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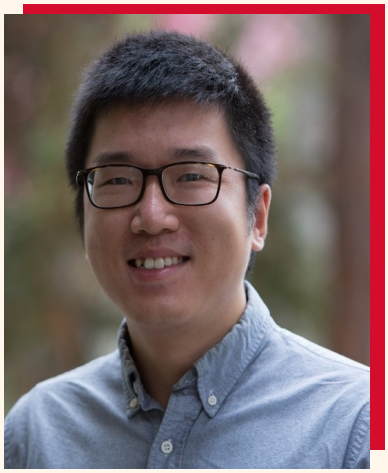
# Development of Computational and Experimental Tools to Understand Transport and Interaction of Microscopic Energy Carriers

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## ABSTRACT:

Solid-state energy converters, including thermoelectric, photovoltaic and photocatalytic devices, hold great promise of providing sustainable clean energy and addressing global challenges such as climate change and air/water pollution. One common feature of these devices is that their performance is largely determined by the transport and interaction processes of microscopic energy carriers, mainly electrons, phonons and photons. It is being increasingly recognized that a thorough understanding of these processes is the key to the ultimate performance of a wide range of energy materials. In this talk, I will first report our recent development and application of DFT-based first-principles simulation tools to understand electron-phonon interactions in thermoelectric materials, as well as a novel three-pulse photoacoustic technique to directly measure phonon damping by electrons in silicon membranes. In the second half of the talk, I will introduce the ultrafast electron beam, which combines the femtosecond time resolution and nanometer spatial resolution, as an ideal probe to reach the single-mode-level detection of transport and interaction. As a demonstration, I will present visualization of photocarrier dynamics in hydrogenated amorphous silicon and black phosphorus using the scanning ultrafast electron microscope, and discuss the findings that can only be revealed by ultrafast spatial-temporal imaging. To conclude, I will share my thoughts on the outlook of combining first-principles simulation and ultrafast optical/electron spectroscopy and imaging to eventually "see" how solid-state energy materials work at the most fundamental level.


## BIOGRAPHY:

Bolin Liao is currently an assistant professor in the Department of Mechanical Engineering at UCSB. Bolin obtained his Ph.D. in Mechanical Engineering from MIT in March 2016, advised by Prof. Gang Chen. His Ph.D. thesis focused on developing theoretical, computational and experimental tools to understand transport and interaction of microscopic energy carriers in thermoelectric materials. He was a Kavli Postdoctoral Fellow at California Institute of Technology from May 2016 to June 2017, hosted by late Prof. Ahmed Zewail, where he worked on scanning ultrafast electron microscopy. Bolin is a recipient of the DOE Early Career Research Program in 2018, Regents' Junior Faculty Fellowship at UCSB in 2018 and the Wunsch Foundation Award for Outstanding Thesis from MIT Mechanical Engineering in 2016.