SES16-2016-000017

Abstract for an Invited Paper
for the SES16 Meeting of
the American Physical Society

Interfacial Engineering and Characterization in Polar/Non-Polar Oxide Heterostructures

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Polar/non-polar interfaces in epitaxial oxide films have been a rich area of research for many years for emergent behavior. Recent work has branched out to explore ways to use these interfaces to engineer optical responses in materials as well. The interfacial dipole that results from the polar discontinuity at such interfaces can generate band bending and a built-in electric field near the interface, which may be used to separate optically-excited electron-hole pairs for enhanced photovoltaic and photocatalytic response. However, detailed characterization of the band structure is needed to understand both the origin of these phenomena and engineer their behavior. In this talk I will discuss our work using interfacial termination in polar/non-polar heterojunctions and superlattices to engineer electric fields in these materials. Recent work has shown short-circuit photocurrents and visible light photocatalysis in $LaFeO_3/n$-$SrTiO_3$ heterostructures where the interface is varied between a positively charged TiO_2-LaO and a negatively charged SrO-FeO_2. Using *in situ* x-ray photoelectron spectroscopy (XPS) characterization of these heterojunctions, we extract the valence and conduction band alignment between the materials. We show that previous reports of a bulk polarization induced in $LaFeO_3$ due to the $SrTiO_3$ termination are not present, raising questions as to the origin of the previously reported behavior. In related work exploring $LaCrO_3/SrTiO_3$ superlattices, we employ synchrotron standing wave XPS to examine the electronic dispersion of buried layers and show that by engineering alternating terminations in confined layers between positively charged TiO_2-LaO and negative CrO_2-SrO interfaces a polarization is induced in each material. This result could open new pathways to engineer electron-hole separation using interfaces.