Yale Institute for Nanoscience
and Quantum Engineering

Friday- October 16, 2015

12:00 to 1:00 p.m.

BECTON SEMINAR ROOM

Light lunch will be served at 11:45 a.m.

Omur Erdinc Dagdeviren

Department of Mechanical Engineering & Materials Science, Yale University

"Robust High-Resolution Imaging and Quantitative Force Measurement with Tuned-Oscillator Atomic Force Microscopy”

Atomic force microscopy and spectroscopy are based on locally detecting the interactions between a surface and a sharp probe tip. For highest resolution imaging, noncontact modes that avoid tip-sample contact are used; control of the tip’s vertical position is accomplished by oscillating the tip and detecting perturbations induced by its interaction with the surface potential. Due to this potential’s nonlinear nature, however, achieving reliable control of the tip-sample distance is challenging, so much so that despite its power vacuum-based noncontact atomic force microscopy has remained a niche technique. Here we introduce a new pathway to distance control that prevents instabilities by externally tuning the oscillator’s response characteristics. A major advantage of this operational scheme is that it delivers robust position control in both the attractive and repulsive regimes with only one feedback loop, thereby providing an easy-to-implement route to atomic resolution imaging and quantitative potential measurement.

Fred Walker

Department of Applied Physics , Yale University

“Perovskite Oxides as Electrochemical Catalysts”

The perovskite oxides display a wide range of properties that depend on their chemical composition. Their properties range from ferroelectricity for $PbTiO_3$ and $BaTiO_3$, to superconductivity for the cuprates, and metallicity in compounds such as $LaNiO_3$. Here, we extend the list to include the catalytic and semiconducting properties of thin film $SrTiO_3$ when used as an electrode for the electrolysis of water. The key is to engineer the bands of an oxide heterostructure that features $SrTiO_3$ as a cathode, so that an applied voltage injects electrons into the $SrTiO_3$ conduction band, which are then transported to the $SrTiO_3$-electrolyte interface. The chemical potential of the electrons in the conduction band of $SrTiO_3$ lies about 0.4 eV above the equilibrium potential for the reduction of H^+ in solution to H_2 gas, thus providing a large thermodynamic driving force for the efficient electrolysis of water. Additional electrocatalytic reactions may be realized, such as the reduction of CO_2 to CO, through monolayer modifications of the $SrTiO_3$ surface or band engineering of the perovskite electrode. The goal is to develop a flexible approach to the design of cathodes and anodes based on the remarkable properties of the perovskites and designed to efficiently drive a variety of electrochemical reactions.

Host: Professor Eric Altman