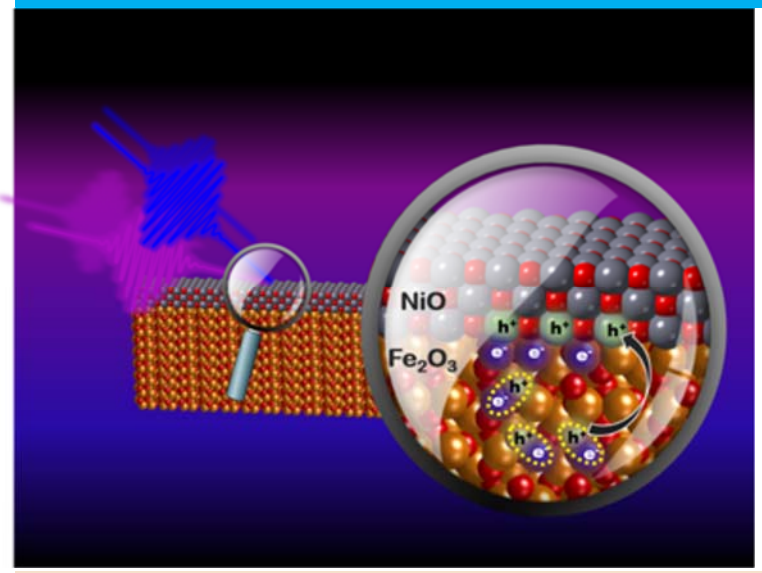
PHYSICAL SEMINAR

Title: "Observing Ultrafast Charge and Spin Dynamics at Photochemical Interfaces"



Guest Speakers:

Professor Robert Baker

Ohio State University

Department of Chemistry

Monday, September 16, 4:00 PM

473 Hutchison Hall

Department of Chemistry

Abstract: The ability to understand and synthetically control charge and spin dynamics at interfaces is at the heart of energy conversion and information processing technologies. Direct observation of these dynamics is required to identify the material properties and surface states, which mediate electron trapping and interfacial charge transfer. To realize this goal, we have developed extreme ultraviolet (XUV) reflection-absorption spectroscopy as a surface specific analog of x-ray absorption spectroscopy. This tabletop version of synchrotron XANES is able to measure oxidation and spin state dynamics of individual elements with a probe depth of less than 3 nm and a time resolution faster than 100 fs. This enables us to measure electron dynamics at photochemical interfaces on the time scale of hot carrier cooling, electron-phonon coupling, and interfacial charge transfer. This technique is applied to the study of electron trapping and defect-mediated recombination at the surface of NiO. Ultrafast measurements of electron trapping and subsequent recombination shows that grain boundaries rather than oxygen vacancies are responsible for fast electron-hole pair recombination. This result clarifies the design parameters for NiO water oxidation catalysts by showing that oxygen vacancies, which enhance catalytic activity, have no detrimental effect on carrier lifetime. Rather, carrier lifetime can be dramatically extended by the elimination of near-surface grain boundaries even in the presence of chemically active oxygen vacancies. Finally, we describe several examples where ultrafast spin dynamics in semiconductor photocatalysts play an important role in the material's photochemical performance.

Host: Professor Kathryn Knowles, email: kknowles@ur.rochester.edu