

***Climate, Energy, and the Changing Environment:  
A Dreyfus Foundation Symposium on Environmental Chemistry Research  
October 24, 2008***



**James G. Anderson**

Philip S. Weld Professor of Atmospheric Chemistry  
Harvard University

**Title of Presentation: Strategic Choices for Global Energy: Constraints from Feedbacks in the Climate System**

James Anderson's research focuses on establishing the primary mechanisms that couple chemistry, dynamics, and radiation in the climate system, the establishment of a high-accuracy record of climate change using interferometry from low Earth orbit, and strategies for testing long-term climate forecasts. His work analyzes feedbacks within the climate system—the net flow of thermal energy into the system's primary reservoirs—and the irreversibility associated with those feedbacks, providing critical information for the development of a global energy policy.

*Dr. Anderson joined the faculty of Harvard University in 1978 as the Robert P. Burden Professor of Atmospheric Chemistry. In 1982 he was appointed the Philip S. Weld Professor of Atmospheric Chemistry. He served as Chairman of the Department of Chemistry and Chemical Biology at Harvard from July 1998 through June 2001.*

*Dr. Anderson is a member of the National Academy of Sciences, the American Philosophical Society and the American Academy of Arts and Sciences, and a frequent contributor to National Research Council activities. He is a fellow of the American Geophysical Union and the American Association for the Advancement of Science. He is a recipient of two United Nations Environment Programme Ozone Awards (1997, 2005); the National Academy of Sciences Arthur L. Day Prize and Lectureship; the E. O. Lawrence Award in Environmental Science and Technology; the American Chemical Society's Gustavus John Esselen Award for Chemistry in the Public Interest; and the University of Washington's Arts and Sciences Distinguished Alumnus Achievement Award. In addition, he received the United Nations Earth Day International Award; Harvard University's 1989 Ledley Prize for Most Valuable Contribution to Science by a Member of the Faculty; and the American Chemical Society's National Award for Creative Advances in Environmental Science and Technology.*

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**Kimberly A. Prather**  
Department of Chemistry and Biochemistry  
University of California, San Diego

**Title of Presentation: New Insights into the Role of Aerosols in Climate Change**

Aerosols—tiny bits of dust and soot in the environment—represent the largest remaining uncertainty in our understanding of climate change, limiting our ability to make predictions regarding the earth's future. These aerosols, which are found in the environment in a variety of forms, such as clouds of ice or water droplets, salt particles from ocean spray, and smoke from a variety of combustion sources, play an enormous role in our daily lives, from affecting visibility and global climate change to endangering our health. These particles can warm or cool the earth depending on their chemistry, yet very little information currently exists in this area.

Members of Dr. Prather's group at the University of California, San Diego are developing analytical methods for probing the composition and size of each particle to determine which are having the greatest impacts on climate and human health. The information obtained in Dr. Prather's research will be used to generate new models for atmospheric processes that will be directly applicable in efforts to control ozone depletion, improve air quality, and develop an understanding of the impact of aerosols on global climate. In the past ten years, Dr. Prather's research group has developed a unique technique, aerosol time-of-flight mass spectrometry (ATOFMS), which provides continuous information on single particle size and chemical composition. Her most recent accomplishments include quantitation on the single particle data as well as extending the lower size limit of detection into the ultrafine size range (<100 nm).

*Dr. Prather received her Ph.D. in 1990 from the University of California, Davis. She was a postdoctoral fellow at University of California, Berkeley from 1990-1992. In 1992, she became an assistant professor at University of California, Riverside. In 2001, she moved to University of California, San Diego as a professor of chemistry. She is the recipient of the American Chemical Society Analytical Chemistry Arthur F. Findeis Award, the Kenneth T. Whitby Award, the GAeF Smoluchowski Award, the National Science Foundation Special Creativity Award, the American Society for Mass Spectrometry Award, and the National Science Foundation Young Investigator Award.*

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**Dianne K. Newman**

John and Dorothy Wilson Professor of Biology and Geobiology  
Massachusetts Institute of Technology

**Title of Presentation: From Iron Oxides to Infections: Roles for Redox-active Antibiotics in Microbial Survival and Development**

Wouldn't it be ironic if antibiotics were actually critical for sustaining life rather than killing cells?

This is the hypothesis that investigators in Dianne Newman's lab at MIT are testing. While much is known about the adolescent phase of bacterial growth, very little is understood about what sustains bacterial metabolism once they reach middle/old age. Interestingly, it is at this later stage that many bacteria begin to produce colorful, redox-active pigments—compounds that have, until now, been classified as “secondary” metabolites, or “antibiotics.” Recent results in the Newman lab suggest that the production of pigmented antibiotics may be essential for sustaining life at this late phase of microbial growth. This discovery has potentially wide-ranging applications, from providing new strategies to boost the efficiency of microbial fuel cells to new therapeutic targets in the context of infection.

*Dr. Newman has received a Clare Booth Luce Professorship, the Office of Naval Research's Young Investigator Award, a Packard Fellowship for Science and Engineering, and an Investigator of the Howard Hughes Institute. She began her career at the California Institute of Technology in 2000 and moved to the Massachusetts Institute of Technology in 2008.*

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**Paul T. Anastas**

Professor in the Practice of Green Chemistry, and  
Director, Center for Green Chemistry and Green Engineering  
Yale University

**Title of Presentation: Transformative Innovations in Green  
Chemistry Needed for Sustainability**

Paul Anastas coined the term "Green Chemistry" in 1991 and has pioneered the development of the field over the past 17 years. Cutting across the range of sub disciplines in the molecular sciences and many industries, much of the early work in Green Chemistry focused on important but incremental improvements in catalysis, solvents, synthesis and feedstocks that demonstrated both the scientific rigor of the approach as well its practical applicability. More recently, new discoveries in the field are proving the power and potential to apply the principles of green chemistry in a more systematic way to bring transformative innovations in the molecules we make and in the way we make them.

*Dr. Anastas serves as Yale's director of the Center for Green Chemistry and Green Engineering, which advances the sciences, education and use of sustainable technologies. Before coming to Yale, he was the director of the Green Chemistry Institute, headquartered at the American Chemical Society in Washington, D.C., where he established 24 green chemistry chapters in countries around the world, including China, Ethiopia, India, Japan, and South Africa. In a prior position with the White House Office of Science and Technology Policy, he spent five years as the principal supporter within the administration for governmental programs related to the environment. Dr. Anastas has published widely on topics of science through sustainability. His books include Benign by Design, Designing Safer Polymers, Green Engineering, and his seminal work with co-author John Warner, Green Chemistry: Theory and Practice.*

*Among Dr. Anastas's numerous awards are the John Jeyes Medal from the Royal Society of Chemistry, the H. John Heinz III Award for the Environment and the U.S. Environmental Protection Agency's Joseph Seifter Award, its highest scientific recognition. Recently, the Council of Scientific Society Presidents awarded him their Leadership in Science award for founding the field of "Green Chemistry."*

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**Eric N. Jacobsen**  
Sheldon Emery Professor of Chemistry  
Harvard University

**Title of Presentation: Selective Yet General Catalysts**

Eric Jacobsen's research focuses on the development of new methods for organic synthesis that can minimize or even eliminate the creation of waste, especially toxic waste. His group aims to design and develop catalysts that will allow them to synthesize useful products with maximum efficiency. Drawing inspiration from enzymes, Dr. Jacobsen and his researchers create small-molecule catalysts that have the necessary features to promote selective chemical reactions, providing access to valuable building blocks and final target structures inexpensively and with little or no waste generation.

*Dr. Jacobsen began his independent career in 1988 at the University of Illinois, where he was promoted to associate professor in 1991. He moved to Harvard University as full professor in the summer of 1993 and was named the Sheldon Emery Professor of Organic Chemistry in 2001. He is a consultant for a number of private corporations.*

*Dr. Jacobsen has been honored with the NSF Presidential Young Investigator Award (1990), the Packard Fellowship (1991), the Camille and Henry Dreyfus Teacher-Scholar Award (1992), the Alfred P. Sloan Foundation Fellowship (1992), the Cope Scholar Award (1993), the Fluka "Reagent of the Year" Prize (1994), the Thieme-IUPAC Prize in Synthetic Organic Chemistry (1996), the Baekeland Medal (1999), and the ACS Award for Creativity in Synthetic Organic Chemistry (2001).*

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**Nathan S. Lewis**

George L. Argyros Professor of Chemistry  
California Institute of Technology

**Title of Presentation: Artificial Photosynthesis: Fuel from the Sun**

Improving upon the natural process of photosynthesis...that's precisely what Nathan Lewis and his group of researchers at Caltech are attempting to do in pioneering artificial photosynthesis technology that converts solar energy directly into a usable, clean chemical fuel.

The group is working to develop inexpensive, highly efficient solar collectors, using tiny nanowires made from semiconductors. The electrons produced when the sunlight is absorbed are directed into stable, inorganic molecular catalysts "painted" on the surfaces of an absorbing layer. The system works like "solar bubble wrap," according to Dr. Lewis, where in one side goes water and out the other sides come hydrogen and oxygen. The oxygen is vented to the air, while hydrogen is collected to be burned later for heat or used in a fuel cell to make electricity.

Dr. Lewis's research interests include 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.

*Dr. Lewis joined the faculty at Stanford University in 1981 as an assistant professor and in 1986 he became an associate professor. He has been on the faculty at the California Institute of Technology 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.*

*Dr. 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, and the Princeton Environmental Award in 2003. He chaired the BES workshop that produced the widely cited report: Basic Research Needs for Solar Energy Utilization.*

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**Daniel A. Nocera**

The Henry Dreyfus Professor of Energy and Professor of Chemistry  
Massachusetts Institute of Technology

**Title of Presentation: The Chemistry of Renewable Energy**

Dr. Nocera is breaking down one of the principal barriers to widespread deployment of solar energy systems. This mainstream use requires both the development of relatively inexpensive photovoltaics to generate electric power and a means of storing the excess energy when sunlight is not available.

Photovoltaics, available now and systematically lowering in cost, will generate the power when the sun shines. What has been needed is a catalyst to enable excess electricity from the photovoltaic to be used to split water molecules into hydrogen and oxygen, providing stored solar fuels for power when the sun isn't out.

Dan Nocera and postdoctoral fellow Matthew Kanan have discovered an inexpensive, abundant, safe catalyst made from the common elements cobalt and phosphorus that will efficiently and rapidly split water into hydrogen and oxygen. As a result, Dr. Nocera predicts that people will be powering their homes and cars on solar energy within a decade.

A scholar in the basic mechanism of energy conversion in biology and chemistry, and pioneer in the science of photogeneration of hydrogen and oxygen, Dr. Nocera created the field of proton-coupled electron transfer (PCET) at a mechanistic level with the publication of the first ultrafast laser study of an electron transfer through a hydrogen bonded interface.

*Dr. Nocera began his career as a faculty member at Michigan State University in 1984. He joined the faculty of the Massachusetts Institute of Technology as a professor of chemistry in 1997. With his graduate student Alan Heyduk, Dr. Nocera described the first molecule to produce hydrogen photocatalytically from homogeneous solutions of hydrohalic acid. In 2005, he was awarded the Italgas Prize for his fundamental contributions to the development of renewable energy at the molecular level. He received the IAPS Award (2006) and the Burghausen Prize (2007) for his studies on renewable energy. In 2007, the Massachusetts Institute of Technology named him the Henry Dreyfus Professor of Energy. Dr. Nocera has worked with the presidents of five universities to set up energy initiatives at their institutions.*

*Dr. Nocera's research in energy conversion has been featured on the nationally broadcast television programs ABC Nightline and PBS NOVA in the U.S., Explora in Europe and radio shows such as NPR. He developed the pilot that was used to begin the new PBS science program ScienceNow, and his PBS NOVA show was nominated for a 2006 Emmy Award.*

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**Ralph J. Cicerone**  
President  
National Academy of Sciences

**Title of Presentation: Putting Science to Work in Developing Science Policy**

Ralph Cicerone's research in atmospheric chemistry and climate change has involved him in shaping science and environmental policy at the highest levels nationally and internationally.

Dr. Cicerone's research was recognized on the citation for the 1995 Nobel Prize in chemistry awarded to University of California, Irvine colleague F. Sherwood Rowland. The Franklin Institute recognized his fundamental contributions to the understanding of greenhouse gases and ozone depletion by selecting Cicerone as the 1999 laureate for the Bower Award and Prize for Achievement in Science. One of the most prestigious American awards in science, the Bower also recognized his public policy leadership in protecting the global environment. In 2001, he led a National Academy of Sciences study of the current state of climate change and its impact on the environment and human health, requested by President Bush. The American Geophysical Union awarded him its 2002 Roger Revelle Medal for outstanding research contributions to the understanding of Earth's atmospheric processes, biogeochemical cycles, and other key elements of the climate system. In 2004, the World Cultural Council honored him with the Albert Einstein World Award in Science.

*Early in his career, Dr. Cicerone held faculty positions in electrical and computer engineering at the University of Michigan. In 1978 he joined the Scripps Institution of Oceanography at the University of California, San Diego, as a research chemist. From 1980 to 1989, he was a senior scientist and director of the atmospheric chemistry division at the National Center for Atmospheric Research in Boulder, Colorado. In 1989 he was appointed the Daniel G. Aldrich Professor of Earth System Science at the University of California, Irvine and chaired the department of earth system science from 1989 to 1994. While serving as dean of physical sciences for the next four years, he brought outstanding faculty to the school and strengthened its curriculum and outreach programs. Prior to his election as Academy president, he was the chancellor of the University of California, Irvine from 1998 to 2005.*

*Dr. Cicerone is president of the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society. He has served as president of the American Geophysical Union, the world's largest society of earth scientists, and he received its James B. Macelwane Award in 1979 for outstanding contributions to geophysics. He has presented invited testimony to the U.S. Senate and House of Representatives on a number of occasions.*