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CHEMISTRY & BIOCHEMISTRY COLLOQUIUM:
Sustainable Energy Conversion

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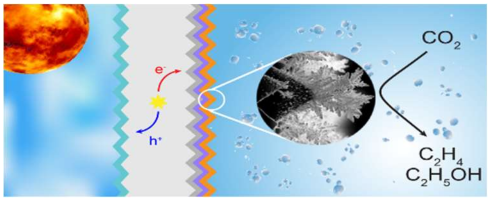
About The Speaker:

Joel W. Ager III is a Senior Staff Scientist in the Materials Sciences Division of Lawrence Berkeley National Laboratory and an Adjunct Full Professor in the Materials Science and Engineering Department, UC Berkeley. He is a Principal Investigator in the Electronic Materials Program and in the Liquid Sunshine Alliance LiSA) at LBNL and in the Berkeley Educational Alliance for Research in Singapore (BEARS). He graduated from Harvard College in 1982 with an A.B in Chemistry and from the University of Colorado in 1986 with a PhD in Chemical Physics. After a post-doctoral fellowship at the University of Heidelberg, he joined Lawrence Berkeley National Laboratory in 1989. His research interests include the discovery of new photoelectrochemical and electrochemical processes for solar to chemical energy conversion, fundamental electronic and transport properties of semiconducting materials, and the development of new types of transparent conductors. Professor Ager is a frequent invited speaker at international conferences and has published over 300 papers in refereed journals. His work is highly cited, with over 40,000 citations and an h-index of 107 (Google Scholar).



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Abstract:

Since the industrial revolution, human activities have caused the atmospheric carbon dioxide concentration to rise at a rate that has no precedent in the Earth's history. If renewable power sources such as solar and wind could be used to produce chemical precursors and/or fuels, it would provide an alternative to mankind's currently unsustainable use of fossil fuels and slow the rate of CO2 emission.

Photosynthesis provides a canonical example of light to chemical energy conversion and thus motivates work to make systems which achieve similar function. Photovoltaic devices convert photons to electricity by absorbing light, separating electrons and holes, and steering the carriers to charge selective contacts. To further electrical to chemical energy, the electrons and holes must perform redox reactions associated with a thermodynamically uphill process [1]. In this context, examples of engineered structures which steer electrons and holes to drive the electrochemistry of the water splitting reaction will be discussed [2].

Developing devices which will use sunlight to convert carbon dioxide to hydrocarbons, is considerably more challenging. It will be shown that optimized coupling of photovoltaics to electrolysis cells incorporating tandem catalysts can be used to convert CO2 to C-C coupled products such as ethylene and ethanol with an overall energy conversion efficiency of over 5%, 10x that of natural photosynthesis [3] and with multi-day stability [4].

A viable sustainable energy conversion technology must, eventually, operate at the scale of our current carbon emissions, i.e. at gigatons per annum. I will discuss the current technological challenges which include control of selectivity, product separation, and operational lifetime [5,6].

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