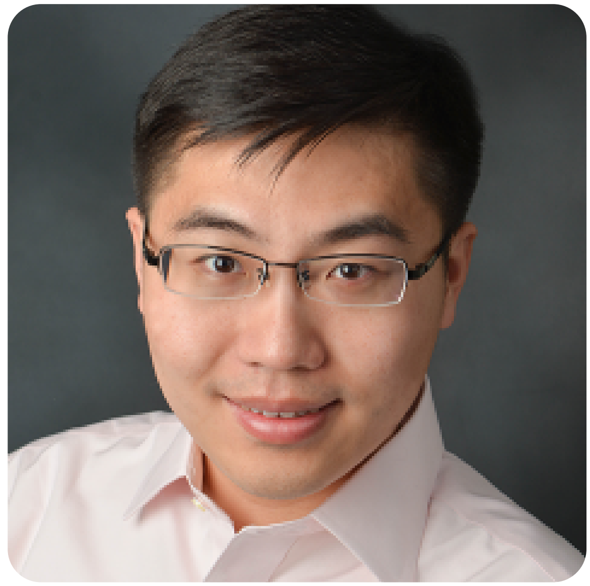
Penn Engineering | Chemical and Biomolecular Engineering
UNIVERSITY of PENNSYLVANIA

Spring 2024 Seminar Series

SHU HU

"Carbon Capture and Utilization in Flowing Oceanwater: A New Frontier in Photocatalysis"

Wednesday
March 13, 2024
3:30 PM
Wu and Chen Auditorium
Levine Hall



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ABSTRACT

Carbon capture, utilization, and storage (CCUS) are critical for managing anthropogenic carbon dioxide (CO2) emissions. Great strides have been made in electrification so far, but there are a handful of scenarios that still require hydrocarbon fuels and chemicals, such as aviation, long-haul trucking, and marine shipping. On the one hand, atmospheric CO2 is only 420 ppm, and using alkaline sorbents for direct air capture is energy intensive; and there are issues with carbon utilization during electrochemical CO2 reduction. On the other hand, atmospheric CO2 exchanges with surface seawater constantly, and the concentration of dissolved inorganic carbon (DIC) in the oceans is approximately 140 times higher in carbon molarity than atmospheric CO2. Thus, capturing and converting DIC in seawater represents an alternative approach to CO2 direct air capture. For these new opportunities, our group takes a multi-scale approach: i.e., combining light-driven photocatalysis with reactive transport using engineered photo-reactors, such as utilizing the 2.3-millimolar dissolved bicarbonate in oceanwater under sunlight. Photocatalysis concerns multiple redox reactions located within nanoscale distances: I will first elucidate the chemical physics of coupled processes during photocatalysis essentially to achieve >85% quantum efficiency; and then, I will describe the design and realization of 3D-printed reactors. A flow photoreactor enables realistic ocean operation. This new process achieves one-step conversion to syngas, which directly enables on-site liquid fuel production. Thus, it saves over 50% of the energy that is used for stepwise separation of the 420 ppm CO2 in the air.

BIO

Dr. Shu Hu is an Assistant Professor in the Department of Chemical and Environmental Engineering at Yale University, joint with the newly formed Energy Sciences Institute on the Yale West Campus. Prof. Hu's group studies photocatalysis in the context of multi-scale reaction environments. Shu Hu received his Ph.D. from Stanford University in Materials Science and Engineering. Between 2012 and 2015, he did postdoctoral work in the Department of Chemistry with Professor Nathan S. Lewis at California Institute of Technology, where he discovered coating-stabilized photochemical interfaces.

He has been recognized by the DOE Early Career Award, ECS Young Investigator Award for Energy Technology, and Global Chinese Chemical Engineer Awards, and was given several named lectureships. He currently serves as the Secretary of the New England Catalysis Society and serves on the editorial board for Frontier in Chemistry.