for pricing the helium sold, that Congress commit more resources to managing the facilities at the helium reserve, and that scientists using helium get some assistance in purchasing and conserving the material.—DJH

U.S. STILL ILL-PREPARED FOR A BIOTERROR ATTACK

The U.S. government is not taking the necessary steps to protect the nation from the threats posed by weapons of mass destruction (WMD) and terrorism, a congressionally mandated panel concluded last week. "The assessment is not a good one, particularly in the area of biological threats," says a report by the Commission on the Prevention of Weapons of Mass Destruction Proliferation & Terrorism. "While the government has made progress on preventing such attacks, it is simply not paying consistent and urgent attention to the means of responding quickly and effectively so that they no longer constitute a threat," the report says. The commission criticized the White House and Congress for failing to build a rapid-response capability for dealing with bioterror threats and for not providing adequate oversight over homeland security and intelligence agencies. "Each of the last three Administrations has been slow to recognize and respond to the biothreat," says former Sen. Bob Graham (D-Fla.), commission chairman. The panel warned a year ago that unless countries take decisive action, it is "more likely than not" that a WMD terrorist attack will occur somewhere in the world by 2013 (C&EN, Dec. 8, 2008, page 6).—GH

SHUTTERSTOCK

SCHOOL LABS GO UNDER MICROSCOPE

Laboratory accidents in academia to be investigated by CHEMICAL SAFETY BOARD

JEFF JOHNSON, C&EN WASHINGTON

MARY BETH MULCAHY is one of two Chemical Safety & Hazard Investigation Board (CSB) investigators who this month will examine a chemistry department laboratory accident at Texas Tech University. It is the first investigation the safety board has ever done of a school lab accident, and safety experts tell C&EN it is long overdue.

The Jan. 7 accident at the Lubbock, Texas, campus put a 29-year-old student into critical condition at a hospital burn unit, where he remains. Preston Brown's research was part of a Department of Homeland Security (DHS) contract to study explosives.

It is unclear how common university accidents like this one are since there are no systematic academic lab accident records. But every lab rat has a story, including Mulcahy.

On a Saturday afternoon in the fall of 2001, she was hard at work at a University of Colorado chemistry lab bench, wrapping up an experiment and putting away her equipment. It was her second year as a chemistry department graduate student at the Boulder campus.

"I was cleaning my glassware with ethanol and nitric acid," she recalls to C&EN. It was a technique she'd learned from another graduate student who learned it from a postdoc who had come from Germany. She put the mixture in a waste bottle and began taking off her protective clothing and goggles.

"I thought I was done with the reaction when the bottle detonated. I got acid burns on my body and face, and glass blasted through my clothing and was embedded in my side. It cut a nerve in my elbow. It was messy," she says.

Shocked, she ran into the hall, yelling, and then hustled into the shower. "Nitric acid is a slow burn," she says. "You don't feel it right away but when you do, it really burns."

An alarm went off and the fire department arrived quickly and tried to set up a personal, private area for her to shower, but she wasn't waiting. She took a fast scrub, slipped on the fire department's Tyvek suit, and was taken by an ambulance to a nearby hospital. She wound up with stitches and burns, but didn't need surgery.

There was never a thorough investigation, she says. It merited a brief announcement in the Boulder newspaper since the alarm led to a building evacuation.

Mulcahy was using an old, but common technique, she says, and "one that others in my lab were also using. There were even references to it online." Her adviser was unaware students were using the practice and ended it after her accident.

Mulcahy points out that many graduate students and faculty can tell a story about their near-miss. There is a tension, many interviewed for this story tell C&EN, between the rush and excitement of student-led experiments and the considerations needed to ensure safety. Mulcahy said this dichotomy will be examined as part of CSB's investigation.

"LABORATORY inbreeding" is James A. Kaufman's term for the root cause of accidents like Mulcahy's. If schools lack a mandatory, formal lab safety training program, he says, the rite of passage into the lab for a new student researcher is to be taught lab practices by a more experienced grad student, and that, he says, is a big problem.

"Those graduate students eventually become faculty, and they never step out of the loop," says Kaufman, who is president and chief executive officer of the Laboratory Safety Institute, a Massachusetts-based lab safety training and education organization.

For over 35 years, Kaufman has collected information about more than 5,000 university and high school lab accidents. He estimates that academic lab accidents occur on a man-hour basis 10 to 50 times more frequently than chemical plant accidents.

His first job was at a Dow Chemical lab, where he spent the first day with his boss who talked about nothing but safety, Kaufman says. "I thought I must have gone to work at the most dangerous place in the world," he says. "I am going to die," he recalls thinking.

Two weeks later, the lab had an explosion and fire that cleared the place, but no one was hurt. And then two weeks after

"We have to change the paradigm where faculty and students say they never have had an accident."

that, an accident and explosion took place at his alma mater, Worchester Polytechnic Institute. "A graduate student was hurt who was doing six things I learned not to do at Dow during my first day. I visited the lab and saw broken-out windows, benches destroyed—and a student was crippled for life. Right then, I decided I would share my experience at Dow with schools."

Kaufman went on to prepare and publicize lab safety information for most of his life, often through American Chemical Society programs and workshops at national meetings.

He applauds CSB's decision to investigate Texas Tech, and for a decade, he says, he has urged the board to comprehensively examine high school and college lab accidents. "We have to change the paradigm where faculty and students say they never have had an accident, so why make such a big deal out of it?" He says they don't have statistics and they simply don't know.

It isn't a problem just at universities, Kaufman notes. A few weeks ago, on Jan. 19, an explosion ripped through a chemistry lab at Onteora High School, in Boiceville, N.Y., injuring seven students and their teacher. He also points to a much-cited and tragic chemistry class accident involving a methanol flash fire at Western Reserve Academy in Hudson, Ohio, in 2006. Eight people were injured, including two badly burned students and their chemistry teacher, as well as her nine-year-old son who was helping that day.

GETTING A NATIONAL perspective on the frequency and cause of school accidents could grow from the CSB investigation at Texas Tech, says CSB Chairman John S. Bresland. Depending on what the board turns up at Texas Tech, he says, CSB may embark on an examination of U.S. academic lab safety, which could happen next fall (C&EN, Jan. 25, page 7).

The board, Bresland says, has begun taking notice of school lab accidents, such as the tragic fatality a year ago at UCLA (C&EN, Aug. 3, 2009, page 29).

CSB searches for the root cause of chemically related accidents and has issued some 60 reports on accidents at industrial and distribution facilities. It has never investigated a school lab accident.

According to CSB, the injured Texas Tech student received severe burns and lacerations to his face and hands when a mixture of nickel hydrazine perchlorate exploded during the afternoon accident in the chemistry building. University officials told CSB the accident involved the detonation of a high-energy metal compound, most likely $[Ni(N_2H_4)_3][ClO_4]_2$. Texas Tech, the board reported, has an agreement with Northeastern University to study high-energy materials for DHS.

In a statement, Texas Tech Vice President for Research Taylor Eighmy said, "We appreciate the opportunity to collaborate with the U.S. Chemical Safety Board on the investigation of this incident. We look forward to completing our own internal investigation. Texas Tech is committed to safe practices and procedures. We have an excellent program in place, yet we believe this incident affords us an opportunity to proactively look at our safety training."

In an interview with C&EN, Eighmy would not comment on the accident's cause or lab damage, or provide information on the student, other than he was a graduate student and university employee. The university, he adds, will conduct its own investigation.

Texas Tech has "a very rigorous lab training program," he continues, but Eighmy would not comment on whether Brown had gone through the program, saying only "that is part of our investigation."

He adds that the federal Occupational Safety & Health Administration does not have jurisdiction at the university, and it was unclear if any state agencies would investigate. The question of what government bodies, federal and state, investigate school accidents is one of the issues CSB will examine, notes CSB investigations supervisor Don Holmstrom, who along with Mulcahy will conduct the board's investigation.

The board also will look at the responsibility of granting agencies for accidents that occur under their contracts as well as the employment status of experimenters—that is, are they students, postdocs, graduate students, or employees.

"This investigation will be very interesting," says Russell W. Phifer, safety consultant and past chair of ACS's Division of Chemical Health & Safety and its Committee on Chemical Safety. There is a need to improve the safety practices and culture at many university labs, he says.

"Maybe publicizing this particular investigation will wake up other institutions to the need to start paying attention and not lose track of the fact that there are hazardous materials and equipment in labs," he says.

A HUGE DIFFERENCE exists, he says, between university and industry labs. "There are industrial labs where the first time you are caught not wearing appropriate eye protection, you're fired. That would never happen in an academic lab. It is a difference in culture," Phifer says.

But there are rare instances where safety violations in academic labs have had ramifications. For example, a chemistry faculty member was fired at the University of Texas, San Antonio, in 2002 over safety issues, including unsafe chemical storage (C&EN, March 18, 2002, page 39).

TEXAS TECH U

ICEBERG TIP A CSB accident investigation at the Texas Tech chemistry building could lead to a national examination of school lab safety.

Phifer and Kaufman add that there is a strong need to educate principal investigators and university deans on the importance of safety. "By and large, grant production and money is what it is all about for many PIs, not all, but many. Work is the number one priority, and I think it should be safety," Phifer says.

He notes that there will be a presidential symposium on laboratory safety in academic institutions at the fall 2010 ACS national meeting in Boston. He hopes the symposium helps elevate lab safety among ACS members.

Additional reporting was done by Jyllian Kemsley and Stephen K. Ritter.

RAIL REFORM EFFORT GAINS MOMENTUM

Chemical shippers want Congress to tighten oversight of FREIGHT RATES

GLENN HESS, C&EN WASHINGTON

A BROAD COALITION of shippers that includes chemical manufacturers, electric utilities, and agricultural groups is pushing Congress to pass legislation this year that would overhaul federal freight railroad transportation policy for the first time in 30 years.

"Because of consolidation in the rail industry, we face a marketplace that sometimes results in lack of competition," says Calvin M. Dooley, president and chief executive officer of the American Chemistry Council (ACC), a trade group representing 135 major chemical manufacturers. "This leads to our industry paying significantly higher transportation rates than what could be justified if we had a more competitive marketplace."

The shippers' coalition, Consumers United for Rail Equity (CURE), is putting its support behind the Surface Transportation Board Reauthorization Act of 2009 (S. 2889), the bill that was unanimously approved on Dec. 17, 2009, by the Senate Commerce, Science & Transportation Committee (C&EN, Jan. 4, page 18).

"This is historic legislation," says CURE Chairman Glenn English, a former 10-term Democratic congressman from Oklahoma. "It is the first bill since 1980 to move out of the Senate Commerce Committee with customer-advocated improvements in the freight rail regulatory program."

English cautions, however, that "there is still much work to be done to see that consumer-oriented reforms included in this bill, as well as others advocated by freight rail shippers, are enacted into law and implemented. But this bill is an important step forward in the long effort to increase fairness and competition in the freight rail system."

Sen. John D. Rockefeller IV (D-W.Va.), chairman of the Commerce Committee and the bill's lead sponsor, says the measure addresses long-standing complaints by shippers about disadvantages they face when negotiating with the railroad industry over pricing. "We very much want the railroads to be successful, but we believe the playing field must be level," Rockefeller remarked at the Dec. 17 committee meeting to debate S. 2889.

"I initially came to this issue 25 years ago, after hearing from so many West Virginia shippers—coal and chemical shippers mostly—who came to me frustrated that their local railroad held incredible power over them," Rockefeller said. "Again and again, they told me that the two biggest cost factors pushing their operations overseas were energy costs and transportation costs."

OFFICE OF SEN. JOHN ROCKEFELLER

Rockefeller

As a result, Rockefeller said, he set out to try to understand and solve the difficult and complicated issues the shippers were facing, such as bottlenecks and terminal access. "This bill would fix these problems and prepare our rail regulatory structure to encourage a vital, robust rail industry," he said.

Since Congress passed the Staggers Rail Act of 1980, which largely deregulated the railroad industry, consolidation and mergers have left just a handful of large "Class I" carriers serving the U.S. market. There were 41 major freight railroads operating 30 years ago. Only seven remain today, and four of those companies—BNSF, CSX, Norfolk Southern, and Union Pacific—carry more than 90% of all rail freight. Shippers say this has resulted in regional monopolies, leaving many rail customers "captive" to a single railroad.

ACCORDING TO ACC, nearly two-thirds of chemical facilities that rely on railroads to deliver their products are served by only one carrier. "When a single railroad enjoys a monopoly, it does not need to quote reasonable rates to its customer or guarantee its service," says an ACC issue brief. Consequently, captive shippers "are routinely subject to poor service and exorbitant prices," ACC states.

The trade association says this is a significant problem for the chemical industry, which ships more than 170 million tons of chemicals and related products by rail each year. After coal, chemicals are the second-largest commodity transported by rail and represent more than 12%, or nearly $7 billion, of annual railroad revenue.

The Government Accountability Office (GAO), the investigative arm of Congress, has studied rail shipping rates several times over the past two decades. Reports released in 1999 and 2002 found rates generally decreased between 1985 and 2000. But a 2006 GAO analysis found that shipping rates increased slightly from 2001 to 2004. The report noted that even though rail rates across the industry have generally declined since enactment of the Staggers Act, "some shippers are paying significantly higher rates than others."

In 1995, Congress created the Surface Transportation Board (STB) to settle rate and service disputes between railroads and captive shippers. But shippers say the board has not been responsive to their concerns. "STB has consistently turned a blind eye to the substandard service and predatory pricing practices that have become standard operating procedure in the rail industry," says Robert G. Szabo, CURE's executive director and counsel. "STB rarely says 'no' to a railroad."

Cosponsored by Sens. Kay Bailey Hutchison (R-Texas), Frank R. Lautenberg (D-N.J.), John Thune (R-S.D.), and Byron L. Dorgan (D-N.D.), the STB reauthorization

"When a single railroad enjoys a monopoly, it does not need to quote reasonable rates to its customer or guarantee its service."

bill (S. 2889) would make the board an independent agency, removing it from within the Department of Transportation, where it currently resides. The board would be allowed to launch inquiries into railroad industry practices on its own, a reversal of current procedures that allow investigations only after a formal complaint is filed.

The bill would also expand the size of the board from three voting members to five and beef up STB's budget. And it would set lower fees for shippers to file complaints in small and midsized rate cases as well as create a rail customer advocate to help resolve shippers' concerns about service and rate issues.

In addition, S. 2889 would allow certain rate and practice disputes to be resolved by an arbitrator. And carriers would be required to quote a freight rate for each segment of a so-called bottleneck shipment, in which a single carrier serves an origin or destination facility, but another carrier has the ability to serve a portion of the movement from a nearby interchange point. Furthermore, the bill would authorize STB to require a railroad to make its terminals available to a competing carrier to provide access for captive traffic.

"Our legislation addresses rail shipper concerns while also taking into consideration the needs of the rail industry and the importance of maintaining a viable freight rail network," Hutchison remarked after the Dec. 17 Commerce Committee vote. "I am pleased that we have been able to reach a bipartisan consensus on what has been an extremely divisive issue for years and look forward to moving the legislation through the full Senate as soon as possible."

The bill is "an important step toward creating a more competitive and viable freight rail system," ACC's Dooley says. "We are glad to see that the bill enhances the role of STB and encourages it to proactively protect the rights of both the shippers and railroads."

Edward R. Hamberger, president of the Association of American Railroads, the main lobbying group for the freight rail industry, says he has "concerns about certain provisions in the bill" but is willing to work with Congress and the White House to craft final legislation that "ensures railroads can continue to make the investments that sustain a healthy national rail network."

Railroads have long warned that "re-regulating" the industry could threaten the profits that allow them to invest in track system upgrades. Since passage of the Staggers Act, freight railroads say they have invested more than $440 billion to revitalize the nation's rail infrastructure.

"This bill would be the most significant rewrite of the railroad industry's regulatory system in the past three decades," Hamberger says. "Under the bill, Class I railroads would be required to open their privately owned and maintained rail networks and would face vastly expanded government involvement in railroad operations."

Missing from the legislation is language that would end the railroads' long-standing exemption from federal antitrust laws. Unlike other transportation industries, such as trucking and airlines, freight rail is exempt from Justice Department oversight and needs only STB approval for mergers, acquisitions, and collective rate-making agreements.

The railroad industry has used its antitrust immunity to "consolidate the country's rail shipping down to four regional monopolies, giving these corporate behemoths tremendous monopoly pricing power that results in record profits at the expense of captive shippers," CURE's English says.

"We believe the bill needs to do more to fix outdated federal policies by including the antitrust measures approved last year by the Senate Judiciary Committee," Dooley says.

In March 2009, the Judiciary Committee unanimously approved legislation (S. 146) that would strip railroads of their antitrust exemption (C&EN, March 16, 2009, page 34). But the Senate measure and a companion bill in the House of Representatives (H.R. 233) have been held up by strong opposition from the Association of American Railroads, which says the legislation would create a scenario where multiple agencies have overlapping authority over railroads.

That would cause "nothing but confusion for the railroads and those charged with enforcing the regulations," Hamberger declares. "Overlapping regulatory schemes could derail the industry's ability to meet the nation's increased need for environmentally sound freight transportation."

Many businesses besides the railroads, including agricultural marketing cooperatives, newspapers, and soft-drink bottlers, operate with limited antitrust exemptions, Hamberger points out. "All aspects of railroad practices exempt from antitrust laws are subject to STB jurisdiction," he notes. "Eliminating the railroads' exemptions would not fill any void in the law. There is no justification for singling out railroads."

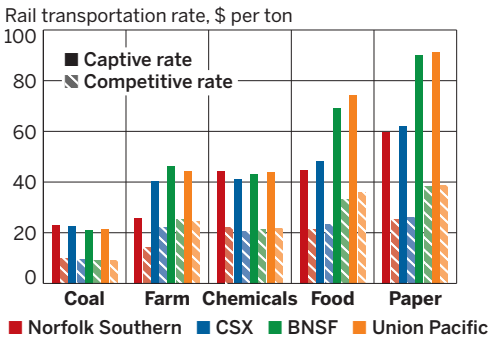
IT'S UNCLEAR whether an antitrust reform amendment could muster the 60 votes it would need to clear the Senate floor. But Sen. Herbert H. Kohl (D-Wis.), chief sponsor of S. 146, says he will push to "include an effective repeal of the railroads' antitrust exemption" in the STB reauthorization measure before the bill is considered by the full Senate later this year.

"The railroads' antitrust exemption is wholly undeserved, shared by virtually no other industry, and clearly anticompetitive," says Kohl, who chairs the Senate Judiciary Subcommittee on Antitrust, Business Rights & Competition.

Rockefeller says he has "long supported repealing the railroads' antitrust exemptions and greater antitrust scrutiny of the rail industry." And he will continue working with Kohl and other lawmakers, he vows, "to add antitrust reforms to our bill as it moves to the floor." ■

PRICING POWER

Customers served by only one railroad pay higher prices



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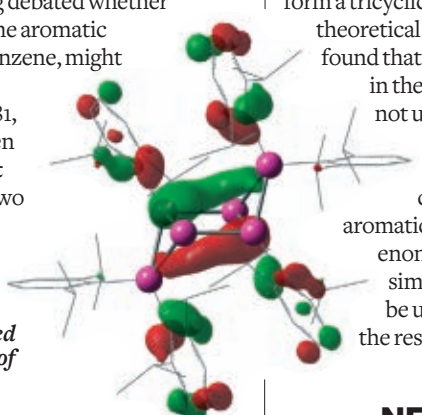
MAGNETICALLY PROBED PROTEIN INTERACTIONS

Biomolecular radicals are of growing interest—for instance, some scientists speculate they are the basis for a magnetosensitive compass that guides migrating birds. But magnetic-field-sensitive phenomena have been observed in few biological systems. Now, Kiminori Maeda, Christiane R. Timmel, and coworkers at Oxford University have used the magnetosensitivity of photoinduced radical pairs as a probe of protein-substrate interactions (*J. Am. Chem. Soc.*, DOI: 10.1021/ja908988u). Time-resolved absorption spectra of radicals generated from a tryptophan residue and an anthraquinone substrate, plus data on the dependence of radical concentration on magnetic field strength, showed that the substrate binds to the surface of hen egg white lysozyme but on the inside of a pocket in bovine serum albumin. Timmel notes that using a magnetic field to probe biomolecular radicals could make it possible to "learn about biomolecular dynamics, diffusion on surfaces, charge interactions, or surface potentials of biomolecules with a magnet no stronger than one you might find on your refrigerator."—SB

AROMATIC SILICON ANALOG FOR BENZENE

Chemists have long debated whether hexasilabenzene, the aromatic silicon analog of benzene, might ever be coaxed into existence. Until 1981, chemists didn't even realize that stable π bonding between two silicon atoms could occur at room temperature. Then in 1993, the first isomer of hexasilabenzene was made, but it wasn't aromatic. Now, a research team led by David Scheschkewitz of Imperial College London has built the first aromatic ring compound based on a scaffold of six silicon atoms (*Science* **2010**, *327*, 564). In particular, Scheschkewitz and coworkers used a systematic synthesis to couple two cyclotrisilanes containing zero, one, or two bulky triisopropylphenyl substituents on the silicon atoms. X-ray crystallography reveals that molecules in hexasilabenzene's bright green crystals form a tricyclic, chairlike conformation. In theoretical studies, Scheschkewitz' team found that the six delocalized electrons in the hexasilabenzene isomer are not uniformly distributed over the entire molecule as they are in benzene, leading them to coin the term "dismutational aromaticity" to describe the phenomenon. The hexasilabenzenes or similar compounds may one day be useful in optical electronics, the researchers note.—SE

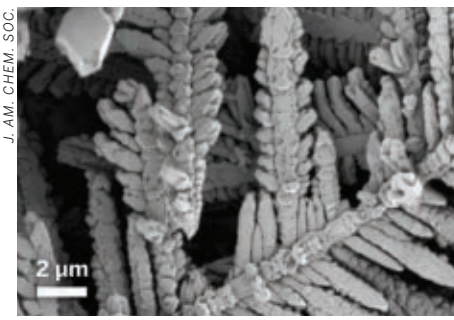


"Dismutational aromaticity" is on display in the highest occupied molecular orbital of hexasilabenzene.

SCIENCE

FOIL AND TAPE SERVE RAMAN

A simple method that generates a forest of silver dendrites on aluminum foil turns out to be ideal for creating material to use as a substrate in surface-enhanced Raman spectroscopy, or SERS (*J. Am. Chem. Soc.*, DOI: 10.1021/ja909806t). Since the 1970s, scientists have used metal surfaces to amplify the normally weak signals generated during Raman spectroscopy. Although the mechanism for the enhancement is still debated, researchers have produced numerous variations of substrates using different metals. But many of these processes are expensive and time-consuming. Roya Maboudian, Albert Gutés, and Carlo Carraro of the University of California, Berkeley, tried yet another approach: They soaked squares of aluminum foil in an AgF solution. After silver dendrites formed on the aluminum surface, they collected the pastelike silver and spread it on double-sided Scotch tape. The team used the novel substrate to obtain Raman spectra of 1,2-benzenedithiol, 1-phenylethyl mercaptan, and 2,2´-dithiodipyridine. The dendrite paste can be spread on any surface, the researchers note, making the process "an excellent candidate for analytical SERS control processes or for easy in-the-field measurements."—EKW



J. AM. CHEM. SOC.

An SEM image displays silver dendrites on aluminum foil.

NEWLY FOUND ENZYME DEGRADES 8-OXOGUANINE

8-Oxoguanine (8-oxoG) is produced by oxidation of guanine in DNA and is excised during DNA repair. What happens to the free 8-oxoG after it's removed? The answer to that question has been elusive because 8-oxoG isn't a substrate for any known enzymes that degrade guanine. Frank M. Raushel of Texas A&M University and coworkers have now found an enzyme in the bacterium *Pseudomonas aeruginosa* that deaminates 8-oxoG to form uric acid (*J. Am. Chem. Soc.*, DOI: 10.1021/ja909817d). Although the researchers have been unable to crystallize this 8-oxoG deaminase, they crystallized a homologous protein identified during environmental DNA sequencing of marine samples. The homologous protein has a single zinc ion bound to the enzyme in a similar way to what has been observed in cytosine, guanine, and adenosine deaminases. "I'm convinced there is much more to 8-oxoG and its roles in oxidative stress, from signaling to mutations, than is currently appreciated," says nucleic acid chemist Cynthia J. Burrows of the University of Utah. "The very nice work of Raushel and coworkers adds a piece to the puzzle, or perhaps enlarges the puzzle."—CHA

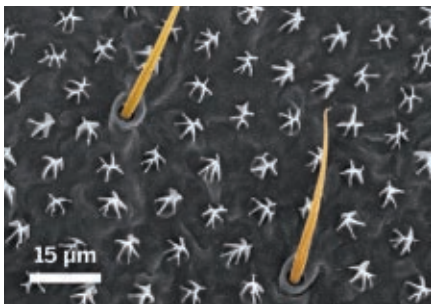
CONVENIENT ACCESS TO THORIUM CHEMISTRY

The burgeoning use of nonaqueous thorium chemistry in catalysis and materials science could benefit from a trio of anhydrous thorium complexes created by a team of Los Ala-

mos National Laboratory chemists (*Chem. Commun.*, DOI: 10.1039/b923558b). The complexes also could improve the prospects for developing thorium-based nuclear-power reactors (C&EN, Nov. 16, 2009, page 44). Anhydrous halide complexes are key starting points for synthesizing transition-metal, lanthanide, and actinide compounds. However, preparing thorium halides is hampered by tricky reactions that require harsh conditions and scarce thorium metal. Seeking a better approach, Thibault Cantat, Brian L. Scott, and Jaqueline L. Kiplinger refluxed commercially available thorium nitrate, $Th(NO_3)_4(H_2O)_5$, with 12 M HCl to produce $ThCl_4(H_2O)_4$ in quantitative yield under mild conditions. The team then used a novel combination of anhydrous HCl and $(CH_3)_3SiCl$ to remove the coordinated water molecules and replace them with dimethoxyethane (DME), 1,4-dioxane, or tetrahydrofuran solvent molecules to make the three new reagents. Kiplinger and coworkers demonstrated the versatility of $ThCl_4(DME)_2$ by using it to prepare thorium alkoxide, amide, metallocene, and other compounds on multigram scales.—SR

TINY FEATURES KEEP TERMITE WINGS DRY

Proving yet again that nature is a skilled nanotechnologist, scientists in Australia have discovered that termites keep their wings free of water using micro- and nanostructures on the wings' surface (*ACS Nano*, DOI: 10.1021/nn900869b). Compared with other insects, termites have a large wing surface area in relation to their body mass. They're also weak flyers and often take flight in the rain. All these things make them susceptible to becoming waterlogged. Gregory S. Watson and Jolanta A. Watson of James Cook University along with Bronwen W. Cribb of the University of Queensland therefore reasoned termite wings must have a water-repelling mechanism. Taking an extreme close-up of both *Nasutitermes* and *Microcerotermes* wings, the researchers noted star-shaped microstructures and tiny hairs with nanoscale ridges along the shaft. These ridges, they discovered, are critical. When the team coated a hair with enough hydrophobic polydimethylsiloxane to make the hair smooth, it lost its water-repelling power. "Understanding the interaction of water with surfaces through development of the scientific basis for these processes will ultimately lead to the next generation of advanced materials with attributes such as contamination resistance, self-cleaning, and for water collection and conservation," the researchers write.—BH

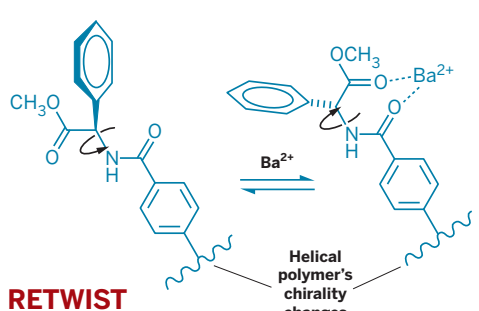


ACS NANO

SEM image of a termite wing reveals antiwetting hairs in sockets and star-shaped "micrasters."

HELICAL POLYMERS UNDER STEREOCONTROL

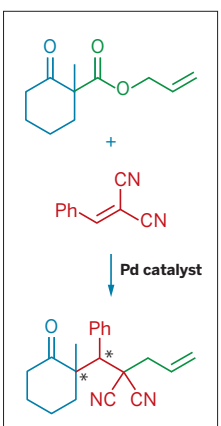
Polyphenylacetylenes, developed in the 1970s by Virgil Percec of the University of Pennsylvania and coworkers, adopt left- and right-handed forms. The polymers are under active investigation as possible molecular devices, chiral catalysts, and memory elements, among other uses, and their helical sense can be switched by changes in temperature, light, or solvent. But those control techniques are difficult, or they require that the polymer be bound to a surface—and none is reversible. José M. Seco, Ricardo Riguera, and coworkers of the University of Santiago de Compostela, in Spain, now report reversibly controlling polyphenylacetylene helicity by attaching chiral phenylglycine methyl ester pendant groups to the polymer backbone and then changing the conformation of the pendant groups by adding or removing Ba^{2+} or by modifying solvent polarity (*Angew. Chem. Int. Ed.*, DOI: 10.1002/anie.200905222). The researchers propose a detailed mechanism by which the Ba^{2+}-induced conformational change is transmitted to the polymer backbone. This is "a premier" study, Percec comments, noting that the reversible nature of the process could make the system useful for sensor applications.—SB



RETWIST
Adding or removing Ba^{2+} (or changing solvent polarity) induces a conformational change in a chiral pendant group, thereby modifying the helical sense of the polymer to which it is attached.

CASCADE REACTION TO CROWDED CARBONS

Making a quaternary carbon center is tough enough as it is, but that can pale in comparison to making a crowded tertiary center next to it. Caltech's Brian M. Stoltz, Jan Streuff, and colleagues have adapted a metal-catalyzed reaction to do both those things at once (*Nat. Chem.*, DOI: 10.1038/nchem.518). Stoltz's team previously developed a palladium-mediated process for making lone quaternary centers. The researchers wondered whether they might be able to intercept an intermediate in that reaction, presumably a palladium enolate, with another reactant. They imagined that the resulting cascade of events might lead to products with additional stereocenters. Inspired by another group's efforts in enolate chemistry, they found that electron-poor aryl-substituted malononitriles worked. In a cut-and-paste maneuver, the malononitriles replace an ester moiety on the β-ketoester starting material to make optically pure products with adjacent quaternary and tertiary stereocenters. So far, other electrophiles don't work as well as malononitriles. "You can imagine a list of other things you could trap that enolate with—we'd like to broaden the scope of the electrophile," Stoltz says.—CD



DOUBLED
A malononitrile (red) replaces an ester (green), making two new stereocenters (asterisks).

NASA (ALL)

LAB IN THE SKY The International Space Station on Nov. 25, 2009.

SCIENCE IN ORBIT

The future of research on the INTERNATIONAL SPACE STATION is up in the air

BETHANY HALFORD, C&EN NORTHEAST NEWS BUREAU

VERY FEW RESEARCH facilities exist where a broken toilet is as likely to make international news as a scientific breakthrough. But the International Space Station—or ISS as it's known in the acronym-rich world of NASA, the National Aeronautics & Space Administration—is no ordinary research center. Flying 200 miles above Earth, the space station's environment of microgravity makes unique scientific research possible and plumbing problems a major issue.

More than a decade after its construction began, ISS is nearly finished—at a cost of $48.5 billion. As the final pieces are bolted into place and crew members can begin shifting their focus from construction to conducting experiments, research on the space station faces an uncertain future. Scarce research funding, limited crew time for research, and few opportunities to actually fly new experiments onto the station all threaten to keep the unique research facility from achieving its potential.

In December, the Government Accountability Office released a report (GAO-10-9) that identified four major challenges for ISS (C&EN, Jan. 4, page 18). First, GAO noted that when NASA retires the space shuttles this year, opportunities to transport research cargo to and from the space station will be extremely limited.

A space shuttle can carry almost 38,000 lb to and from ISS, but the existing vehicles that NASA will rely on once the shuttles are retired—from space agencies in Russia, Japan, and Europe—have far less so-called upmass capability and virtually no downmass capability. So getting experiments up to the space station will be difficult, but getting them back down for analysis will be nearly impossible. Other vehicles from commercial space flight companies are in the works, but their ability to get to and from ISS hasn't been demonstrated yet.

Paying for experiments is also a major source of concern, GAO says. NASA estimates that it costs $44,000 per kg to launch an ISS experiment, and other agencies told GAO costs were much higher. The Department of Agriculture, for example, said its average payload cost was $250,000 for an experiment that fit in a compartment the size of a shoe box. Without dedicated funding for ISS, it's unclear how such costly experiments will be financed.

Although the ISS crew expanded from three to six last March, GAO worries that the fixed crew size and the many demands on crew members' time pose "a significant constraint for science on board the ISS."

Finally, GAO cites ISS's uncertain future as a major obstacle in attracting scientists to do research on the station. ISS is currently scheduled to be retired in 2015, which puts quite a crimp on any long-term scientific projects. The Review of Human Space Flight Plans Committee, a blue-ribbon panel established by President Barack Obama to assess NASA's plans for human exploration, has proposed extending ISS's mission until 2020. And Congress has requested that NASA ensure the station can stay viable until that time. Still, no commitment has been made to ISS beyond 2015, although that could change when Obama announces ISS's fate—likely sometime this week.

"I am convinced that stopping the station in 2015 would be a mistake because we cannot attract the best scientists if we are telling them today, 'You are welcome on the space station but you'd better be quick because in 2015 we close the shop,' " said Jean-Jacques Dordain, director general of the European Space Agency, at a press conference last month.

SCIENTIFIC RESEARCH on ISS was originally planned to encompass a wide range of disciplines in the physical and biological sciences. In 2004, however, NASA reoriented ISS's research priorities following then-president George W. Bush's plan to send Americans back to the moon by 2020 and to Mars after that. With this new mission, NASA chose to focus ISS research on the effects of prolonged time in space on humans and on the technology needed for such long-duration space operations.

Consequently, many space station research projects in the basic physical sciences fell by the wayside. However, Congress designated ISS a national lab in 2005, making about half of the station's space and crew time available to organizations other than NASA. The idea was that other agencies and private-sector organizations would make use of the station for experiments that no longer fit with NASA's mission.

John A. Pojman Sr., a chemistry professor at Louisiana State University, says he has yet to see such opportunities arise for his area of research, the behavior of miscible fluids in microgravity. Pojman had two projects scheduled for ISS that were canceled when NASA refocused its research priorities.

He was able to conduct some experiments in 2004 and 2005 when NASA called for projects that could be done with materials already on board ISS. Using water, Russian honey, and some urine collection

syringes, Pojman had the astronauts mix the miscible fluids and film their behavior.

"You're really dependent on which astronaut is doing the experiment and how much time they want to spend on it," Pojman says. The trouble, he explains, is that the crew has very limited time.

Automated experiments aren't necessarily any easier, Pojman says. Doing an automated experiment on the space station is like doing an automated experiment on a school bus full of kindergartners, he explains. "The children won't be able to help you, but they're going to be a safety risk."

One highly successful ISS project where automation is going to become far more important once the space shuttles are retired is the Materials International Space Station Experiment (MISSE). In MISSE, a suitcase-like metal container holds hundreds of mounted samples of different materials. The suitcase is attached to the outside of ISS so that these materials, which include everything from solar panels to space suit fabrics, are exposed to the ravages of space.

"These are experiments that can only be done in space," says Kim de Groh, a senior materials research engineer at NASA's Glenn Research Center. "Ground test facilities do not simulate exactly the combined atomic oxygen, temperature cycling, and radiation conditions of space," she says. Data from MISSE have been important, for example, in helping aerospace companies decide what materials to use when building satellites, de Groh notes.

MATERIALS TESTING MISSE-6 docked to ISS (right) and back on terra firma (left).

Robert Walters, head of solid-state devices at the Naval Research Laboratory and a principal investigator on MISSE, says MISSE projects are moving from so-called passive experiments, where materials come back to Earth for analysis, to active experiments, where the analytical instrumentation is built into the experiment and data are sent back to Earth in real time.

MISSE-7 is currently aboard ISS and MISSE-8 is scheduled to go up this summer. But the big question, Walters says, is with the shuttles retiring, how are we going to get MISSE-8 back home? The current plan is to send it back on *Dragon*, a vehicle that's being developed by the commercial space flight corporation SpaceX. "It's very risky for me because it's an unproven vehicle," Walters says.

ALTHOUGH MISSE has been tremendously successful, Walters notes that it's pretty low maintenance for the ISS crew. Aside from hooking it on and off the station, there's nothing for the astronauts to do. That's not the case for many of the other science experiments on board ISS.

"It's hard to do world-class science when you don't have world-class scientists up there doing it," says Albert Sacco Jr., a chemical engineering professor at Northeastern University. Sacco grew zeolite crystals aboard ISS in 2001 and 2002 and found that the microgravity environment created larger crystals and can be used to modify the number and location of lattice site defects. He wishes that NASA would bring more scientists on board ISS. The primary goal of the crew that's up there now is to operate the space station, he says.

Sacco also says he had a tremendous advantage in designing his ISS experiment—he was in the astronaut corps and flew on the space shuttle *Columbia* in 1995. "The skill set for space is actually quite different from the skill set you'd use on the ground," he says. "It takes years to learn how to utilize the environment so you do the right experiment and you do it correctly."

"Right now we can't do the kind of science that we'd call cutting edge," he points out, because the science is done at a distance. Everything must be done by computer, and it takes years to get a new experiment on board.

Lawrence J. DeLucas, director of the University of Alabama, Birmingham's Center for Biophysical Sciences & Engineering, was one of many investigators who crystallized proteins on ISS in 2001 and 2002. DeLucas and his colleagues found that in microgravity, they were able to grow crystals far superior to what they saw on the ground.

"It's sad that this program has been done away with," DeLucas says. "Instead of putting up 10 samples like we did back then, we now have hardware that will hold 1,000 samples."

He agrees with Sacco that it was frustrating to get results from an experiment and then not be able to send another up for a year or more. "You need constant access to the space station environment," DeLucas says. If you were able to send samples up every three months, he notes, "you could see a lot of projects turn the corner."

"We spent a lot of money on the space station, and we should be doing science on it," DeLucas says. "We're not doing enough of it. It's just a shame."

Such complaints are familiar to Julie Robinson, an ISS program scientist, although she says that they're uncommon among scientists currently working on ISS. What's important to keep in mind, she says, is that NASA and the ISS international partners are only now just completing construction on the station. "We have not yet seen the depths of what scientists looking at their particular discipline can accomplish," she adds.

Robinson notes that in the past three months, modules for combustion and fluid experiments have been installed on ISS, and a confocal microscope and microgravity glove box are also in place. "We now have really amazing infrastructure for doing physical science research," she says.

But Robinson also acknowledges that the challenges highlighted by GAO are legitimate. "The most important of those challenges is having the funding available," she says. "Scientists live or die by the funding they get."

Robinson also notes that if ISS is retired in 2015, it's unlikely to reach its full potential. "The challenge is in having the time to get the results and to do any follow-on investigations that need to be done to move a discipline forward," she says. "We need more than just five years to do that. We've never had this opportunity in space before, and we probably won't again for a very long time." ■

ACS INTRODUCES NEW POLICY STATEMENT

Society calls for more research and education on ENDOCRINE DISRUPTION

LINDA WANG, C&EN WASHINGTON

THE AMERICAN Chemical Society has issued a new official policy statement that calls for more research and education on endocrine disruption. The society has also revised five other statements that were introduced in 2007 and renewed a sixth without revision. The ACS Board Committee on Public Affairs & Public Relations (PA&PR) reviews policy statements every three years. All statements are available on the ACS website at www.acs.org/policy.

"Policy statements are a way for ACS to represent the interests of its more than 161,000 members and communicate them to policymakers in the government," says Ray Garant, assistant director of public policy in the ACS Office of Public Affairs and the Office of the Secretary & General Counsel. "We've had a lot of successes recently, including in the past year, with our members influencing what's going on in policy areas ranging from research funding to regulation of chemical sites for security-related matters."

ACS's new policy statement on endocrine disruption endorses expanded endocrine disrupter education and research and the development of more effective science-based and decision-making tools and methods for reducing and eliminating human and environmental exposure to these compounds.

For example, the statement calls for increased funding for improvements in testing for endocrine disruption with an emphasis on the development of assays that can serve as screening tests to model endocrine disrupting activity. It also seeks research funding to identify exposure pathways, uptake mechanisms, and trends in human exposure and its impact. The statement also supports greater funding for green chemistry research aimed at identifying and de-

& MORE ONLINE Various ACS committees are updating or creating new position statements. ACS members can contribute their thoughts on the statements by clicking on this story at www.cen-online.org.

POLICY POINTS

Current ACS Position Statements

All statements are online at www.acs.org/policy.

FOSTER INNOVATION THROUGH RESEARCH & TECHNOLOGY

Department of Defense: Calls for an 18% increase in basic research to $2.2 billion. Supports the President's proposal for a $300 million increase in peer-reviewed basic research.

Department of Energy: Supports a 3.5% increase to $169 million for the Office of Science.

Department of Homeland Security: Supports the proposal to increase funding by 3.8% to $968 million for the Science & Technology Directorate.

Energy Science & Technology: Calls for government, industry, and academia to develop a comprehensive science and technology policy.

Environmental Protection Agency: Supports Office of R&D funding to return to $646 million, representing a 10% increase. Opposes cuts to Science To Achieve Results extramural research and fellowships and calls for a return to a $110 million funding level.

Innovation & Competitiveness: Supports investment in a talented workforce through education and training, long-term commitments to basic research and technology development, and the development of a sustainable infrastructure for innovation.

National Institute of Standards & Technology: Supports a proposal of at least $652 million, which is a 1.2% increase, for the core programs under the Bush Administration's American Competitiveness Initiative (ACI) and calls for higher funding in keeping with the America Competes Act. Supports $535 million for NIST laboratories, representing a 13% increase. Opposes termination of the Technology Innovation Program and urges the authorized spending level of $140.5 million.

National Institutes of Health: Supports funding of $32.5 billion, representing a 7% increase.

National Science Foundation: Supports a minimum $7 billion, which is an 8.6% increase, under ACI and calls for higher funding in keeping with the America Competes Act. Supports funding for the NSF Math & Science Partnerships program to approach the authorized level of $123 million.

Patent Reform: Supports comprehensive reform of the U.S. patent system.

Various Agencies: Supports predictable and sustainable increases for the basic science agencies and cautions the Administration to focus on the long-term benefits of basic research rather than short-term economic impacts such as immediate job creation. Makes specific recommendations for eight agencies.

STRENGTHEN SCIENCE EDUCATION & THE SCIENTIFIC WORKFORCE

Computer Simulations: Says computer simulations

COURTESY OF CONNIE MURPHY

ON THE HILL Connie Murphy, a member of the ACS Committee on Chemistry & Public Affairs, visits her representative, Dave Camp (R-Mich.), to advocate for support of basic research and science education.

veloping functional alternatives that do not have endocrine disrupting activity.

PA&PR has also revised five statements that were introduced in 2007. The statement on energy strategy, which ACS drafted in partnership with the American Institute of Chemical Engineers, calls for government, industry, and academia to come together to develop a comprehensive energy science and technology policy. It recommends that "policymakers move promptly to designate a lead federal entity to coordinate these efforts, to fully fund existing federal programs in this area, and to support international collaborations and activities to coordinate energy strategy assessments with other nations" and that "policymakers continue to fund efforts such as those at the Environmental Protection Agency and Department of Energy to develop life-cycle assessment methodologies."

In its position on health care policy, ACS says that association health care plans can address some health care-related issues, but they are not an all-encompassing solution to the health care problem that society faces. Briefly, association health care plans, if approved by Congress, would allow nonemployer groups, including professional associations such as ACS, to offer health insurance to their members.

THE STATEMENT on science and technology funding makes specific recommendations for EPA, the National Institutes of Health, DOE, and the National Science Foundation. It urges the Administration to "focus on the long-term benefits of basic research rather than on short-term economic impacts such as immediate job creation."

that mimic laboratory procedures have the potential to be a useful supplement to student hands-on activities but not a substitute for them.

Department of Education: Supports the proposed $450 million, which is a 151% increase, for Math & Science Partnership program for K–12 teacher training and $95 million for the Math Now initiative.

Employment Nondiscrimination: Recommends federal legislation to extend employment discrimination protection to include sexual orientation, gender expression, and gender identity.

Evolution: Supports teaching of evolution and opposes alternative, nonscientific theories in the science classroom.

Health Care Policy: Supports access to affordable, quality health care for all Americans and sets out broad principles that should guide policy on association health care plans and other health care options.

Retirement Security: Calls for Congress to deal with major areas impacting financial and health security of retirees.

Science Education: Summarizes the science education policies of ACS.

ADVANCE SCIENCE THROUGH OPENNESS

Public Access: Opposes government-mandated free access to published research results. Supports 2005 NIH public access policy.

Scientific Freedom: Advocates freedom of scientific exchange and stronger scientific collaboration to benefit humankind.

Visa Restrictions: Supports timely screening for visiting scientists and students.

PROMOTE SCIENCE & SUSTAINABILITY IN PUBLIC POLICY

Biomonitoring: Reviews the science and interpretation of biomonitoring data on human health. Calls for research to improve the utility of biomonitoring information in policy.

Climate: Reviews the science and recommends action on global climate issues.

Endocrine Disruption: Endorses expanded endocrine disrupter education and research and the development of more effective science-based decision-making tools and methods for reducing and eliminating exposures of humans and the environment.

Inherently Safer Technologies: Endorses federal support of developing IST and greater use of IST in reducing risk.

Regulation of Laboratory Waste: Reviews the pitfalls of regulations that are intended for large-scale chemical manufacturing being applied to laboratories.

Scientific Insight & Integrity: Supports the use of insightful and comprehensive scientific and engineering research and analyses to assist the development and evaluation of policy options.

Sustainability of the Chemical Enterprise: Defines the concept of sustainability in the context of the chemical enterprise. Supports government incentives for sustainable technologies including regulatory flexibility, tax incentives, and research support.

The statement on innovation and competitiveness asks policymakers to support U.S. innovation through investments in education and training, "long-term commitments to basic research and technology development, and the development of a sustainable infrastructure for innovation."

Finally, the statement on the regulation of laboratory waste, among other things, encourages consistent interpretation and enforcement of regulations at the state and federal levels; recommends the elimination of the land disposal restriction notification requirement for laboratories; and proposes that legislation, rulemaking, and guidance allow qualified laboratory personnel to treat small quantities of hazardous waste without a permit.

THE COMMITTEE renewed the statement on inherently safer technology (IST) with no changes to the version introduced in 2007. The statement urges greater federal support of developing inherently safer technologies and their increased use. In a nutshell, the goals of IST in chemical operations are to minimize the potential for accidents, to aim for substituting less hazardous materials and processes, and to support design of safer equipment, among other things.

ACS members can play a role in shaping these policy statements and raising awareness about them among legislators. "There are many opportunities for members to be involved," Garant says. For example, members can join the ACS Legislative Action Network, which updates members on ACS-relevant federal legislation; join one of the nearly 100 local section government affairs groups; or serve on an ACS committee. Another way to contribute ideas is to join the Act4Chemistry forum on the ACS Network. All of these programs can be accessed at www.acs.org/policy.

The policy statements have produced results. In 2008, in an effort to influence state-level policy, ACS launched a pilot program to focus on enhancing K–12 science education. The pilot has become a full program in operation in five states. Garant says this year's goal is to develop state-based programs in two to six additional states so that more members have an opportunity to get involved.

ACS hopes that more members will join the effort to help shape public policy that affects the chemical enterprise. "The more members who participate," Garant says, "the stronger our voice is going to be." ■

LINDA WANG/C&EN (BOTH)

ACS BOARD ELECTS CHAIR, EXECUTIVE COMMITTEE MEMBERS

VACANCIES FILLED AND LEADERS ELECTED at December meeting of society's top governance body

AT ITS MEETING held on Dec. 3–5, 2009, in Arlington, Va., the ACS Board of Directors elected Bonnie Charpentier for a one-year term as its chair. It also selected three members to fill open slots on its Executive Committee: Diane Grob Schmidt, Eric C. Bigham, and William F. Carroll Jr. Schmidt was elected for a two-year term, Bigham will serve the remaining year of a two-year term previously h eld by Charpentier, and Carroll was elected for a one-year term.

As chair of the ACS Board, Charpentier is also chair of its Executive Committee. Current members of the ACS presidential succession—Nancy B. Jackson, Joseph S. Francisco, and Thomas H. Lane—are ex officio members of the Executive Committee. The ACS executive director and chief executive officer, Madeleine Jacobs, is the sole nonvoting ex officio member of the Executive Committee.

The duties of the committee are spelled out in the society's bylaws: "The primary responsibilities of the Executive Committee shall be to act ad interim for the Board of Directors in accordance with the provisions of the Constitution, and to provide oversight for all employee personnel policies and practices administered by the Executive Director."

For members who wish to observe, the ACS Board of Directors will meet in an open session on Sunday, March 21, from 10 AM to noon at the Marriott Marquis in San Francisco.

In addition to electing its Executive Committee, the board received various committee reports. These are printed here.—LINDA RABER

SOCIETY COMMITTEE REPORT

BUDGET & FINANCE

The Society Committee on Budget & Finance reviewed the society's 2009 probable financial performance and considered the 2010 proposed operating and capital budgets.

The society is expected to end 2009 with a net contribution from operations

PRESIDENTIAL Jackson (from left), Francisco, and Lane are the current ACS presidential succession and serve on the ACS Board of Directors and its Executive Committee.

of $11,530,000, or $858,000 favorable to the approved budget. After including the Member Insurance Program and new ventures, the society's projected net contribution for 2009 is $11,611,000, or $2,256,000 favorable to the approved budget. The society is projected to end the year in compliance with four of the five board-established financial guidelines.

Finally, the committee voted to recommend to the ACS Board of Directors that it approve a 2010 proposed operating budget with a projected net contribution of $10,810,000. The committee also voted to recommend to the ACS Board that it approve the 2010 proposed capital budget of $23,384,000.—DENNIS CHAMOT, CHAIR

BOARD COMMITTEE REPORTS

GRANTS & AWARDS

The ACS Board Committee on Grants & Awards (G&A) received the report that the Awards Impact Survey was sent in early November to the 2010 ACS national award recipients. The purpose of the survey was to collect data regarding the ways in which the ACS national awards program has altered the professional status of the 72 award winners.

Based on survey results, approximately 10 award winners will be asked to participate in in-depth, videotaped interviews (during the spring national meeting in San Francisco) focused on how their accomplishments can be and are used to improve the lives of everyday people. The series of interviews will be called "Prized Science," and the committee previewed a draft version of the first in the series, an interview with the 2010 Priestley Medalist, Richard Zare. The series will consist of six videos for students and nonscientists that will be posted to YouTube, the ACS Awards website, Twitter, ACS Press Pac, and others. The videos will also be used for promotional purposes, to illustrate best practices, to communicate the contributions that chemists make, and to add to performance measurement data.

The Awards Review Committee reported that it held a conference call to discuss process improvements for 2010. Acting under delegated authority, G&A voted to accept the guidelines for review of national awards, dated Nov. 10, 2009, with minor revisions.

Acting under delegated authority, the committee also voted to adopt the purpose, nature, and eligibility statements for the Parsons Award and the Priestley Medal as they appear on the ACS website and to invite the 2010 G&A Subcommittee on Nominations to develop a shorter nomination form for the national awards program.

Staff from the ACS Petroleum Research Fund (PRF) presented an update on the financial status of PRF. For fiscal 2009, ACS PRF funded 299 grants in support of advanced scientific education and fundamental research in the petroleum field for a combined total of $19.4 million. The ACS Committee on Pensions & Investments authorized a distribution of 5% of the end-of-the-year, three-year rolling average for fiscal 2010. It is estimated that this would give PRF a grant budget of approximately $18.5 million for fiscal 2010, assuming the financial markets remain the same or increase by the end of the year.

The committee discussed the request from the Division of Chemical Health & Safety to include safety as part of the award review process. At the August G&A meeting, the committee asked staff to draft a statement regarding the importance of safety. After a lengthy discussion, the committee decided not to add a statement regarding safety to the administrative guidelines on the awards website.

G&A was briefed on the status of the ACS Fellows Program, and acting under delegated authority, the committee voted to appoint a small transition working group for the program.

The committee then discussed whether ACS national award winners must be members of the society, and it was decided that ACS award winners do not need to be ACS members.

Acting under delegated authority, the committee voted to add the National Women's Hall of Fame to the list of external awards for which ACS generates a nomination, and the Committee on Patents & Related Matters has agreed to prepare the nomination materials for this award. G&A then voted to recommend to the ACS Board of Directors the Committee on Patents & Related Matters' selection of Helen M. Free, Edith M. Flanigen, and Ruth R. Benerito as the society's nominees for the National Women's Hall of Fame.

Acting under delegated authority, G&A voted to add the National Science Board Public Service Award to the list of external awards for which ACS generates a nomination, and the Committee on Public Relations & Communications has agreed to prepare the nomination materials for this award.—ERIC C. BIGHAM, CHAIR

PLANNING

The Planning Committee met to discuss the revision of the draft ACS Strategic Plan for 2010 & Beyond in preparation for approval by the board of directors in December. Input received from governance and members over the summer was incorporated along with new content that reflects important strategic developments. Key elements of the current plan, including the vision, mission, core values, and the essence of the six society goals, will remain intact. The plan will be posted at strategy.acs.org in early 2010, along with videos of board members describing the aspirations of each goal. The committee also began environmental scanning and scenario planning. Along with staff, it will merge existing and new information to inform the next annual cycle of strategic planning.—JUDITH L. BENHAM, CHAIR

LEADERS Charpentier (right) is the newly elected chair of the ACS Board of Directors and also chairs the Executive Committee, of which ACS Executive Director and CEO Jacobs is an ex officio member.

PROFESSIONAL & MEMBER RELATIONS

At its December meeting, consistent with the recommendation of the Membership Affairs Committee, the Committee on Professional & Member Relations (P&MR) approved a draft charter and voted to recommend to the board the establishment of a Joint Board-Presidential Task Force on Society Services & Associated Pricing Models to review dues-associated bylaws and explore changes to make ACS more competitive.

P&MR reviewed documents provided by the Professional Advancement Subcommittee and approved the proposed methodology and questionnaire content for the 2010 Membership Satisfaction Survey. P&MR also supported the subcommittee's recommendation to send a letter to the Committee on Economic & Professional Affairs (CEPA) expressing appreciation for the work of its Globalization Task Force and deference to CEPA on handling this issue going forward.

The Community & Network Building Subcommittee reported on the recommendations of the Divisional Activities Committee on the 2009 effort to post national meeting content online. Consistent with recommendations, P&MR approved the establishment of a Task Force on Electronic Dissemination of Meeting Content to set policy guidelines for this initiative. P&MR also approved a draft charter for a new P&MR subcommittee to develop and recommend policies on ACS Web strategies, continuing the work of the outgoing Board Web Advisory Group.

At the recommendation of the International Strategy Subcommittee, P&MR reviewed and voted to recommend to the board approval of draft bilateral collaboration alliance agreements with the Chinese Chemical Society and the German Chemical Society. P&MR also was briefed on recent activities to advance the International Year of Chemistry 2011, society-wide sustainability efforts, and the ACS Diversity Partner Program.—DIANE GROB SCHMIDT, CHAIR

PUBLIC AFFAIRS & PUBLIC RELATIONS

The chair opened the meeting of the Committee on Public Affairs & Public Relations (PA&PR) by highlighting several major governance activities:

■ ACS President Thomas H. Lane attended a White House press event where President Barack Obama announced the Educate to Innovate initiative.

■ ACS Executive Director and CEO Madeleine Jacobs participated in a December innovation conference panel with National Institutes of Health Director Francis S. Collins and Columbia University professor Brian Greene that discussed U.S. support for science.

■ Jacobs also participated in a meeting with House Speaker Nancy Pelosi and other members of Congress to discuss U.S. innovation strategies.

■ Committee member Jan Hayes testified before a California Assembly Committee in support of an ACS-sponsored resolution to establish a California Legislative STEM Education Task Force.

■ Lane attended a White House reception honoring the U.S. 2009 Nobel Laureates on Dec. 1, 2009.

The committee addressed five ACS position statements set to expire at the end of 2009 by acting on recommendations made by ACS committees and staff. The committee voted to adopt updated statements on innovation and on laboratory waste and to extend the statements on inherently safer technologies and public access to scientific research. The committee agreed to let the statement on labeling of chemicals expire.

The committee then discussed nominations received from the Committee on Chemistry & Public Affairs for the 2010 ACS Public Service Awards and voted to recommend to the full board of directors that it approve the nominations. The committee also discussed a nomination for a National Historic Chemical Landmark to recognize development of the nuclear magnetic resonance spectrometer and the invention of magnetic resonance imaging and voted to approve the nomination.

PA&PR received a presentation from staff of the Office of Public Affairs (OPA). The presentation covered the following topics:

■ Examination of the extensive media (print and electronic) coverage generated for the 238th national meeting held in Washington, D.C., in August, which reached a potential audience of 1.7 billion people.

■ Media coverage generated by ACS has nearly doubled from 2008 to 2009. The value of this earned coverage—if ACS had to purchase the space on the basis of advertising rates—was $6.6 million for the period of May to September 2009.

■ An OPA publication—"In Their Own Words"—a compendium of testimonials received from researchers whose work has been publicized by ACS.

■ Details were presented on ACS President-Elect Joseph S. Francisco's participation in the NBC "Science of the Winter Olympics" series, which is set to air in February.

■ A member survey revealed that 90% of respondents recognized the new ACS logo and tagline "Chemistry for Life" and that 83% were favorable to the new look. Chemistry Ambassadors now number in excess of 1,100, and local section Public Relations Committees have grown by 40% this year to 52.

■ The Legislative Action Network has grown to 18,549 members, and the number of local section Government Affairs Committees has increased to 97.

■ ACS legislative activities and a review of the 11 ACS Science & the Congress briefings held in 2009, with two additional briefings slated for December.

■ An update on the State Government Affairs program, its achievements, and plans to leverage a modest program expansion using existing resources.

■ An OPA update that covered the realignment of the National Historic Chemical Landmark program, reinstitution of the OPA Science Policy Fellow, and creation of a new Web/communications position in OPA.

The committee discussed activities that have led to the attainment of the 2009 committee goals.—BONNIE CHARPENTIER, CHAIR

COUNCIL MEETING

At its meeting in San Francisco, the ACS Council will receive oral or written reports from all ACS committees.

2010 ACS NATIONAL AWARD WINNERS

Recipients are **HONORED FOR CONTRIBUTIONS** of major significance to chemistry

FOLLOWING is the fifth set of vignettes of recipients of awards administered by the American Chemical Society for 2010. C&EN will publish the vignettes of the remaining recipients in February issues. A profile of Richard N. Zare, the 2010 Priestley Medalist, is scheduled to appear in the March 22 issue of C&EN along with his award address.

Most of the award recipients will be honored at an awards ceremony that will be held on Tuesday, March 23, in conjunction with the 239th ACS national meeting in San Francisco. However, the Arthur C. Cope Scholar awardees will be honored at the 240th ACS national meeting in Boston on Aug. 22–26.

ACS AWARD FOR ACHIEVEMENT IN RESEARCH FOR THE TEACHING & LEARNING OF CHEMISTRY

Sponsored by Pearson Education

Even when he first began teaching chemistry back in 1964, **Michael R. Abraham** already "felt the need for fundamentally different instructional materials and methods that would have a solid base in learning research and theory," he says. Rather than waiting for these tools to come along, he went to work to spur their development.

Through his research, Abraham, the David Ross Boyd Professor of Chemistry in the department of chemistry and biochemistry at the University of Oklahoma, has raised the bar on the "accepted good practices in the teaching of chemistry," according to Vickie M. Bentley Williamson, a senior lecturer in the department of chemistry at Texas A&M University.

COURTESY OF MICHAEL ABRAHAM

Abraham

Abraham, 68, has done "exemplary work studying the effects of inquiry-oriented, laboratory-based instructional strategies on student learning of chemistry concepts," says Williamson, who was one of Abraham's graduate students from 1988 to 1992. Abraham's research has supported a teaching strategy called the Learning Cycle Approach, which divides the activities of instruction into phases. It allows students to explore new concepts in a laboratory setting, discuss them with peers and experts, and test their connections to other concepts, she says.

"Now that the National Research Council's K–12 science education standards are calling for an inquiry-based approach to teaching, the nature of Abraham's work 25 years earlier is more clearly understood to be groundbreaking," says Mark S. Cracolice, professor and chair of the University of Montana's department of chemistry.

Equally important is Abraham's later research in explaining the difficulties students have in understanding the particulate nature of matter. That work "has led to a major effort to connect the macroscopic and particulate-level explanations in modern college chemistry textbooks," says Cracolice, who was a graduate student in Abraham's group from 1989 to 1994.

Abraham has also explored new and more effective methods to allow students to visualize atomic and molecular behavior, including computer animation. More recently, he has been involved in collaborations with John I. Gelder, professor of chemistry at Oklahoma State University, and Thomas J. Greenbowe, professor of chemistry at Iowa State University, to develop Web-based, molecular-level laboratory experiments that allow students to control variables and benefit from interactive animation, according to Williamson. "This marriage of inquiry-based learning with particulate animations is an exciting new area for chemical education that builds on Abraham's lifetime of work."

Abraham began teaching high school chemistry after completing a B.A. in chemistry at Grinnell College, in Iowa, in 1964, and while earning a master's degree in education at Emory University in 1965. He received a Ph.D. in science education at Florida State University in 1973 and joined the University of Oklahoma faculty in 1974.

During his long career, Abraham's passion for research has been sparked by "those who have mentored me and the colleagues and students with whom I have collaborated," he says.

After many years of working toward the goal of improving instructional materials and methods for teaching chemistry, he says he is "gratified and honored" to receive the award. "I feel it serves as a capstone to my career."

Abraham will present the award address before the Division of Chemical Education.—SUSAN AINSWORTH

ACS AWARD IN CHROMATOGRAPHY

Sponsored by Supelco

Udo A. Th. Brinkman became actively involved in optimizing liquid chromatography so he could help reveal what chemicals were polluting rivers throughout Europe, particularly in the Rhine River Basin, more than 30 years ago. That early work eventually led to the development of hyphenated systems that combine sample preparation (such as solid-phase extraction), analysis, and detection in one instrument.

Today, Brinkman, 74, an emeritus professor at the Free University of Amsterdam, is being honored for developing instrumentation and fully automated methods that are widely used in environmental, food, and biomedical applications.

Brinkman is "a world leader in chromatography," says Patrick J. F. Sandra, a professor of organic chemistry and director of the Pfizer Analytical Research Center at Ghent University, in Belgium. Brinkman has been active in all fields of chromatography, but he is best known for advancing on-line sample preparation strategies and

comprehensive two-dimensional gas chromatography (GC×GC).

In recent years, Brinkman has combined comprehensive GC×GC with time-of-flight MS, rapid-scanning quadrupole MS, and microscale electron capture detection. He finds the technique "intriguing and highly rewarding" and has published dozens of papers and several reviews on the topic.

COURTESY OF UDO BRINKMAN

Brinkman

Peter J. Schoenmakers, a chemistry professor at the University of Amsterdam, calls Brinkman "instrumental in raising the level of chromatography to its current high standards." Schoenmakers says he and many others have been inspired by Brinkman. "He emphasized the importance of working on real problems, dealing with real sample matrices, and producing reliable results."

Brinkman was "extremely effective in bridging the gap between new technology and analytical practice," Schoenmakers adds. "He was often the driving force behind the implementation and utilization of the latest developments in industrial and institutional laboratories."

A prolific author, Brinkman has published more than 700 scientific papers. He has organized several chromatography conferences and has served as editor of the *Journal of Chromatography A* since 1993.

Winning the ACS award is important, Brinkman says, because it shows that people recognize the high quality of his work over the past three decades. But he emphasizes that it was not just his work, but also that of his students and collaborators.

Officially retired, but still publishing chromatography papers, Brinkman lives with his wife, Jacqueline, and four dogs "in a beautiful part of the province of Zeeland, close to the North Sea beach" in the Netherlands. In his free time, he can be found gardening and reading history books, "with a special appreciation for the accomplished narrative style of so many British authors." He also enjoys time with his three daughters and three grandchildren.

Brinkman will present the award address before the Division of Analytical Chemistry at the fall ACS national meeting in Boston.—BRITT ERICKSON

FRANCIS P. GARVAN-JOHN M. OLIN MEDAL

Sponsored by the Francis P. Garvan-John M. Olin Medal Endowment

When 2009 ACS President Thomas H. Lane called to tell **Judith C. Giordan** she would receive the award, she was uncharacteristically silent. So silent, in fact, that Lane thought perhaps the phone had gone dead. "Are you there? Judy? Can you hear me?" he asked. Luckily, he didn't hang up.

"I couldn't speak. I was in shock. I had no idea I had even been nominated," she ebulliently recalls. "It was truly a surprise and a dream come true. This is such an honor that I was, for once, at a loss for words."

Giordan, however, rarely hesitates to speak her mind. She is sought after by companies that need her carefully honed research skills applied to management, education, and entrepreneurism. She has recently started to focus on career management strategies for women in industry, a subject that she knows very well.

MAIRIN BRENNAN/C&EN

Giordan

Giordan's life as an industry executive began 20 years ago, when, at 36, she became vice president of R&D at Henkel, the first woman executive at the company. After developing a technical organization model that was adopted at the company headquarters in Germany, Giordan was recruited into a comparable position by Pepsi-Cola and then by International Flavors & Fragrances (IFF).

According to a former colleague, "At Henkel, Judy led the formation of a first-class research institution from scratch, and at IFF, she brought a staid 1930s-style research organization into the 21st century." These were no small accomplishments because at the time Giordan was hired, "both organizations were unaccustomed to change or to women in upper management." She taught both firms her entrepreneurial style and introduced them to technology portfolio selection and management, leading to sustained increases in corporate profitability and funding for R&D.

After her time in industry, Giordan changed tracks and is now a serial entrepreneur and consultant. She is managing director of Steel City Re, a company that helps businesses safeguard their intangible assets; vice president and cofounder of Visions in Education, which provides strategic services to universities, start-ups, and nonprofits; senior adviser for the National Collegiate Inventors & Innovators Alliance; and professor of practice at the University of Southern Mississippi, where she consults on a partnership between its polymer science and medicinal chemistry programs. She was detailed from her university position to the National Science Foundation in 2006 for a stint as program director for the Integrative Graduate Education & Research Traineeship Program, which she has recently completed.

Giordan received a bachelor's degree in chemistry from Rutgers University in 1975 and a Ph.D. in physical organic chemistry from the University of Maryland in 1980. After that, she was off to Germany for an Alexander von Humboldt postdoctoral fellowship at the University of Frankfurt.

Former ACS president William F. Carroll sums up his experience with this award-winning dynamo. "To know Judy Giordan is to experience a type and volume of energy undocumented by physics. She is unrelenting in her efforts to support initiatives on behalf of science. She is personable, knowledgeable, and a master at getting good work done."

Giordan will present the award address before the Division of Business Development & Management.—LINDA RABER

JAMES BRYANT CONANT AWARD IN HIGH SCHOOL CHEMISTRY TEACHING

Sponsored by Thermo Fisher Scientific

Jeffrey Hepburn, a high school chemistry teacher at Central Academy in Des Moines, likes to give his students a little "CPR" in the classroom; that's chemistry, problem solving, and relevance.

"I present the chemistry material that needs to be presented," he explains. "This is enhanced by the problem solving, which is completed by multiple types of activities. The relevance is the crucial component. Students need to see the relevance behind the material being presented and why it is important to their everyday experiences."

Whatever he's doing, it's working: Hepburn estimates that 20 to 25% of his students start college in a chemistry-related field, and each year his students score well above the national average on the Advanced Placement chemistry examination.

DENNIS JOHNSON

Hepburn

Hepburn "is without doubt, the best science teacher and one of the best overall teachers I have had the pleasure of observing in my 32 years in the profession," says Dennis V. Johnson, a program supervisor at Central Academy.

Hepburn, 54, has known he wanted to be a teacher since the eighth grade. "I had some phenomenal role models in high school and college, which kept reinforcing the importance of teaching," he says.

If the praise from his students is any indication, Hepburn has followed in the footsteps of his mentors and become a phenomenal role model himself. "His students write that 'Mr. Hepburn is a very enthusiastic teacher who cares about his students' and 'Mr. Hepburn sparked my interest in chemistry,' " says Thomas J. Greenbowe, a chemistry professor at Iowa State University.

"I continually get notes or school visits from former students thanking me for the preparation they received," Hepburn says. "This can happen during the next year or up to 15 or 20 years later. The success stories happen any time a student feels more positive about chemistry and science than they did before class."

Hepburn received a B.A. in chemistry from the University of Northern Iowa in 1978 and earned an M.S. in science education from the University of Iowa in 1993. In addition to ACS, he is a member of the National Science Teachers Association and the National Education Association.

He has won numerous awards, including the Siemens State Award for AP Mathematics/Science Teacher (2006), the Distinguished Service Award to Iowa Science Teachers from Iowa Science Teachers/Iowa Academy (2003), and the Iowa Chemistry High School Teacher for Excellence in Science Teaching from the Iowa Academy of Science (1993).

Hepburn is also a semi-professional magician. "I love presenting my applications of chemical magic around the country and demonstrating the inquiry nature of science by use of magic," he says. He also collects wine, plays chess, and has signatures, programs, or pictures of more than 100 chemistry Nobel Laureates (C&EN, Jan. 25, page 104).

Hepburn will present the award address before the Division of Chemical Education.—FAITH HAYDEN

GABOR A. SOMORJAI AWARD FOR CREATIVE RESEARCH IN CATALYSIS

Sponsored by the Gabor A. & Judith K. Somorjai Endowment Fund

For the past four decades, **Robert J. Madix'** pioneering fundamental research has established the molecular foundation for elementary surface reactions on single-crystal catalytic metals. According to one colleague, "The work of Professor Madix has produced a paradigm shift in the fundamental analysis of many catalytic reactions and, indeed, of the concept of active sites on metal surfaces."

In the 1970s, Madix, still in his early 30s, was the first surface scientist to undertake cutting-edge research on the surface chemistry of complex molecules on well-defined metallic surfaces. By innovative experimental design, using isotopically labeled molecules, he determined for the first time surface reaction mechanisms, identified the surface reaction intermediates, and quantified their reaction kinetics on metallic single crystals.

The first application of surface science studies to heterogeneous catalysis was achieved by Madix in the seminal studies of methanol oxidation to formaldehyde over Cu(110) and Ag(110) surfaces. The mechanism of this important commercial reaction was misunderstood for 100 years before the elegant fundamental studies by Madix. The new surface reaction mechanistic insights from these surface science studies fundamentally changed industry's approach to this catalytic reaction, leading to improvements in productivity in the oxidation of methanol as well as higher alcohols.

A former student notes, "In addition to impacting the heterogeneous catalysis community and catalysis industry, these seminal studies also significantly influenced the surface science community in subsequent years." Madix was quick to apply spectroscopic techniques to verify the identity of the surface reaction intermediates on catalytic single crystals. As more advanced molecular-level surface spectroscopic techniques became available, the surface science community turned to the well-defined surface intermediates synthesized and identified by Madix with these new spectroscopic methods. His publications on surface reactions on single crystals are among the most cited in the surface science literature.

In addition to developing temperature-programmed methods for surface reaction studies, Madix also pioneered time-resolved molecular beam spectroscopy for the study of surface reactivity and the dynamics of adsorption of molecules on metallic surfaces. These studies provided additional fundamental insight into the kinetics and mechanisms of surface reactions. The combination of the temperature-programmed and molecular beam studies provides complete understanding of surface reactivity from the initial adsorption step through complex multistep reactions.

COURTESY OF ROBERT MADIX

Madix

Madix, 71, is the Charles Lee Powell Emeritus Professor of Chemical Engineering at Stanford University and senior research fellow in the School of Applied Science & Engineering at Harvard University. He received a B.S. degree in chemical engineering from the University of Illinois (1961) and a Ph.D. degree in chemical engineering from the University of California, Berkeley (1964).

He was an Alexander von Humboldt Senior Scientist awardee in Germany (1978, 2007) and received the Paul Emmet Award for Fundamental Studies in Heterogenous Catalysis (1984), the Alpha Chi Sigma Award for Fundamental Research from the American Institute of Chemical Engineers (1990), the Arthur Adamson Award of ACS (1997), and the Henry J. Albert Award of the International Institute of Precious Metals (1997).

Madix will present the award address before the Division of Catalysis Science & Technology (Probationary).—WILLIAM SCHULZ

GEORGE A. OLAH AWARD IN HYDROCARBON OR PETROLEUM CHEMISTRY

Sponsored by the George A. Olah Endowment

Vanishingly thin surface films—often just a molecule or two thick—can dominate the properties of solids. The reactivity and selectivity of solid catalysts, for example, is critically dependent on the intricacies of the outermost layers, which are notoriously difficult to characterize and control.

Since the 1970s, that's exactly where Northwestern University chemistry professor **Peter C. Stair** has focused his research talents, which his colleagues respect immeasurably. "He is among the most skilled experimentalists working on the surface chemistry of hydrocarbons," says Bruce C. Gates of the University of California, Davis. Gates adds that Stair is "the rare individual who knows the field of catalysis well and combines his knowledge with physical chemistry to get to the heart of reactions on surfaces."

COURTESY OF PETER STAIR

Stair

Hans-Joachim Freund, professor and director of the Fritz Haber Institute of the Max Planck Society in Berlin, points out that many of the sophisticated techniques used in Stair's laboratory were also invented there. One example is the use of azomethane to generate methyl radicals and deposit them on catalytic surfaces. That versatile technique enabled Stair's group to probe methyl groups' surface chemistry, which deepened understanding of C–C bond-forming reaction mechanisms.

Another key example is Stair's seminal advances in Raman spectroscopy, an analytical technique of limited scope in catalysis research prior to his innovations due to seemingly insurmountable fluorescence interference. By developing instrumentation, procedures, and a novel reactor system that permits catalysts to be probed in situ with UV Raman spectroscopy, Stair contributed a powerful analytical tool to catalytic science. Experts agree that virtually no other technique can probe the catalyst, reactants, and products in a single measurement and under reaction conditions.

In a series of pioneering studies with the UV Raman method, Stair identified reaction intermediates during zeolite-driven conversion of methanol to hydrocarbons as well as various types of carbonaceous (coke) deposits that accumulate on catalyst surfaces. He also used the technique to elucidate the structure and chemical nature of catalytically active sites and to deduce critical relationships between catalyst structure and performance in hydrocarbon conversion reactions.

Stair, 60, completed his undergraduate education at Stanford University in 1972 and earned a Ph.D. at UC Berkeley in 1977, working with noted surface scientist Gabor A. Somorjai. He began his academic career that year at Northwestern, where he has mentored nearly 60 graduate students and postdoctoral researchers and has published more than 175 articles in scholarly books and journals.

In addition to holding a Northwestern faculty position, Stair is a senior scientist at Argonne National Laboratory and serves as director of two Northwestern research organizations: the Center for Catalysis & Surface Science and the Institute for Catalysis in Energy Processes.

Stair is the recipient of numerous awards and honors, including the Alexander von Humboldt Senior Scientist Award and the Alfred P. Sloan Fellowship. He has served on the editorial and advisory boards of *Langmuir, Catalysis Letters,* and other journals, and as a guest professor at Dalian Institute of Chemical Physics in China.

Stair will present the award address before the Division of Catalysis Science & Technology (Probationary).—MITCH JACOBY

21ST BIENNIAL CONFERENCE ON CHEMICAL EDUCATION

THE 21ST BIENNIAL Conference on Chemical Education (BCCE), sponsored by the ACS Division of Chemical Education, will be held on Aug. 1–5 at the University of North Texas, Denton. Like its predecessors, this conference is designed to provide opportunities for secondary school through undergraduate-level chemistry instructors to interact in both formal and informal settings.

To receive the most current information and deadline notifications relating to the conference, please join the 21st BCCE listserv by adding your name to the list at chemed.tamu.edu/bcce2010. Registration and reservations for on-campus housing open on Feb. 12, which is also the date abstracts are due. Participating hotels in the area are already filling up. For more information on all aspects of the meeting go to bcce2010.org

NORTHEAST REGIONAL MEETING CALL FOR PAPERS

THE 37TH ACS Northeast Regional Meeting, hosted by the Northern New York Section, will be held on June 2–5, on the State University of New York, Potsdam, campus. The conference theme is "Chemistry for a Sustainable World." Full details can be found at nerm2010.org.

General sessions are being planned in analytical, inorganic, organic, and physical chemistry, as well as chemical education. Invited plenary speakers include Paul T. Anastas, deputy administrator at the Environmental Protection Agency's Office of R&D and professor at Yale University; John C. Warner of Warner Babcock Institute; Vicki Colvin of Rice University; and Catherine T. Hunt of Dow Chemical.

Special symposia will be offered on the following: smart polymer materials and hybrid systems, novel materials and nanomaterials for energy conversion, nanotechnology and the environment, analytical chemistry for emerging contaminants in the environment, new trends in chromatography, emerging analytical/bioanalytical and medical applications of nanotechnology, bioelectronics and biosensors, scanning probe microscopy in modern nanotechnology, metals in living systems, metal ions and metalloproteins, metal ion complexes in biological imaging, toxic metals, nanoparticles and oxidative stress, detection of protein biomarkers for medical applications, biochemistry and biophysics of proteins and membranes, organometallics and main-group chemistry, next generation of synthetic organic chemistry, Cope Scholar Symposium honoring John A. Porco Jr., green chemistry in industry for a sustainable world, the chemistry of natural products, biomass combustion, chemistry and the war against cancer, drug development and design, chemical education, and K–12 education.

Abstract submission opens on Feb. 1 at nerm2010.org. Contact Martin A. Walker, general chair, at walkerma@potsdam.edu for more information. ■

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ASSISTANT PROFESSOR OF CHEMISTRY
The Department of Chemistry at Oregon State University (OSU), in **Corvallis, Oregon** is currently in the midst of a rapid expansion. With the ground-breaking of the new landmark Linus Pauling Science Center, the addition of several new faculty members, an increased incoming student population, and state-of-the-art research facilities (an innovative fluorescence microscopy system, an advanced X-ray diffraction laboratory, a new 700-MHz NMR, and Electron Microscopy facility), OSU seeks a candidate for a full-time, tenure-track faculty position at the rank of assistant professor for Fall 2010. Candidates must have a Ph.D. in chemistry or an allied discipline, capabilities for developing and maintaining a strong research program, and a commitment to undergraduate and graduate education. Specifically a physical chemist with research interests in any one or more areas of fundamental physical, materials, analytical, or biological chemistry is sought. Preferred qualifications include a demonstrable commitment to promoting and enhancing diversity. To view posting **# 0005144** and apply, go to **http://oregonstate.edu/jobs.** For full consideration, all materials should be submitted by March 1, 2010. Oregon State University is an AA/EOE and has a policy of being responsive to dual-career needs.

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R·I·T

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Radiation Laboratory at University of Notre Dame seeks a postdoctoral researcher to participate in the project of ultrafast spatial imaging of energy flow in nanostructured solar cells. The objective of this project is to directly visualize interfacial charge transfer and capture processes within photovoltaic devices with simultaneous high spatial and temporal resolution. Current research efforts focus on polymer based organic solar cells and quantum dot sensitized solar cells. Previous experience in ultrafast spectroscopy, single molecule spectroscopy and microscopy, or scanning probe microscopy is highly desirable. To apply, please e-mail a copy of CV along with the names of three references to **Dr. Libai Huang at lhuang2@nd.edu.**

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TASTEFULLY SWEET

As Valentine's Day approaches, even people who normally avoid extremely sweet treats will likely find themselves tempted to consume pink-tinged food made almost entirely of sugar. Who hasn't eaten those little candy hearts or cupcakes with messages such as "Be Mine"?

The problem with these confections, observes one food scientist, isn't the sickly sweet messages, but the sickly sweet taste. It's not clear if anything can be done about the flavor of the candy hearts, but cupcake frosting can be improved, according to Jack Fastag, flavor chemist at David Michael Flavors.

ISTOCK

Frosting's high sugar content is what gives it structure, but it can also make some flavored frostings over-the-top sweet. The manufacturer could replace some of the sugar, but that might affect the texture, Fastag points out. Another option is to add a **SWEETNESS INHIBITOR.**

Fastag admits that in these days of non-sugar sweeteners, introducing a product that makes sugar seem less sweet is rather counterintuitive. But, he says, "there are times when you want to reduce the perception of sweetness when sugar cannot be taken out of the product." He offers the more typical example of lactose-reduced milk. Because the lactose is enzymatically broken down into simple sugars, the milk becomes a little sweeter. Adding a sweetness inhibitor makes it taste more like regular skim milk.

"The inhibitor acts directly on the sweetness receptors on your tongue," Fastag explains. "The first time you try it, it's really uncanny," he says, using soda as an example. "You taste some regular soda, then some of the sweetness inhibitor solution. When you try the soda again, it won't taste sweet." But Fastag would not reveal the chemical structure of David Michael's inhibitor.

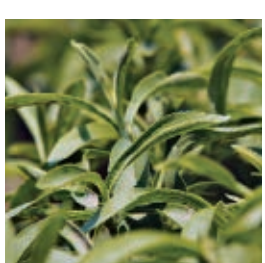
A paper in the *Journal of Food Science* reported on research at another flavor firm on the effect of **ZINC SALTS** in blocking sweetness perception (**2003**, *68*, 1871). R. S. J. Keast of the Monell Chemical Senses Center in Philadelphia, tested a number of zinc salts, already used as nutritional and functional ingredients, to see what effect they have on taste perception. He found that zinc sulfate ($ZnSO_4$) significantly inhibited the sweetness of glucose.

Keast hypothesized that taste receptors are susceptible to protein-zinc complexes because they are composed of amino acids. If zinc binds to taste receptor proteins, it can change the shape of the receptor and prevent it from detecting the presence of sugar.

Still, flavor scientists spend more of their time trying to increase, rather than block, the perception of sweet taste. Now that the natural sweetener **REBAUDIOSIDE A,** derived from the *Stevia rebaudiana* shrub (C&EN, July 28, 2008, page 30), has received the thumbs-up from the Food & Drug Administration, the race is on to perfect its use in food and beverages.

On the plus side, rebaudioside A adds no calories. High concentrations, however, impart a bitter aftertaste, sometimes described as licorice-like. The long list of firms reportedly working on the problem includes Cargill, Comax Flavors, Wild Flavors, Purac, and Givaudan.

Purac says its purified lactic acid masks the bitterness and allows food makers to reduce the amount of the pricy sweetener by 15%. Givaudan has taken a biological approach, boasting that it has identified the bitterness taste receptor triggered by rebaudioside A. "Screening of a diverse chemical library has led to a portfolio of more than 20 new best-in-class flavor ingredients effective against rebaudioside A bitterness," the company announced.



CARGILL

Stevia: Mostly sweet, a little bitter.

So far, none of the firms has admitted to working on stevia-sweetened candy hearts.

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

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