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Electroanalysis using semiconductor/metal junction light-addressable electrochemical sensor

ABSTRACT: Electrochemical measurements have a fundamental constraint: each working electrode requires an electrical connection and a dedicated electronic circuit to control and measure the current and potential. This limitation has held back advancements in electroanalytical research for decades.

In this seminar, I will discuss my group's attempts to overcome the "one electrode, one wire" limitation using light-addressable electrochemistry (LAE). LAE is a recently developed technique that uses light to activate an electrochemical reaction at the surface of a semiconducting photoelectrode. A challenge of this research is that LAE uses semiconductors as the light-absorbing electrode material.

Understanding and controlling the electrochemical response of these sensors is considerably more challenging than with traditional metallic electrodes. We recently showed that LAE sensors prepared using n-Si and metal nanoparticles (e.g., Au, Pt) demonstrate "textbook" cyclic voltammetry towards standard redox species–essentially behaving like metal electrodes that can be turned on and off with light. We applied these sensors to detect sub-μM concentrations of neurotransmitters and other biologically relevant species (e.g., H2O2).

Subsequently, we investigated the origin of the photovoltage in these systems and explored the implications of the photovoltage on electroanalytical measurements. We also studied how alternative voltammetric waveforms can be used to both provide richer electrochemical information about the interface and increase the sensitivity of the sensors.

Finally, I will present our most recent efforts to perform selective surface modifications of the interfaces using self-assembled monolayer chemistry with the goal of expanding the scope of potential analytes that can be probed with LAE. The findings presented here pave the way to exciting applications in chemical imaging, array-based sensing, surface patterning, nanomaterial synthesis, and electrocatalysis.

Wednesday, February 26th

2:00 - 3:15 p.m.

Science Hall 126 & Zoom

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