Yale Institute for Nanoscience and Quantum Engineering

Friday- February 5, 2016

12:00 to 1:00 p.m.

BECTON SEMINAR ROOM

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

Kevin P. Regan
Department of Chemistry, Yale University

"Size-Dependent Ultrafast Charge Carrier Dynamics of WO_3 for Photoelectrochemical Cells"

Time-resolved terahertz (THz) spectroscopy and open circuit photovoltage measurements were employed to examine the size-dependent charge carrier dynamics of tungsten oxide (WO_3) particles. Specifically, films of commercially available WO_3 nanoparticles (NP) and granular particles (GP) with diameters of 77 ± 34 nm and 390 ± 260 nm, respectively, were examined in air and also while immersed in 0.1 M Na_2SO_4 electrolyte. Examination of the frequency-dependent transient photoconductivity at short and long timescales demonstrated the presence of high and low mobility photoinduced charge carriers with comparable carrier densities. The presence of long-lived photoinduced charge carriers that contribute to surface chemistry are not detectable until the highly mobile carriers were trapped. Optical pump − THz probe (OPTP) measurements revealed that the majority of highly mobile photogenerated carriers are trapped within 50 ps after photoexcitation in both the NPs and GPs. However, for the NP sample in the presence of electrolyte, a non-negligible quantity of long-lived carriers (~2% of the total OPTP signal) were detected beyond 600 ps.

Ke Zou
Department of Applied Physics and Center for Research on Interface Structures and Phenomena (*CRISP*), Yale University

"$LaTiO_3/KTaO_3$ interfaces: A New Two-Dimensional Electron Gas System"

Emergent conducting channels at complex oxide interfaces display a wide range of solid state phenomena, ranging from superconductivity to magnetism. To date, the only transition metal oxide that has been found to host a conducting channel for a 2D electron gas (2DEG) is the perovskite $SrTiO_3$. We present a new 2DEG system at the interface between a Mott insulator, $LaTiO_3$, and a band insulator, $KTaO_3$. For $LaTiO_3$ / $KTaO_3$ interfaces, we observe metallic conduction from 2 K to 300 K. One limitation of $SrTiO_3$-based conducting oxide interfaces for electronics applications is the relatively low carrier mobility (0.5 - 10 cm^2/Vs) of $SrTiO_3$ at room temperature. The mobility is a product of the carrier effective mass, an intrinsic property of the oxide band structure, and the carrier scattering rate, which is large in $SrTiO_3$ due to a strong interaction of carriers with optical phonons. By using $KTaO_3$, we achieve mobilities in $LaTiO_3$ / $KTaO_3$ interfaces of 21 cm^2/Vs at room temperature, a factor of 3 higher than observed in doped bulk $SrTiO_3$. *Ab initio* calculations predict the formation of a 2DEG in the interfacial $KTaO_3$ layers that resides in bands having Ta 5d character. We attribute the higher mobility in the $KTaO_3$ 2DEGs, compared to $SrTiO_3$ 2DEGs, to the smaller effective mass for electrons in $KTaO_3$ in these bands.

Host: Professor Eric Altman