Visualizing Structures and Photoinduced Dynamics of Materials and Interfaces Using Time-Resolved Electron Imaging Techniques

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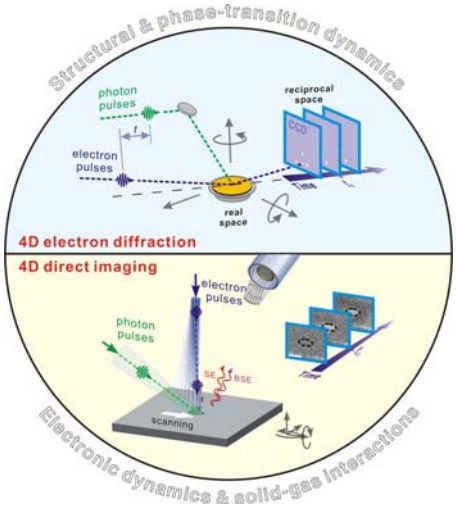

Modern applications and technological advances in materials and interfacial phenomena often require a fundamental understanding of condensed matter at the atomic level, especially those involving ultrafast light-matter interactions. To study photoinduced dynamics, all-optical femtosecond spectroscopic techniques have been the typical methods of choice, which provide information mostly about electronic changes and sometimes, indirectly, about structures. In this presentation, I will discuss the use of ultrafast electron imaging techniques to visualize structures and dynamics at the pertinent spatial and temporal resolutions. Direct structure-probing at ultrashort time scales allows for the discovery of a structural intermediate and a stepwise pathway for the photoinduced transformation of vanadium dioxide. Our recent results further reveal the behavioral differences between ultrathin supported films and the strain-free specimens. At interfaces, unique structural changes of interfacial molecular assemblies (such as water and methanol) on selected surfaces can be uncovered directly. Present experimental observations indicate that the structures of an assembly have a strong impact on the energy transfer and relaxation across the interface. These findings, together with additional first discoveries of solid–molecule structures at equilibrium, exemplify the strength of using electrons as the probe for interfacial phenomena. I will conclude the talk with a discussion of the potential broad use of ultrafast electron imaging methods for materials and heterogeneous interfacial studies.

Biographical sketch. Ding-Shyue (Jerry) Yang received his B.S. and M.S. in Chemistry from National Taiwan University. Under the supervision of the late Nobel laureate Ahmed Zewail at Caltech, he was involved in the development of ultrafast electron diffraction for condensed matter during his Ph.D. study. He continued on as a postdoctoral scholar and a research scientist in the Zewail group and successfully designed and built the first scanning ultrafast electron microscope. In 2012, he joined the Department of Chemistry at the University of Houston. He is a recipient of the junior Welch Professorship in 2013 and the NSF CAREER award in 2017. Jerry Yang's research interests include ultrafast dynamics and transformation pathways of transition metal materials as well as interfacial energy- and charge-transfer dynamics in heterogeneous solid–molecule systems.