HAJIM SCHOOL OF ENGINEERING & APPLIED SCIENCES
UNIVERSITY of ROCHESTER

Department of Chemical Engineering

Dr. Daniel Esposito

Postdoctoral Associate
National Institute of Standards and Technology (NIST)

Metal-Oxide-Semiconductor (MOS) Photoelectrodes for Efficient Solar Water Splitting

Thursday, December 20, 2012
9:00 a.m.
101 Goergen Hall

Solar-driven water splitting with Photoelectrochemical (PEC) cells is an attractive pathway for renewable production of hydrogen (H_2), but the efficiency and stability of semiconducting photoelectrodes must be improved. One promising approach to achieving both high efficiency and good electrochemical stability is the metal-oxide-semiconductor (MOS) photoelectrode design. This MOS architecture consists of catalytic metal structures, or collectors, deposited on an oxide-covered semiconductor. Of great importance to this design is the oxide layer, which must simultaneously protect the semiconductor from the potentially corrosive electrolyte while mediating tunneling of electrons between the semiconductor and collectors. Silicon is a commonly used photovoltaic material that is attractive for use in MOS photoelectrodes, but the performance of Si-based MOS electrodes demonstrated to date has been very poor, with efficiencies less than 1 %.

In this seminar, I will describe a systematic approach to improving the performance of Si-based MOS photocathodes that is based on studying well-defined arrays of MOS structures with *in-situ* scanning probe techniques. Specifically, we have combined scanning photocurrent microscopy (SPCM) and scanning electrochemical microscopy (SECM) to simultaneously record images of quantum efficiency and catalytic activity on MOS photocathodes with high spatial resolution. I will show how this powerful combination of techniques can be used as a diagnostic tool, for predicting optimal MOS geometries, and elucidating complex interfacial charge transfer phenomenon. A major focus of this talk will be the use of combined SPCM/SECM in revealing the occurrence of a hydrogen-spillover assisted H_2 evolution mechanism on MOS photocathodes. These findings have important implications for the optimization and design of MOS photoelectrodes. I will also discuss several other aspects of this research project, including modeling efforts, interfacial engineering in MOS junctions, and integration of MOS photocathodes into stand-alone water splitting devices.