The University of Arizona

Chemical and Environmental Engineering Department – Seminar

®"Exploring Bio-Nano Interfaces for Renewable Energy"

Jennifer Cha, PhD
Professor and Associate Chair for Faculty
Department of Chemical and Biological Engineering
University of Colorado, Boulder

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Zoom: https://arizona.zoom.us/j/99357350715

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ABSTRACT

With increasing demands for alternative sources of fuel, extensive research has focused on discovering methods to generate renewable energy from earth abundant resources. In recent years, a wide range of inorganic nanostructures with high surface areas and tunable band gaps have been synthesized and used as photocatalysts. To increase their activity, "Z-scheme" photocatalytic systems have been implemented in which multiple types of photoactive materials simultaneously oxidize water and reduce molecules upon photoillumination. In this talk, I will show our recent efforts to utilize DNA as a structure-directing agent to organize well-defined photoactive donor and acceptor nanocrystals into optimal configurations. In the first part, I will demonstrate that using DNA as a structure directing agent to assemble TiO_2 and Pt decorated CdS nanocrystals caused a significant improvement in water splitting as opposed to utilizing a single type of particle or simply mixing the particles in solution. In addition, DNA also allowed positioning of a single or series of electron mediators site-specifically between the two catalysts to further increase H_2 production. In a similar vein, I will also show some of our recent efforts in applying Z-schemes for reducing CO_2 to usable fuels.

In the latter part of the talk, I will showcase our very recent efforts to apply a bioinspired approach to tailor protein-nanoparticle interfaces for studying photoassisted redox activity. In order to drive enzymatic reduction of dissolved gases, electron sources such as photocatalysts and electrochemistry have been studied. However, in order to optimize electron flow, there is a significant need to understand how the interface between the organic enzyme and inorganic semiconductor influences protein binding and dynamics. Many redox enzymes function through assembly of protein subunits utilizing complex and multivalent interactions, with binding strengths ranging from long-range and weak to short-range and near-covalent. Mimicking such exquisite binding motifs is likely to be key for replacing protein subunits with photoactive semiconductors. This talk will showcase our recent insight into the design of interfaces between semiconductor surfaces and proteins to control binding and conformational dynamics of enzymes to promote photodriven redox catalytic activities.

BIOSKETCH

Jennifer Cha obtained her PhD in Materials Chemistry from UC Santa Barbara in 2001 with Profs. Galen Stucky, Dan Morse and Tim Deming. She then did her postdoctoral research with Prof. Paul Alivisatos at UC Berkeley from 2002-2004. Following this, she worked as a Research Staff member at the IBM Almaden Research Center where she started a program focused on using bionanotechnology for nanoelectronics. In 2008, she began her academic career in the Department of Nanoengineering at UC San Diego, receiving tenure in 2012. Since July 2012, she joined the Department of Chemical and Biological Engineering at University of Colorado, Boulder where she is currently a David Clough Endowed Professor and Associate Chair for Faculty. Her group's research focuses on the design and use bio-nanotechnology to synthesize and create well-defined organic-inorganic systems from nanoscale building blocks. Specific applications include engineering protein therapeutics, using DNA for engineering photocatalytic architectures and developing bioinspired interfaces for catalysis. Over the last few years, she has obtained a DARPA Young Faculty Award, an NSF CAREER award, a DOE Early Career Award and a Sloan Award.

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