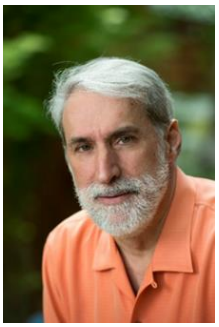
Department of Chemistry & Biochemistry Seminar

Friday, April 30th, 2021

1:30pm – 2:45pm

Zoom ID: 960 452 0800

Password: Energy



A Complete Artificial Photosynthesis: Sustainable and Renewable Carbon and Nitrogen Cycles for Distributed Energy and Food Production

Speaker: ***Dr. Daniel G. Nocera Harvard University***

Abstract: Hybrid biological inorganic (HBI) constructs have been created to use sunlight, air and water as the only starting materials to accomplish carbon and nitrogen fixation, thus enabling distributed and renewable fuels and crop production. The carbon and nitrogen fixation cycles begin with the Artificial Leaf, which was invented to accomplish the solar fuels process of natural photosynthesis – the splitting of water to hydrogen and oxygen using sunlight – under ambient conditions. To create the Artificial Leaf, self-healing catalysts were created to permit water splitting to be accomplished under benign conditions and thus the system may be interfaced to bioorganisms to accomplish fuels and fertilizer production. To this end, bio-engineered organisms converts carbon dioxide and nitrogen from air, along with the hydrogen produced from the catalysts of the Artificial Leaf, into liquid fuels and ammonia, respectively. The HBI, called the Bionic Leaf, operates at carbon-fixing and nitrogen-fixing efficiencies (×10 of nature), greatly exceeding the 1% yield of natural photosynthesis. The organism can also fix phosphorus from waste sources. By interfacing energy with agriculture, we show that for a 400-acre farm, that the budget saving of carbon dioxide is 253,000 lbs while enhancing crop yields. The science that is presented will show that using only sunlight, air and water, a distributed and renewable system may be designed to produce fuel (carbon neutral) and food (carbon negative) within a sustainable cycle for the biogenic elements of C, N and P. The discoveries described in this talk are particularly useful to the poor of the world, where large infrastructures for fuel and food production are not tenable

Biography: Daniel G. Nocera is the Patterson Rockwood Professor of Energy at Harvard University. He moved to Harvard in 2013 from Massachusetts Institute of Technology, where he was the Henry Dreyfus Professor of Energy and was Director of the Solar Revolutions Project and Director of the Solar Frontiers Center at MIT. Nocera is recognized for his discoveries in renewable energy, originating new paradigms that have defined the field of solar energy conversion and storage. Nocera created the field of proton coupled electron transfer (PCET) at a mechanistic level by making the first measurement that allowed an electron and proton to be timed. On this experimental foundation, he provided the first PCET theory. Within this framework, he is the inventor of the Artificial Leaf and the Bionic Leaf, discoveries set the stage for the large-scale deployment of distributed solar energy for fuels and food production. Nocera has been awarded the Leigh Ann Conn Prize for Renewable Energy, Eni Prize, IAPS Award, Burghausen Prize, Elizabeth Wood Award and the United Nation's Science and Technology Award for his discoveries in renewable energy. On this topic, he has also received the received the Inorganic Chemistry, Harrison Howe, Remsen and Kosolapoff Awards from the American Chemical Society. He has received honorary degrees from Harvard University, Michigan State University and the University of Crete. He is a member of the American Philosophical Society, American Academy of Arts and Sciences, the U.S. National Academy of Sciences and the Indian Academy of Sciences, and he is a Fellow of the Royal Society of Chemistry. He was named as 100 Most Influential People in the World by Time Magazine and was 11th on the New Statesman's list on the same topic. He is a frequent guest on TV, radio and is regularly featured in print. His latest projects include the French film 'Supernature' and his feature in Leonardo DiCaprio's film, "Ice on Fire", which premiered at Cannes Film Festival in May 2019 and was released internationally in June 2019. Nocera has supervised 168 Ph.D. graduate and postdoctoral students, 73 of which have assumed faculty positions, published over 475 papers, given over 1100 invited talks and 133 named lectureships. Nocera

founded Sun Catalytix, a company committed to developing energy storage for the wide-spread implementation of renewable energy. His advanced technologies in energy storage are now being commercialized and implemented by the Lockheed Martin, the largest engineering company in the world. A second company, Kula Bio, is focused on the development of renewable and distributed crop production and land restoration by replacing the biogenic elements from air (C, N) and wastewater (P).