UNIVERSITY OF CAMBRIDGE

LEWIS LECTURES 2012

PROFESSOR DANIEL G. NOCERA

Department of Chemistry

Massachusetts Institute of Technology

13 & 14 March 2012

Professor Daniel G. Nocera

Daniel G. Nocera is the Henry Dreyfus Professor of Energy at the Massachusetts Institute of Technology, the founder of Sun Catalytix, the Director of MIT's Solar Revolutions Project and director of the Eni Solar Frontiers Center at MIT. He is a member of the American Academy of Arts and Sciences and the U.S. National Academy of Sciences. He was named as one of Time Magazine's 100 Most Influential People in the World.

His group pioneered studies of the basic mechanisms of energy conversion with a recent primary focus on solar water splitting. Solar hydrogen evolution from water requires the coupling of multielectron processes to protons, which are energetically uphill, thus requiring a light input. He was one of the pioneers in the field of proton-coupled electron transfer (PCET) at a mechanistic level and has developed in recent years a solar fuels process that mimics photosynthesis. In 2008 his group published an efficient electrocatalyst system for water oxidation consisting of cobalt phosphate on an indium-tin oxide anode. In 2011 his group presented a prototype solar-powered device that splits water. The device, an 'artificial leaf', consists of a silicon chip to absorb solar light and it evolves hydrogen and oxygen with catalysts painted on this chip. He believes that this discovery will set the stage for the large-scale storage, distribution and deployment of solar energy and provide a sustainable energy supply for the developing world.

Lectures

13 March 2012: 4-5pm, Wolfson Lecture Theatre, Chemistry

'Personalized Energy for 1 (x 6 Billion): A Solution to the Global Energy Challenge

Abstract The supply of secure, clean, sustainable energy is arguably the most important scientific and technical challenge facing humanity in the 21st century. Rising living standards of a growing world population will cause global energy consumption to double by mid-century and triple by the end of the century. Even in light of unprecedented conservation, the additional energy needed is simply not attainable from long discussed sources – these include nuclear, biomass, wind, geothermal and hydroelectric. The global appetite for energy is simply too much. Petroleum-based fuel sources (i.e., coal, oil and gas) could be increased. However, deleterious consequences resulting from external drivers of economy, the environment, and global security dictate that this energy need be met by renewable and sustainable sources. The dramatic increase in global energy need is driven by 3 billion low-energy users in the non-legacy world and by 3 billion people yet to inhabit the planet over the next half century. The capture and storage of solar energy at the individual level – personalized solar energy – drives inextricably towards the heart of this energy challenge by addressing the triumvirate of secure, carbon neutral and plentiful energy. This talk will place the scale of the global energy issue in perspective and then discuss how personalized energy (especially for the non-legacy world) can provide a path to a solution to the global energy challenge.

14 March 2012: 4-5pm, Wolfson Lecture Theatre, Chemistry

'The Artificial Leaf'

Abstract: It has been said for an ideal solar fuels process that the system requirements are:

- Earth-abundant materials
- No wires
- Direct solar-to fuels process.

We now describe two earth abundant catalysts that promote the oxygen evolving reaction (OER) and hydrogen evolving reaction (HER) with a solar AM 1.5 (1 sun) input mediated by an earth abundant silicon wafer, and all of this is done with no wires. The system captures many of the elements of photosynthesis and it is indeed functionally an artificial leaf. But the system surpasses the prescription from the community. It also does not rely on a membrane and it operates under very simple conditions, thus obviating complicated engineering requirements. The science behind the artificial leaf will be presented.