INNOVATION DAY 2014

September 15–16

Where early-career scientists and industry leaders consider solutions to society's most pressing needs.

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Manager, R&D Acetyls, BDO and Olefins Research, Lyondell Chemical Company

About Innovation Day

In an age of increasing interconnectivity and complexity in the chemical industries, successful innovators connect face-to-face with their peers and look beyond immediate technical matters to understand the broader implications of their work. In taking early-career scientists out of the lab and introducing them to their peers, to industry leaders, and to the historical and social context of their research, Innovation Day supports a 21st-century chemical enterprise that addresses society’s most pressing needs.

Innovation Day is jointly organized by the Chemical Heritage Foundation (CHF) and the Society of Chemical Industry (SCI) America International Group. The annual event includes the Warren G. Schlinger Symposium and the awarding of the SCI Gordon E. Moore Medal, the only award of its kind, presented each year to an early-career researcher who has achieved market success. The Schlinger Symposium is the core of Innovation Day, bringing together promising young scientists and seasoned technology leaders from across the chemical industries with a focus on the frontiers of chemical R&D. Plenary, breakout, and poster sessions highlight areas where the chemical industry interfaces with other emerging business sectors. The symposium offers participants the opportunity to learn about cutting-edge science and technology, exchange ideas with peer industrial researchers and entrepreneurs, and prepare to be the innovators and leaders of the next generation.

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Schedule

Monday, September 15

2:30–4:00 p.m. **Innovation Day Pre-Session**
"Developing Strategic Plans for Innovation"
Franklin I and II, Conference Center at CHF, 2nd Floor

Moderator:
Ron Reynolds, Senior Adviser to the President, CHF

Speakers:
George Day, Geoffrey T. Boisi Professor of Marketing and Codirector of the Mack Institute for Innovation Management, Wharton School, University of Pennsylvania

Robert Henske, Partner, Roland Berger Strategy Consultants, Boston, Massachusetts

4:00–5:30 p.m. **Break**
The Museum at CHF will be open until 5:00 p.m. for self-guided tours.

5:30–6:30 p.m. **Opening Reception**
Jacobs Reading Room, 3rd Floor

6:30–9:00 p.m. **Dinner and Evening Plenary Address**
Ullyot Meeting Hall, 1st Floor

Title of Talk:
"The Case for Responsible Innovation"

Speaker:
David Guston, Codirector, Consortium for Science, Policy and Outcomes, and Professor of Political Science, Arizona State University

Tuesday, September 16

7:30 a.m. **Speakers' Breakfast**
Jacobs Reading Room, 3rd Floor

8:00 a.m. **Continental Breakfast**
Ullyot North, 1st Floor

8:30–9:25 a.m. **Schlinger Symposium Opening Plenary Address**
Ullyot Meeting Hall, 1st Floor

Title of Talk:
"Using Sunlight to Turn Water and Carbon Dioxide into Fuel"

Speaker:
Nate Lewis, George L. Argyros Professor of Chemistry, California Institute of Technology

SCHEDULE

9:30–11:00 a.m. **Breakout Sessions**
Conference Center at CHF, 2nd Floor
Room 603, 6th Floor

Open Innovation
Moderator:
Paul Westgate, Vice President, Strategic Development and Technology, W. R. Grace and Company

Speaker:
Felek Jachimowicz, Vice President of R&D, Construction Materials, W. R. Grace and Company

Recent Advances in Polymer Technology
Moderator:
Daniel White, Manager R&D, Acetyls, BDO & Olefins Research, Lyondell Chemical Company

Speakers:
Hanze Ying, Cheng Research Group, University of Illinois, Urbana-Champaign

Gavin Jones, Research Staff Member (Computational Chemistry), Almaden Research Center, IBM

Rare Earths: Inorganic Petroleum?
Moderator:
David Sikora, Global Director, Technology, Industrial Performance Products, Chemtura, Inc.

Speakers:
Vitalij Pecharsky, Distinguished Professor, Ames Laboratory, University of Iowa

Drew Polli, R&D Director, Rare Earth Systems Global Business Unit, Solvay Corporation

11:00 a.m. –12:15 p.m. **Poster Session**
Overlook Lounge, 2nd Floor

Coordinator:
Rebecca Ortenberg

Presenters:
Ben Barton, Eastman Chemical Company
Soumendra Basu, Eastman Chemical Company
Jonathan Bauer, University of Delaware
Natnael Behabtu, DuPont
Justin Bogart, University of Pennsylvania
Xiaochun Fan, DuPont
Geoff Fichtl and **Rashmi Patwardhan**, Honeywell
Cassandra Gallaschun, Braskem America
Daniel Himmelberger, Dow Chemical
Meghan Koback, Dow Chemical
Jessica Levin, University of Pennsylvania
Ludivine Malassis, University of Pennsylvania

Nick Mitchell, Dow Chemical
Abhijit Namjoshi, Dow Chemical
Julia Ramone, Braskem America
Mary Ronan, Solvay
Jonathan Rosen, University of Delaware
Fuquan Tu, University of Pennsylvania
Bryan Yonemoto, University of Delaware

12:15–2:15 p.m. **SCI Gordon E. Moore Medal Ceremony and Luncheon**
Ullyot Meeting Hall, 1st Floor

Awardee:
Andrew Taggi, Senior Research Associate, DuPont Company

2:30–4:00 p.m. **Breakout Sessions**
Conference Center at CHF, 2nd Floor
Room 603, 6th Floor

Responsible Innovation
Moderator:
Hugh Helferty, Manager, Global Chemical Research, ExxonMobil Chemical Company

Speaker:
Matthew Wisnioski, Associate Professor, Department of Science and Technology in Society, Virginia Tech

Biomimicry
Moderator:
Nilesh Shah, R&D Director, Dow Advanced Materials

Speakers:
Bojana Ginovska, Research Scientist, Physical Sciences Division and Institute for Interfacial Catalysis, Pacific Northwest National Laboratory

Christine D. Keating, Professor of Chemistry, Penn State University

Emergence of Industrial Biotechnology
Moderator:
William D. Provine, Director, Science & Technology External Affairs, DuPont Company

Speakers:
Timothy Lu, Associate Professor of Biological and Electrical Engineering, Synthetic Biology Group, Massachusetts Institute of Technology

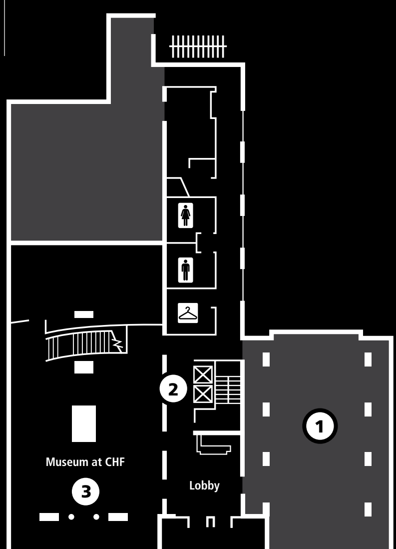
Carlos Olguin, Leader, Bio/Nano/Programmable Matter Group, Autodesk Research

4:00–5:00 p.m. **Closing Reception and Museum Tours**
Overlook Lounge, 2nd Floor

Tours of the Museum at CHF will be available at 4:15 p.m. and again at 4:45 p.m.

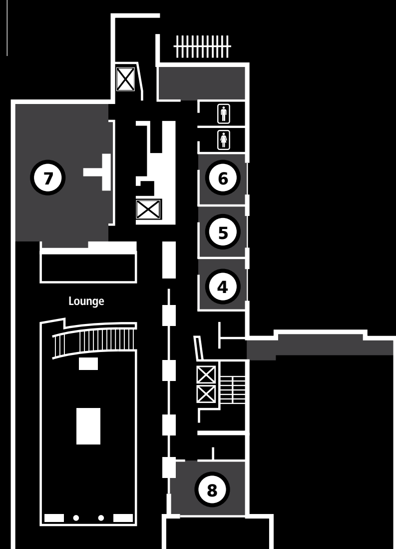
1st Floor

1 Ullyot Meeting Hall
2 Elevators to 3rd and 6th floors
3 Museum at CHF



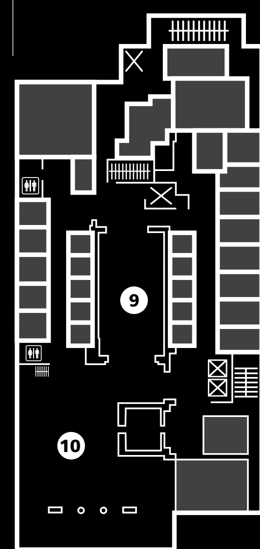
2nd Floor: Conference Center at CHF

4 Garden Room 1
5 Garden Room 2
6 Garden Room 3
7 Franklin Meeting Rooms
8 O. Röhm & O. Haas Meeting Room



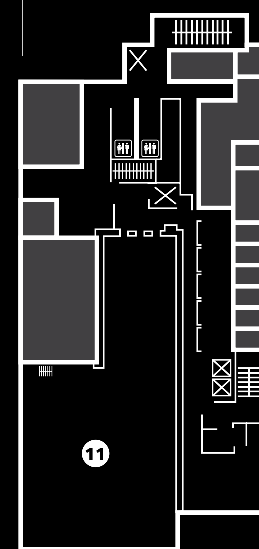
3rd Floor

9 Dow Public Square
10 Jacobs Reading Room



6th Floor

11 Room 603



Open Innovation

We can adjust the temperature in our homes while we're driving from the airport. Tank monitors call us when our customers are running low on our products. Sensors, digital devices, all kinds of interactive systems are invading every area of technology and changing our lives with unprecedented speed. But can these advances be used to enhance the value of our chemical product offerings?

Certainly one aspect of open innovation is connecting what on the surface would appear to be two completely different technical areas. In this session we are going to explore the possibilities of combining the technologies of sensors and traditional chemical products to generate new value and differentiation. Attendees will be challenged to develop specific ideas.

Recent Advances in Polymer Technology

Polymers remain an important class of materials for the chemical industry, but maintaining that position and ensuring their economic value requires the continued development of innovative products. This session will focus on the research being pursued in academia and in a laboratory outside the traditional chemical companies. A researcher from the University of Illinois will describe work on "dynamic chemistry," a process that leads to self-healing polymers. And a speaker from IBM's Almaden Research Center will report on what has been purported to be the first really new polymer in 20 years.

Rare Earths: Inorganic Petroleum?

Concern has been growing in the advanced economies about the long-term availability of rare-earth elements. Used in a range of products from solar panels to catalytic converters, these materials have very unique properties. Most production comes from China, but in the United States, government-sponsored research has been increased because of national security concerns. Does this scenario present opportunities for chemical companies? Can products be reformulated to use fewer of the key ingredients? Is recycling or recovery economically viable?

A materials scientist from the Ames Laboratory will give his assessment of the big picture and discuss work now proceeding in government labs. Solvay, a major industrial player in rare earths, will report on a project to recover rare earths from discarded lightbulbs.

BREAKOUT SESSIONS

Responsible Innovation

Innovation doesn't occur in a vacuum. Indeed, technology is a world-shaping force. Governance of emerging science and innovation is a major challenge for contemporary democracies. In addition to meeting the obvious scientific and business goals, many believe that innovation should be governed and stewarded toward societally desirable and acceptable ends. Arriving at a balance requires a dialogue between scientists, engineers, social scientists, and sociologists.

In this session we will attempt to build on the ideas advanced by David Guston in his Monday-evening plenary address. A historian of science from Virginia Tech will talk about his research on the U.S. engineering profession in the postwar era. One objective is to begin thinking about a framework for responsible innovation.

Biomimicry

Biomimicry, technological innovation inspired by systems in nature, is one of the hottest ideas in science. Living organisms have evolved over millions of years and solved such engineering problems as flight, self-assembly, and harnessing solar energy. Certainly, biomimicry has been championed by many who have issues with today's industrial technologies, but even with increased attention, this field has yet to yield many practical advances.

Two speakers will discuss work that may have future potential. A scientist from the Pacific Northwest National Laboratory has been working on separating hydrogen from water using a catalyst based on hydrogenase, a type of natural protein. Then a Penn State researcher will report on her groups' efforts to construct functional materials from the bottom up. Controlling composition at the nano-level can lead to products with applications in medicine, sensors, electronics, and a variety of other fields.

Emergence of Industrial Biotechnology

Over the last few decades biotechnology has expanded its reach from applications in pharmaceuticals to agriculture and industrial chemicals. The emergence of industrial biotechnology and the new advances in bioengineering tools provide an opportunity for a new wave of innovation in industrial sectors. This panel, composed of speakers from academia and a private research institute, will present and discuss new capabilities in bioengineering and envision how these tools can be applied to transform the chemical industry.

Application of Life-Cycle Assessments as a Tool in the Innovation Process

Ben Barton, Eastman Chemical Company

The concept of life-cycle assessment (LCA) is over 40 years old and is now the leading method used to quantify the potential environmental impact of a product or activity. Although Eastman Chemical Company first began its journey with LCA more than 15 years ago, in 2008 the company focused efforts to increase LCA work after a key customer requested environmental-footprint information. Today, the environmental costs of 74% of Eastman's top-selling product lines, which represent 80% of Eastman's total 2013 sales revenue, have been characterized as using LCA. The impetus for performing LCAs has been growing as end-use consumers, regulatory bodies, and industry organizations have become more aware of and concerned about the environmental impacts of the products we buy and use. Societal awareness is expected to influence purchasing behavior as customers demand new products with increased functionality and a lower impact on the environment. With these trends environmental footprinting needs to be embedded in the innovation process. We believe there are great insights to be made with customers and our internal processes by using a life-cycle approach. In this presentation we will discuss how LCA may be applied proactively in the early stages of innovation to enable environmentally sustainable choices and to provide rigorous assessments to our customers and to organizations that craft environmental policies.

Directed Self-Assembly

Jonathan Bauer, University of Delaware

Directed self-assembly is a promising route to nanomanufacturing that can be used to create advanced phononic, photonic, and catalytic materials. In one version of this bottom-up approach a homogeneous suspension is placed in an external field, such as a macroscopic flow or electromagnetic field. The external field modifies the interactions between constituent particles, making it possible to create structures and phases that are otherwise unobtainable in the absence of the field. However, during the assembly process kinetic bottlenecks can halt the structural transitions in glassy, nonequilibrium states.

In this work we use suspensions of superparamagnetic colloids to demonstrate the ability to circumvent these arrested states by toggling the external field, that is, cycling it on and off at a fixed frequency. We rapidly and reversibly form equilibrium microstructures, which are confirmed through small-angle light scattering and microscopy experiments. Furthermore, the applied field strength and toggle frequency affect the macrostructural evolution and most notably lead to instabilities similar to the Rayleigh-Plateau breakup of a water jet. It is possible to extend the toggled-field procedure to other methods of directed self-assembly, such as DNA-mediated techniques, to help shape the next generation of advanced materials.

Structure-Property Relationship of Polysaccharide: Case Study on Carrageenans

Natnael Behabtu, DuPont

Glucose-based (glycan) polymers are essential biopolymers used in in a wide variety of commercial applications. Examples of commercially relevant glycans are cellulose, starch, and fermentation-based glycans (for example, curdlan and pullulan). DuPont plays an active role in this field through its nutrition and health and industrial biosciences business units. One application field uses glycans (or modified glycans) to control viscosity. Viscosity control is critical for a number of applications, including food ingredients, paper coating, enhanced oil recovery, and water-based paint.

In this presentation the theoretical basis for viscosity enhancement and the existing literature will be reviewed. Specifically, commercially relevant polysaccharides will be reviewed, highlighting their structure and its implications in their solution stability and viscosity. The structure-property relationship of carrageenan will also be reviewed, including a comprehensive review of small-angle X-ray diffraction (SAXD), SEC, and cryogenic transmission electron microscopy (cryo-TEM) and their implications to their measured viscosity and solvent stability.

Coordination Chemistry of the Rare Earths in a Tripodal Nitroxide Ligand Framework: Potential Applications in Rare-Earth Separations

Justin Bogart, University of Pennsylvania

The rare-earth elements La-Lu, Y, and Sc are important for green-energy technologies because of their electronic and magnetic properties. In particular, neodymium iron boron ($Nd_2Fe_{14}B$) permanent magnets are essential components in motors used in electric vehicles and wind turbines. These alloys may have up to 9 weight % Dy added in order to increase the temperature stability of the permanent magnets. An untapped supply of these critical materials involves magnet recycling from end-of-life products. This process requires the development of efficient separations technologies for the rare-earth elements. Toward this goal we have synthesized a tripodal nitroxide ligand, $[((2\text{-}^{t}BuNO)C_6H_4CH_2)_3N]^{3-}$ (TriNOx), and successfully formed RE(TriNOx)THF complexes for RE = La-Nd, Tb, Dy, and Y. An equilibrium between RE(TriNOx)THF (monomer) and $[RE(TriNOx)]_2$ (dimer) was discovered for the early RE elements, whereas for the later RE elements, no dimerization was observed. As such, the application of this process toward the separation of Nd and Dy for purposes of magnet recycling will be discussed.

(J. A. Bogart and E. J. Schelter, Provisional Patent Disclosure, U.S. Application No. 62/030,227.)

Engineering of Metabolic Pathways and Global Regulators of *Yarrowia lipolytica* to Produce Polyunsaturated Fatty Acids

Xiaochun Fan, DuPont

We use the oleaginous yeast *Yarrowia lipolytica* as a host to produce carotenoids, resveratrol, and omega-3 and omega-6 fatty acids via metabolic engineering and global regulator modifications at DuPont. We will report on the development of clean, renewable commercial products of eicosapentaenoic acid (EPA, C20:5, omega-3 fatty acid) oil and EPA-rich biomass by fermentation. The EPA oil has been used as a human nutritional supplement, and the EPA-rich biomass has been used as salmon feed to raise brand salmon (Verlasso). Triacylglyceride oil from engineered strains has a unique fatty-acid profile—with less than 5% as saturated fatty acids and more than 55% as EPA—that has great health benefits for humans and animals. The EPA-rich biomass for feed reduced fish-oil consumption more than 75% and produced premium salmon.

We will discuss in detail such approaches as modification of global regulators, engineering of metabolic pathways, and developing of the fermentation process for manufacture of these two commercial products. The bioengineering of *Yarrowia* generates a platform technology to produce high-value oil and biomass with tailored omega-3 or omega-6 fatty-acid compositions. Our land-based production of EPA, DHA, ARA, and GLA provides a superior source of these essential molecules for applications in nutritional supplements, functional foods, infant foods, medical foods, pharmaceuticals, and animal feeds.

Long-Chain Branching Analysis for "Y" Type Polyethylene by HSEC and ^{13}C-NMR

Cassandra Lynn Gallaschun, Braskem America

Using metallocene catalyst–based samples (Affinity 1880, Affinity 1840, and Flexus 9211) that have mono-dispersed molecular weight distribution with different long-chain branching (LCB) concentrations and LCB indexes, an LCB characterization method was developed using HSEC and ^{13}C-NMR. By plotting the molecular weight versus intrinsic viscosity, the branching index (*g*′) was calculated. The individual *g*′ values were calculated by dividing the intrinsic viscosity of the different LCB-PE samples over the viscosity of a theoretical linear PE sample. The ratios of the mean radii of gyration (*g*;) were also calculated. The parameter *g* can be related to a frequency of LCB by assuming a randomly branched and polydisperse polymer with trifunctional branching points. The weight-average number of LCB per molecule (n_w) was measured and was calculated directly by the Malvern software program. Using ^{13}C-NMR, the LCBs were identified and the branch numbers, λ_n, were calculated. In order to further examine the methodology an LCB sample series was prepared by solution blending of the LCB-PE sample (MF1806S5) with a linear PE (Flexus 9211) and analyzed using the LCB characterization method discussed.

Opulux Optical Finishes Technology for Packaging

Daniel Himmelberger, Dow Chemical

Matte finishes have existed for many years. In the last few years they have become an important tool in advertising. They are used to grab the attention of the consumer and improve the visual appeal of packaging. The food-packaging industry is interested in matte finish especially to impart a more natural, paperlike appearance as well as to deal with harsh lighting in grocery stores. The lighting found in a refrigerated display case creates high glare on such flexible packaging as shredded cheese, making it difficult to read the package.

Opulux Optical Finishes technology offers a breakthrough in matte finishes by reducing glare on a package's surface without reducing the color and definition of the graphics. That means that black stays black rather than becoming gray as with other technologies. This is accomplished through acrylic beads engineered to have a gradient refractive index that acts like a lens. Opulux Optical Finishes technology is also able to impart a "soft touch" feeling to a package, improving haptics, since the acrylic beads are compressible. The two attributes of color retention and haptics are highly desired by the industry and provide much-needed improvement over traditional solutions.

Influencing the Oxidation State of Cerium Cations in $M_{4\text{-}5}$(sol)[Ce(PhNNPh)$_4$] Complexes through Variation in the Secondary Coordination Sphere

Jessica Levin, University of Pennsylvania

Developing electron transfer systems with cerium cations is challenging and unpredictable because of the largely ionic character of cerium-ligand interactions.[1] Owing to the ionic bonding character the 4f orbital involved in electron transfer from cerium complexes is understood to be isolated from its environment.[2] Using 1,2-diphenylhydrazine (PhNHNHPh) and alkali metal cations (M = Li^+, Na^+, and K^+), we have developed a system in which the formal oxidation state of the cerium metal center is dependent on the Lewis acid strength and identity of the alkali metal cation in the secondary coordination sphere. The use of multiple Lewis acids in concert with a redox-active ligand is proposed as a general strategy to access high-valent cerium cations.

[1] S. Cotton, *Lanthanide and Actinide Chemistry* (Hoboken, NJ: John Wiley, 2006).

[2] N. A. Piro, J. R. Robinson, P. J. Walsh, and E. J. Schelter, *Coord. Chem. Rev.* 260 (2014), 21.

Tunability of the Gold Particles' Surfaces

Ludivine Malassis, University of Pennsylvania

For next-generation technologies in the areas of medicine, materials science, photonics, and plasmonics, incorporation of metal nanoparticles into various materials or solvents is a key technical challenge. This incorporation into different media is directly linked to the nanoparticles' surface chemistry. In aqueous media the surface chemistry of nanoparticles is generally tuned after the synthesis, and the surface exchange is only possible if the new stabilizing agent has a stronger affinity than the one used for the synthesis. This condition often limits the use of industrially and commercially relevant surfactants.

In this vein we will present two syntheses of gold particles designed to allow a facile surface-chemistry modification with surfactants (charged or not), polymers, or exotic organic molecules like dendrimers. Our first system is based on the controlled growth of silica on the surface of gold nanorods. Silica is a material widely studied in the literature and can be functionalized with a large number of alkoxysilanes. Thanks to the asymmetrical shape of the rod, a selective coating either on the tips or on the edges can be performed. These geometrics enable a selective functionalization of the rod that could eventually promote interesting self-assembly materials. The second system is obtained from the synthesis using a stabilizing agent with weak interaction with gold. This stabilizing agent can be exchanged by positively or negatively charged surfactants.

Controlled-Release Silver Technology for Intelligent Freshness in Textiles

Nick Mitchell, Dow Chemical

The Dow Chemical Company has recently introduced the Silvadur antimicrobial line of products, which provides excelled microbial efficacy, durability, and color stability on treated textiles. Silver has been used since ancient times to control the growth of bacteria: through use of silver coins in water to modern uses of silver-infused bandages for burn victims. In textiles silver works by controlling the growth of bacteria that cause unpleasant odors and unsightly material degradation.

The technology behind Silvadur allows for silver to be used as the ionic form through an equilibrium-based release mechanism. The key to the controlled release is the equilibrium relationship formed through the silver-polymer complexation that is tuned precisely for both durability and efficacy. This technology has many advantages over traditional silver-based technologies, such as stability to light and heat, reduced potential to discolor on fabrics, and excellent wash durability without added binders. A key benefit of this technology is that it is supplied as a concentrated liquid product that is readily dilutable in water, enabling easy integration into customers' wet finishing processes.

Challenges Encountered in the Development of Building Integrated Photovoltaic Systems

Abhijit A. Namjoshi, Dow Chemical

Photovoltaic systems provide clean, renewable energy and are the fastest-growing energy source in the world. Residential roofing systems can provide for more than 50% of homeowners' energy demands, and this segment of the photovoltaic industry is the fastest-growing segment in the solar sector. Chemists, chemical engineers, and materials scientists can play a pivotal role in this industry by applying traditional chemical reaction and process principles to the development of photovoltaic devices and to the demonstration of reliability of photovoltaic systems. The Dow Chemical Company has developed a revolutionary new product—the Dow Powerhouse Solar Shingle—to serve the functionality of a traditional roof as well as to provide clean energy. Reliability solutions implemented during the development of the shingle product are discussed.

Mineral-Filled Polypropylene for Lightweighting Automotive Compounds

Julia Ramone, Braskem America

The mechanical, thermal, and melt rheological properties of polypropylene compounded with several minerals that vary in aspect ratio, surface area, morphological properties, and so forth will be discussed. The potential to attain target properties at lower compound densities using polypropylene and certain fillers will be highlighted.

Bringing Moisturizing and Mildness Solutions to the Skin Cleansing Market

Mary Ronan, Solvay

Valued at over $5 billion, the U.S. soap, bath, and shower products market is the largest in the world and is forecast to grow to $5.8 billion by 2017. Moisturizing and mildness are two of the top claims in the body-wash market. Consumers are looking for products that make good on these claims without sacrificing such performance features as cleansing and foam production. As a leading provider of anionic (sodium trideceth sulfate, sodium cocoyl glycinate), amphoteric (cocamidopropyl betaine), and non-ionic (polysorbate 20) surfactants, performance polymers (guar hydroxypropyltrimonium chloride), and synthetic polymers (polyacrylates-33) for hair and body cleansing, Solvay is able to bring solutions to our customers and in turn to their consumers.

Mechanistic Insights into the Electrochemical Reduction of CO_2 to CO on Nanostructured Ag Surfaces

Jonathan Rosen, University of Delaware

Owing to rising energy demand and evidence of the environmental effects of CO_2 emissions, much research has focused on producing and storing energy from renewable sources. An efficient and selective process for the conversion of CO_2 to CO or other reduced products could allow for the widespread production of liquid fuels. Coupled with renewable energy sources, these processes could help solve the large-scale storage issue of renewable energies while creating a carbon-neutral energy source easily integrated into the current energy infrastructure. To date, researchers have identified several potential catalysts, such as Cu, Ag, Au, and Zn, that are able to reduce CO_2 electrochemically in aqueous electrolytes.

Precious metal catalysts, such as Au and Ag, are able to reduce CO_2 selectively to CO and are of interest, while Cu and Zn yield a mixture of formate, hydrogen, CO, alcohols, and other hydrocarbons. Ag is an interesting CO_2 reduction catalyst because it is able to convert CO_2 almost exclusively to CO at a fraction of the cost of Au, albeit requiring a larger overpotential.[1] In addition, nanostructured catalysts are of great interest for CO_2-to-CO conversion because of their high catalytic surface area and unique properties relative to their polycrystalline counterparts.[2] Further understanding of these materials and development of new catalysts with a high density of active surface sites can help improve the economic prospects of such technologies.

Recently, we reported that a nanoporous Ag electrocatalyst is able to electrochemically reduce CO_2 to CO with approximately 92% selectivity at a rate (that is, current) of over 3,000 times higher than its polycrystalline Ag under a moderate overpotential of less than 0.50 V. Such exceptional activity results from a large electrochemical surface area (ca. 150 times larger) and intrinsically high activities (ca. 20 times higher) compared with polycrystalline Ag.[3] The improved intrinsic activity may be a result of higher CO_2 reduction activity on stepped surfaces, which has been observed in single crystal studies.[4] If this hypothesis is correct, other nanostructured Ag catalysts, such as nanoparticles, should show improved current densities and CO selectivity owing to their higher abundance of stepped sites. In addition to confirming this theory our work has shown the ability for nanostructured silver catalysts to stabilize key reaction intermediates, such as the CO_2^- radical, therefore reducing overpotentials needed to drive the reaction. Future work will focus on correlating the density of stepped sites to activity and further identifying key elementary steps and their effect on CO_2 reduction rates on Ag surfaces in an effort to rationally design new catalysts.

[1] Y. Hori, *Modern Aspects of Electrochemistry* 42 (2008), 89.
[2] Y. Chen, C, Li, and M. Kanan, *Journal of the American Chemical Society* 134 (2012), 19,969.
[3] Q. Lu, J. Rosen, Y. Zhou, G. Hutchings, et al. *Nature Communications* (2014), 5.
[4] N. Hoshi, M. Kato, and Y. Hori, *Journal of Electroanalytical Chemistry* 440 (1997), 283.

Stimuli-Responsive Janus Particles as Dynamically Tunable Solid Surfactant

Fuquan Tu, University of Pennsylvania

Janus particles are biphasic colloids that have two sides, with distinct chemistry and wettability. Because of their amphiphilic nature, Janus particles present a unique opportunity for stabilizing multiphasic mixtures, such as emulsions. Inspired by a special class of molecular amphiphiles that are responsive to environmental stimuli, stimuli-responsive Janus particles that drastically change their surfactant properties are successfully synthesized. Transitional phase inversion is achieved in emulsions stabilized with these Janus particles, using pH as stimulus. One-step formation of multiple emulsions is done via catastrophic phase inversion with our Janus particles. These multiple emulsions exhibit triggered-release behavior controlled by solution pH. Our study not only presents a new class of colloidal materials that will further widen the functionality and properties of Janus particles as dynamically tunable solid surfactants but also shows the versatility of Janus particles for stabilizing multiphasic mixtures.

Bifunctional Cathode for Zinc Air Battery

Bryan Yonemoto and Feng Jiao, University of Delaware

A zinc air battery, in theory, can deliver more than 1000 watt hours per kg^{-1} of energy storage because oxygen from the air is used as the cathode, eliminating significant weight from the battery pack. For comparison, state-of-the-art lithium-ion batteries used to power electric vehicles and smart phones can only store 200 to 300 watt hours per kg^{-1}. Unfortunately only nonrechargeable zinc air cells (typically for hearing aids) are commercially available because numerous technical challenges arise during recharge of the battery. At the anode zinc dendrites and hydrogen evolution from zinc corrosion can occur, limiting the performance. On the cathode a need exists to discover a stable, bifunctional electrocatalyst that can reversibly convert oxygen to hydroxide ions during the oxidative and reductive potential swings associated with charging and discharging.

As a cathode catalyst we have selected cobalt spinel particles anchored on stainless-steel mesh, as detailed in a recent report.[1] Pulse testing of the cathode assembly shows stable performance through 200 cycles at 10 milliamps per cm^{-2}. However, at 50% depth of discharge coulombic inefficiencies become apparent, providing some clues to the poor cycle performance. In particular, we are heavily investigating the role carbon corrosion from the gas diffusion layer plays in the degradation of battery performance after 80 to 100 hours of testing at c/10 currents.

[1] D.U. Lee, Ja-Yeon Choi, K. Feng, H. W. Park, et al., *Adv. Energy Mater*. 4 (2014), 1031389.

Additional poster presentations by

Soumendra Basu, Eastman Chemical Company

Geoff Fichtl and Rashmi Patwardhan, Honeywell

Meghan Koback, Dow Chemical

George S. Day

George S. Day is the Geoffrey T. Boisi Professor, a professor of marketing, and codirector of the Mack Institute for Innovation Management at the Wharton School of the University of Pennsylvania. He was previously the executive director of the Marketing Science Institute.

He has been a consultant to numerous corporations, such as General Electric, IBM, Metropolitan Life, Unilever, E. I. DuPont de Nemours, W. L. Gore and Associates, Coca-Cola, Boeing, LG Corporation, Best Buy, Merck, Johnson and Johnson, and Medtronic. He is the past chairman of the American Marketing Association. His primary areas of activity are marketing, strategy development, organic growth and innovation, organizational change, and competitive strategies in global markets.

Day has authored 18 books in the areas of marketing and strategic management. The most recent are *Peripheral Vision: Detecting the Weak Signals That Can Make or Break Your Company* (with Paul Schoemaker; 2006), *Strategy from the Outside-In: Profiting from Customer Value* (with Christine Moorman; 2010), and *Innovation Prowess: Leadership Strategies for Accelerating Growth* (2013).

He has won 10 best-article awards and 1 best-book award, and 2 of his articles were among the top 25 most influential articles in marketing science in the past 25 years. He was honored with the Charles Coolidge Parlin Award in 1994, the Paul D. Converse Award in 1996, the Sheth Foundation award in 2003, and the Mahajan Award for career contributions to strategy in 2001. In 2003 he received the AMA/Irwin/McGraw-Hill Distinguished Marketing Educator Award. In 2011 he was chosen as one of 11 "Legends in Marketing."

Day holds a bachelor's degree from the University of British Columbia and an MBA from the University of Western Ontario. He received a PhD from Columbia University.

Bojana Ginovska

Bojana Ginovska is a research scientist at the Physical Sciences Division and the Institute for Interfacial Catalysis at Pacific Northwest National Laboratory, located in Richland, Washington. Her research focuses on using computational methodologies to study condensed-phase reactions in catalysis for energy applications. Most recently she has worked on incorporating a functional outer-coordination sphere on biomimetic catalysts for H_2 oxidation and production. She leads the theoretical research on large interdisciplinary projects supported by the Department of Energy's Basic Energy Sciences programs.

She completed both her undergraduate and graduate degrees at Washington State University and has published extensively in the field of molecular catalysis.

David H. Guston

David H. Guston is a professor of political science; a codirector of the Consortium for Science, Policy and Outcomes; and the director of the Center for Nanotechnology in Society at Arizona State University. He is widely published and cited on research and development policy, technology assessment, public participation in science and technology, and the politics of science policy. His book *Between Politics and Science: Assuring the Integrity and Productivity of Research* (Cambridge University Press, 2000) was awarded the 2002 Don K. Price Prize by the American Political Science Association for best book in science and technology policy. He has coauthored *Informed Legislatures: Coping with Science in a Democracy* (with Megan Jones and Lewis M. Branscomb, University Press of America, 1996) and coedited *The Fragile Contract: University Science and the Federal Government* (with Ken Keniston, MIT Press, 1994) and *Shaping the Next Generation of Science and Technology Policy* (with CSPO director Daniel Sarewitz, University of Wisconsin Press, 2006). Guston is the editor of the series *Yearbook of Nanotechnology in Society* (Springer), with annual volumes beginning in 2008, and he is the general editor of the forthcoming, two-volume *Encyclopedia of Nanoscience and Society* (Sage, 2010).

Guston has served on the National Science Foundation's review panel on Societal Dimensions of Engineering, Science, and Technology (2000–2002) and on the National Academy of Engineering's Steering Committee on Engineering Ethics and Society (2002). He has held visiting positions at Columbia University, the Copenhagen Business School, and the Kent School of Law. In 2002 he was elected a fellow of the American Association for the Advancement of Science. He holds a BA from Yale University and a PhD from the Massachusetts Institute of Technology.

Hugh Helferty

Hugh Helferty is the manager of global chemical research for ExxonMobil. He is based at ExxonMobil's R&D Center in Baytown, Texas. During his career with ExxonMobil he has held a wide range of manufacturing, planning, research, and engineering management positions in locations in both Canada and the United States. From 2010 to 2012 he was the manager of corporate strategic research in Clinton, New Jersey, and from 2005 to 2009 he served as the manager of products research in Paulsboro, New Jersey. Before that he was the technical manager at ExxonMobil's world-scale refinery in Baton Rouge, Louisiana.

Helferty has served on the board of directors of the Louisiana Arts and Science Museum and the United Way of Gloucester County, New Jersey. He was also executive-in-residence at the Queen's University School of Business in 2009–2010.

Helferty holds a PhD in chemistry from the University of Toronto and an MBA from Queen's University in Kingston, Ontario.

Robert C. Henske

Robert C. Henske became a partner in the Chemicals and Oil Competence Center in Roland Berger's Boston office in 2012. He has 25 years of global strategy and business transformation consulting experience in the chemical and related industries, spanning the commodity, specialty, and fine chemicals markets.

He started his career in new technology development and commercialization at Olin Corporation's specialty chemical business. Before joining Roland Berger he was the global chemicals practice leader of an international consultancy and senior vice president at a leading U.S. consultancy firm.

Henske studied chemical engineering at Yale University and holds an MBA in strategy and finance from the Harvard Business School.

Felek Jachimowicz

Felek Jachimowicz is the vice president of innovation for W. R. Grace and Company. He joined W. R. Grace in 1978 as a scientist at the Washington Research Center in Columbia, Maryland. In 1993 he became the director of research and development for Grace Performance Products and moved to Cambridge, Massachusetts. From 1998 to 2013 Jachimowicz worked as vice president of R&D for Grace Performance Chemicals. During this period he spent two years (2009–2011) in Beijing developing a Grace Beijing R&D laboratory.

Jachimowicz is the author of numerous scientific publications and an inventor or a coinventor on over 20 patents. He holds a PhD in physical organic chemistry from the University of Basel, Switzerland.

Gavin Jones

Gavin Jones is a research staff member of the computational chemistry team at IBM Research Almaden. His work concerns computational investigations of the mechanisms of polymer formation and investigations on physical properties of polymers. Jones has been with IBM Research since 2010, when he started as a postdoctoral researcher. Before that he performed postdoctoral work at the Massachusetts Institute of Technology, where he studied mechanisms of organometallic reactions.

Jones completed his PhD in theoretical organic chemistry at the University of California, Los Angeles, in 2007, where he focused on computational investigations of organic reactions of synthetic interest.

Christine Keating

Christine Keating is a professor of chemistry at Pennsylvania State University. She has published in *Science*, the *Journal of the American Chemical Society*, and many other publications, and has won such awards as the Beckman Young Investigator Award, the Unilever Award for Outstanding Young Investigators, and the Camille Dreyfus Teacher-Scholar Award.

Keating's lab group is interested in construction of functional materials from the bottom up, by control of their nanoscale and mesoscale features. Controlling the composition of matter at these scales can lead to materials with entirely new and tailorable optical, electronic, and structural properties. Such materials may find applications in medicine, biotechnology, sensors, nanoscale electronics, and a variety of other fields. Finding inspiration in cell biology and materials science, her research aims to bring new building blocks and new assembly tools to this task.

Keating earned her PhD in chemistry from Pennsylvania State University and her BS in chemistry from Saint Francis College of Loretto.

Nathan Lewis

Nathan Lewis, the George L. Argyros Professor of Chemistry at the California Institute of Technology, has been on the faculty there since 1988 and has served as professor since 1991. He has also served as the principal investigator of the Beckman Institute Molecular Materials Resource Center at Caltech since 1992, and he is the scientific director of the Joint Center for Artificial Photosynthesis, the Energy Innovation Hub in Fuels from Sunlight. From 1981 to 1986 he was on the faculty at Stanford University, as an assistant professor from 1981 to 1985 and as a tenured associate professor from 1986 to 1988.

Lewis has been an Alfred P. Sloan Fellow, a Camille and Henry Dreyfus Teacher-Scholar, and a Presidential Young Investigator. He received the Fresenius Award in 1990, the ACS Award in Pure Chemistry in 1991, the Orton Memorial Lecture award in 2003, the Princeton Environmental Award in 2003, and the Michael Faraday Medal of the Royal Society of Electrochemistry in 2008. He is currently the editor-in-chief of the Royal Society of Chemistry journal *Energy & Environmental Science*. He has published over 400 papers and has supervised approximately 60 graduate students and postdoctoral associates.

His research topics focus on light-induced electron transfer reactions, both at surfaces and in transition metal complexes; surface chemistry and photochemistry of semiconductor-liquid interfaces; novel uses of conducting organic polymers and polymer-conductor composites; and development of sensor arrays that use pattern recognition algorithms to identify odorants, mimicking the mammalian olfaction process. Lewis received his PhD in chemistry from the Massachusetts Institute of Technology.

Timothy Lu

Timothy Lu is an associate professor in the Department of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology (MIT) and an associate member of the Broad Institute of MIT and Harvard University. He has won the Lemelson-MIT Student Prize, the Grand Prize in the National Inventor Hall of Fame's Collegiate Inventors Competition, and the Leon Reznick Memorial Prize for "outstanding performance in research" from Harvard Medical School. He has also been selected as a Kavli Fellow by the National Academy of Sciences and as a Siebel Scholar.

Lu received his undergraduate and MEng degrees from MIT in electrical engineering and computer science. He obtained an MD from Harvard Medical School and a PhD from the Harvard-MIT Health Sciences and Technology Medical Engineering and Medical Physics Program.

Carlos Olguin

Carlos Olguin heads the Bio/Nano/Programmable Matter Group at Autodesk Research, an 18-member group that is investigating the design spaces enabled by matter programming across domains and scales by collaborating with researchers around the world to coenvision the paradigms and tools needed to establish a robust, scale-free body of knowledge of design.

Olguin is an interdisciplinary designer with more than 13 years of combined experience in such domains as design tools for 2D and 3D modeling, learning, geographic information systems (GIS), risk management, network service brokerage, web search experience, online emergent social phenomena, and more recently systems/synthetic biology.

In 2001 Olguin earned an MS in information networking from Carnegie Mellon University. He holds a BSc in electronics and communications from ITESM Campus Monterrey, Mexico. He has studied telecommunications at the Institut National des Telecommunications in Evry, France, and systems biology at Columbia University.

Vitalij K. Pecharsky

Vitalij K. Pecharsky is a faculty scientist and field-work project leader at the Ames Laboratory, Iowa State University. He leads interdisciplinary research teams in work on responsive magnetic rare-earth materials and complex hydrides. The teams are recognized as leaders in their respective fields. He also directs and participates in research funded by offices within the Department of Energy and industry.

For many years he has worked as a scientist and professor with the Ames Laboratory, studying rare-earth materials, and he has 399 publications to his name. Pecharsky received his BS, MS, and PhD from L'viv State University, Ukraine.

Drew Polli

Drew Polli is the R&D director of Solvay's Rare Earth Systems global business unit, where he is responsible for advanced scouting and assessment of rare-earth and inorganic technologies. Formerly, Polli was the global R&D managing director, responsible for research and innovation of rare-earth products and their recycling, including automotive catalysts and catalyst supports, polymerization catalyst precursors, photoluminescent phosphors, polishing abrasives, environmentally friendly pigments, and nuclear and medical materials.

His professional focus is on inorganic materials product development, and he has significant experience in both technology startup and corporate environments. Polli's career has brought him assignments and management responsibilities in the United States, France, Germany, China, and Japan.

He earned a PhD in materials from the University of California, Santa Barbara.

William D. Provine

William D. Provine is currently the director of Science and Technology External Affairs at DuPont. In this role he is responsible for defining strategic direction for DuPont's science and technology programs with external collaborators and stakeholders, including federal governments, other companies, universities, and the public sector at large. He joined DuPont in 1992 and has served in a variety of research, marketing, business development, and manufacturing leadership roles, including oversight for commercialization efforts. Provine has also managed key strategic collaborations around the world for DuPont with companies, universities, government agencies, and nonprofit organizations.

In addition to his role at DuPont, Provine currently serves on advisory boards for a number of science centers, including those at Oak Ridge National Laboratory; the University of California, Berkeley, Lawrence Berkeley National Laboratory; the University of Delaware; and the University of Wisconsin. He is a founding member of both the World Council on Industrial Biotechnology and the International Council on Nanotechnology. Provine was nominated, appointed, and currently serves on the U.S. Department of Commerce Bureau of Industry and Security's Emerging Technology and Research Technical Advisory Committee, the U.S. Department of Energy–U.S. Department of Agriculture Biomass R&D Technical Advisory Committee, ARPA-E's PETRO working group, the National Academy of Science's roundtable on the Public Interfaces for Life Sciences, and a temporary scientific working group of the Organization for the Prohibition of Chemical Weapons focusing on the convergence of biology and chemistry. He is also a member of the American Institute of Chemical Engineers, the American Chemical Society, and the American Association for the Advancement of Science.

Provine received a BS in chemical engineering from the University of California, Berkeley, in 1987 and a PhD in chemical engineering from the University of Delaware in 1992.

Nilesh Shah

Nilesh Shah is the global research and development director for the home and personal-care business of The Dow Chemical Company. He is also the site leader for the Spring House Technical Center.

Shah joined Rohm and Haas Company in 1985, starting as a research scientist in the plastics business. Thereafter, he held positions of increasing responsibility in research management, leading polymer synthesis and exploratory research. From 1999 to 2002 Shah held commercial roles in the architectural and functional coatings business, with responsibility for strategic planning and marketing, before returning to research in 2003 to become a global technology director. In this role he led the research and regulatory affairs for the consumer and industrial specialties business followed by the process chemicals and biocides business. He made the transition to his new role after Dow acquired Rohm and Haas in April 2009.

Shah graduated with a BS in chemical engineering in 1979 from Jadavpur University in Calcutta, India. He received his PhD in chemical engineering from the University of Massachusetts, Amherst.

David Sikora

David Sikora is the global director of technology for the industrial performance products division of Chemtura Corporation. He joined Chemtura in 1997 after spending 17 years with the Monsanto Company in St. Louis and in Akron, Ohio. His areas of technical experience include homogeneous, heterogeneous, and enzymatic catalysis; alternate route chemistry; petroleum additives; polymer additives; water additives; synthetic lubricants; organometallics; electronic chemicals; and polyurethanes. He is an inventor on 13 patents and an author on 15 publications.

Sikora received a BS in chemistry from Fairfield University and a PhD in organotransition metal chemistry from the University of Massachusetts, Amherst.

Paul Westgate

Paul Westgate is the vice president of strategic development and technology at W. R. Grace. During his 15-year tenure there he has held leadership roles in a wide range of areas, including as vice president of global marketing, construction products, and business director of specialty building materials in the Americas. He has also led marketing, Six Sigma, innovation, and engineering organizations. Further, Westgate co-founded Westgate Research and Strategy, a business process-improvement consulting company, and he was an operating director at Arsenal Capital Partners, a private equity firm in New York City.

Westgate is a Six Sigma master black belt, and he completed an executive management program at the Massachusetts Institute of Technology. He has authored 22 research publications, is an inventor on 5 patents, and has delivered over 20 conference presentations. Westgate earned his undergraduate degree in chemical engineering at Worcester Polytechnic Institute and his PhD in chemical engineering at Purdue University.

Daniel White

Daniel White is the manager of R&D, acetyls, BDO, and olefins research at Lyondell Chemical Company. He joined LyondellBasell in 2001 as a research chemist.

White received his BSc in chemistry from the University of Nottingham and his PhD from the University of St. Andrew.

Matthew Wisnioski

Matthew Wisnioski is a historian of innovation at Virginia Tech, where he is an associate professor of science, technology, and society. Wisnioski is the author of the 2012 book *Engineers for Change: Competing Visions of Technology in 1960s America,* the inaugural volume in the MIT Press Engineering Studies series. The book explores the history of the U.S. engineering profession in the postwar era, focusing particularly on technologists' debates about social responsibility. He currently is writing a book titled *Every American an Innovator* that charts the rise of "innovation expertise" from the 1960s to the present, supported by an NSF Scholars Award and by the Lemelson Center for the Study of Invention and Innovation.

Wisnioski is a senior fellow of Virginia Tech's Institute for Creativity, Arts, and Technology and a cofounder of the Human-Centered Design Interdisciplinary Graduate Education Program, in which he teaches graduate seminars for students from a wide range of disciplinary backgrounds that critically interrogate the meaning and practices of innovation.

Wisnioski received his BS in materials science and engineering from Johns Hopkins University, his PhD in history from Princeton University, and his postdoctoral training as an Andrew W. Mellon Fellow in the Modeling Interdisciplinary Inquiry Program at Washington University in St. Louis.

Hanze Ying

Hanze Ying is a Ph.D. candidate in materials science and engineering at the University of Illinois at Urbana-Champaign. He has published a number of articles and presented on topics related to reversible polymers and self-healing materials and on triggered-degradable materials based on dynamic covalent chemistry. He has a B.S. in chemistry from Peking University.

2014 SCI Gordon E. Moore Medalist

Andrew E. Taggi is an expert in the field of fungicide research and discovery. Using his knowledge of organic and agricultural chemistry, he has combined complex protein binding pockets, field-biology efficacy, toxicology, and environmental fate to design and prepare over 900 new molecules, resulting in the development of candidates with drastically improved biological activity and safety. For the past five years Taggi was the principal chemist and project team leader for a program that has discovered and optimized a new broad-spectrum cereal, fruit, and vegetable fungicide, which has a new mode of action distinct from all current commercial products. Taggi is an inventor on eight patents, filed globally, in this program alone. The total addressable market space for this project is over $6 billion.

Last year the world's population surpassed 7 billion, and it is projected to exceed 9 billion by 2050. Right now roughly 1 billion people are undernourished, with global crop inventories at all-time lows. With the global population rising faster than arable land becomes available, farmers must improve their productivity, and fungicides have become an integral part of efficient food production. New compounds help farmers compete in an environmentally sustainable way so that food is affordable and available.

Taggi is a senior research associate at DuPont Crop Protection's Stine-Haskell Research Center in Elkton, Maryland. He has an impressive record of patents (19 published, 12 in preparation) and publications. His body of work was recognized by the American Chemical Society at the 2009 Young Industrial Investigators Symposium in Washington, DC. Taggi received a BA in chemistry from Cornell University and a PhD in organic chemistry from Johns Hopkins University.

About the Gordon E. Moore Medal

The Society of Chemical Industry (SCI), America Section, established the SCI Gordon E. Moore Medal to recognize early-career success in innovation, as reflected both in market impact and improvement to quality of life. By highlighting extraordinary individuals and their work, SCI America aims to promote public understanding of research and development in modern chemical industries, enhance the interest of students in applied chemistry by providing role models, and emphasize the role of creative research in the global economy.

Past SCI Gordon E. Moore Medalists

Jerzy Klosin (2013)
Dean Rende (2012)
Doron Levin (2011)
Emmett Crawford (2010)
Emma Parmee (2009)
Edmund M. Carnahan (2008)
Paul A. Sagel (2007)
Jonathan M. McConnachie (2006)
Jeffrey John Hale (2005)
George Barclay (2004)

About Gordon E. Moore

Gordon E. Moore cofounded Intel in 1968. He is widely known for Moore's law, in which in 1965 he predicted that the number of components the industry would be able to place on a computer chip would double every year. In 1975 he updated his prediction to once every two years. Moore earned a BS in chemistry from the University of California, Berkeley, and a PhD in chemistry and physics from the California Institute of Technology. He received the Presidential Medal of Freedom, the nation's highest civilian honor, from George W. Bush in 2002. He received the National Medal of Technology from President George H. W. Bush in 1990.

About the Premier Sponsor

Innovation Day's Schlinger Symposium is named in honor of Warren G. Schlinger, a PhD graduate of the California Institute of Technology with a distinguished career in industrial innovation. In Schlinger's 35 years at Texaco, he was a pioneer in gasification technologies now widely used for production of hydrogen, other chemicals, and power. Among other benchmarks, Schlinger had 15 U.S. patents issued during his career. He has been honored with the AIChE Technical Achievement Award and the Chemical Engineering Practice Award, and by the National Academy of Engineering.

About CHF

CHF fosters dialogue on science and technology in society. Our staff and fellows study the past in order to understand the present and inform the future. We focus on matter and materials and their effects on our modern world in territory ranging from the physical sciences and industries, through the chemical sciences and engineering, to the life sciences and technologies. We collect, preserve, and exhibit historical artifacts; engage communities of scientists and engineers; and tell the stories of the people behind breakthroughs and innovations.

About SCI

SCI America, launched in 1894, is part of the Society of Chemical Industry's international organization. It provides a unique networking forum for chemical industry leaders, industrial scientists, and technologists to exchange new business ideas and best practices. It celebrates achievement to promote public awareness of the contributions of industrial chemistry and inspire students to enter technical careers.

SCI America section also offers its members the opportunity to become part of an international network of industry thought leaders and researchers. Through specialized conferences, e-events, and publications, it helps foster best practices in fields as diverse as fine and commodity chemicals, food, pharmaceuticals, biotechnology, agriculture, and environmental protection.

The Perkin Medal was established in 1906 to commemorate the 50th anniversary of the discovery of mauveine. Past recipients include Nobel laureates Glenn T. Seaborg, Carl S. Marvel, and Herbert C. Brown; Donald F. Othmer, chemical engineer; Stephanie Kwolek, inventor of Kevlar; Paul S. Anderson, medicinal chemist; and Gordon E. Moore, the founder of Intel.

INNOVATION DAY

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