



UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

Department of Chemistry Kolthoff Lectureship in Chemistry

February 6-8, 2012

Professor Michael Graetzel

Laboratory of Photonics and Interfaces
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Faculty Hosts: Philippe Buhlmann & Aaron Massari

Professor Michael Graetzel pioneered research on energy and electron transfer reactions in mesoscopic-materials and their application in solar energy conversion systems, optoelectronic devices and lithium ion batteries. He discovered a new type of solar cell based on dye sensitized nanocrystalline semiconductor oxide particles.



He is the author of more than 800 peer-reviewed publications and two books, and is the inventor of more than 50 patents. He has received prestigious awards, including the Balzan Prize, the Galvani Medal, the Faraday Medal, the Harvey Prize, the Gerischer Award, the Dutch Havinga Award and Medal, the International Prize of the Japanese Society of Coordination Chemistry, the ENI-Italgas Energy-Prize and the year 2000 European Grand Prix of Innovation. He was selected by the Scientific American as one of the 50 top researchers in the world.

He received a doctor's degree in natural science from the Technical University Berlin and honorary doctors degrees from the Universities of Hasselt, Delft, Uppsala and Turin. He has been the Mary Upton Visiting Professor at Cornell University and a Distinguished Visiting Professor at the National University of Singapore. He was an invited professor at the University of Berkeley, the Ecole Nationale de Chachan (Paris) and Delft University of Technology. In 2009, he was named Distinguished Honorary Professor by the Chinese Academy of Science (Changchun) and the Huazhong University of Science and Technology. He is a member of the Swiss Chemical Society as well as of the European Academy of Science, a Fellow of the Royal Society of Chemistry and was elected honorary member of the Société Vaudoise des Sciences Naturelles.

Lecture 2: Optimizing Photon Harvesting and Charge Carrier Collection in Mesoscopic Solar Energy Conversion Systems

9:45 a.m. Tuesday, February 7, 331 Smith Hall

The performance of solar energy conversion devices employing mesoscopic photoelectrodes depends critically on the mesostructure. This is evident for the dye sensitized solar cell (DSC) where charge percolation through the TiO₂ nanoparticle network to the transparent conductive (TCO) electrodes takes milliseconds. Slow charge extraction increases chances of electron-hole recombination at the mesoporous oxide - electrolyte interface, and limits DSCs to be used with only a few electrolytes or hole conductors that offer low recombination rates. These limitations can be overcome by judicious molecular engineering of the sensitizer and with advanced nanostructuring techniques. Here we describe our latest advances in optimizing the photon harvesting and the charge transport in these solar conversion systems by applying novel mesoscopic film structures. We shall describe the dynamics of the salient electron transfer and transport processes involved in the solar light harvesting and conversion including femtosecond charge carrier generation by interfacial electron transfer from the excited sensitizer in the conduction band of the oxide nanoparticles. Strikingly high efficiency and excellent stability has been reached rendering these systems competitive with conventional p-n junction solar cells.

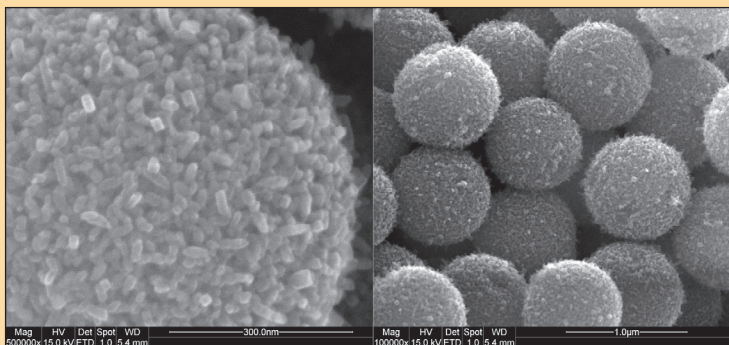


Figure 1. Mesoporous TiO₂ beads for high performance dye sensitized solar cells.

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.

