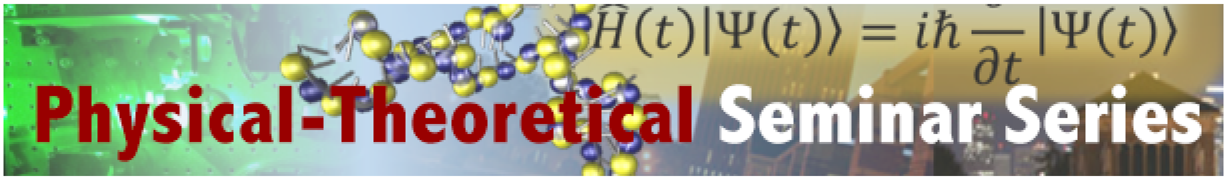

Monday, September 10, 2018, 12:00 pm
Seaver Science Library, Room 150
SSC Auditorium next to the library

Professor Robert Baker

Department of Chemistry and Biochemistry
Ohio State University

Visualizing Ultrafast Electron Dynamics at Catalytic Surfaces

Directly observing electron dynamics at surfaces is required to reveal the material properties that determine efficiency during energy conversion catalysis. Toward this goal, we have developed a tabletop instrument for femtosecond X-ray spectroscopy of surfaces. This method combines the benefits of X-ray absorption, such as element, oxidation, and spin state specificity, with surface sensitivity and ultrafast time resolution, having a probe depth of only a few nm and time resolution faster than 100 fs. Using this technique, we study the electron dynamics in a number of catalytically relevant metal oxides. Specifically, Fe_2O_3 is an earth-abundant semiconductor with a band gap ideally suited for solar light harvesting, but its catalytic performance is low due to surface electron trapping. In these studies, we show that surface trapping occurs in less than 1 ps. Ultrafast trapping occurs by the interactions of the free electrons with the lattice nuclei via a process known as small polaron formation. In contrast to Fe_2O_3, $CuFeO_2$ is a closely related earth-abundant photocatalyst, which can reduce CO_2 using sunlight. Specifically, we have recently shown that $CuFeO_2$ is a selective catalyst for photo-electrochemical CO_2 reduction to acetate. Using ultrafast X-ray spectroscopy, it is possible to track electrons and holes independently in the Fe 3d, Cu 3d, and O 2p states comprising the band structure of this photocatalyst. Results show that photocatalytic activity is related to ultrafast hole relaxation leading to spatial charge separation in the layered $CuFeO_2$ lattice, which cannot occur in Fe_2O_3. This ability to elucidate site-specific charge carrier dynamics in real time provides important criteria for the rational design of catalysts for efficient solar energy harvesting based on their underlying photophysics.

Hosted by Professor Alexander Benderskii

The scientific community is invited

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