



UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

Department of Chemistry Kolthoff Lectureship in Chemistry

April 13-15, 2015
Professor James Mayer
Department of Chemistry at Yale University

Website: <http://www.chem.yale.edu/faculty/mayer.html>
Faculty Host: William Tolman



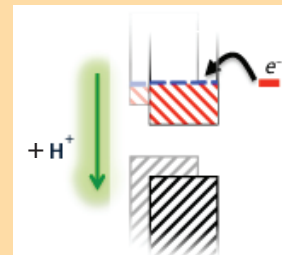
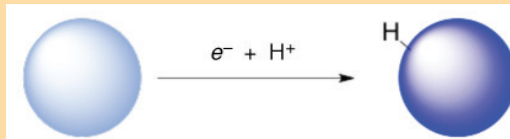
Professor James "Jim" Mayer was born and raised in Manhattan, New York. He attended the United Nations International School, which fostered his passion for science. He started doing research in inorganic chemistry just after high school at Hunter College, with Professor Edwin H. Abbott. He was an undergraduate at Harvard University from 1975-78. He received his doctorate in 1982 from the California Institute of Technology, working with Professor John E. Bercaw on organometallic chemistry of tantalum hydride complexes. He then spent two years as a visiting scientist in the Central Research Department of the DuPont Company. In 1984, he was appointed to the faculty at the University of Washington, where he rose through the academic ranks. He became a professor of chemistry at Yale University in 2014. He has served as chair of the American Chemical Society Division of Inorganic Chemistry and currently serves as an associate editor of the journal *Inorganic Chemistry*.

Professor Mayer's research interests span coordination chemistry, catalysis and electrocatalysis, bioinorganic chemistry, organometallic chemistry, physical organic chemistry, electron transfer, and reactions of nanoscale materials. His focus is on discovering and understanding new reaction chemistry, particularly the involvement of protons in all sorts of redox reactions that make or break chemical bonds. Chemical reactions of this type are involved in many biological, industrial, energy, and environmental processes.

Lecture 3: A Different View of Redox Reactions at Solid-Solution Interfaces: Thinking Beyond the Electron **3:45 p.m. Wednesday, April 15, 331 Smith Hall**

Interfacial charge transfer reactions are almost always described as pure electron (or hole) transfer processes. Electronic energy level pictures, starting from band theory, dominate the thinking in this area. However, many of the processes important for energy production and storage are not simple electron (hole) transfers, but involve the making and breaking of chemical bonds. In particular, the production and use of chemical fuels requires the movement of protons as well as electrons, such as in water splitting into H_2 and O_2 , in the reduction of CO_2 , and in the oxidations of fuels such as H_2 , alcohols and hydrocarbons. Similarly, batteries inherently involve chemical change in the redox-active materials.

This talk will explore how protons and other ions affect the thermodynamics and kinetics of interfacial charge transfer reactions. It will begin with an examination of current models for redox reactivity of materials, contrasting, for example, dye-sensitized solar cells with batteries. Our primary focus will be applying molecular PCET principles to nanoscale interfaces. We have shown that colloidal ZnO and TiO_2 nanoparticles are good PCET reagents. Their reduced forms readily transfer e^- and H^+ (equivalent to a hydrogen atom, H^\bullet) to organic reagents. The thermochemistry and kinetics of these reactions will be discussed, as well as extensions to metal-organic frameworks (MOFs) and high surface area molybdenum nitride (Mo_2N). It is suggested that chemical change of the reacting materials is a key feature of solid-solution interfaces, and that this is not well described by the one-electron band energy level model.



Izaak Maurits Kolthoff was born on February 11, 1894, in Almelo, Holland. He died on March 4, 1993, in St. Paul, Minnesota. In 1911, he entered the University of Utrecht, Holland. He published his first paper on acid titrations in 1915. On the basis of his world-renowned reputation, he was invited to join the faculty of the University of Minnesota's Department of Chemistry in 1927. By the time of his retirement from the University in 1962, he had published approximately 800 papers. He continued to publish approximately 150 more papers until his health failed. His research, covering approximately a dozen areas of chemistry, was recognized by many medals and memberships in learned societies throughout the world, including the National Academy of Sciences and the Nichols Medal of the American Chemical Society. Best known to the general public is his work on synthetic rubber. During World War II, the government established a comprehensive research program at major industrial companies and several universities, including Minnesota. Kolthoff quickly assembled a large research group and made major contributions to the program. Many of Kolthoff's graduate students went on to successful careers in industry and academic life and, in turn, trained many more. In 1982, it was estimated that approximately 1,100 Ph.D. holders could trace their scientific roots to Kolthoff. When the American Chemical Society inaugurated an award for excellence in 1983, he was the first recipient.

