MAR17-2016-030094

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Ultrafast Microscopy of Energy and Charge Transport

LIBAI HUANG, Purdue University

The frontier in solar energy research now lies in learning how to integrate functional entities across multiple length scales to create optimal devices. Advancing the field requires transformative experimental tools that probe energy transfer processes from the nano to the meso lengthscales. To address this challenge, we aim to understand multi-scale energy transport across both multiple length and time scales, coupling simultaneous high spatial, structural, and temporal resolution. In my talk, I will focus on our recent progress on visualization of exciton and charge transport in solar energy harvesting materials from the nano to mesoscale employing ultrafast optical nanoscopy. With approaches that combine spatial and temporal resolutions, we have recently revealed a new singlet-mediated triplet transport mechanism in certain singlet fission materials. This work demonstrates a new triplet exciton transport mechanism leading to favorable long-range triplet exciton diffusion on the picosecond and nanosecond timescales for solar cell applications. We have also performed a direct measurement of carrier transport in space and in time by mapping carrier density with simultaneous ultrafast time resolution and 50 nm spatial precision in perovskite thin films using transient absorption microscopy. These results directly visualize long-range carrier transport of 220nm in 2 ns for solution-processed polycrystalline CH3NH3PbI3 thin films. The spatially and temporally resolved measurements reported here underscore the importance of the local morphology and establish an important first step towards discerning the underlying transport properties of perovskite materials.