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Effect of Growth Induced (Non)Stoichiometry on Interfacial Conductance in $LaAlO_3/SrTiO_3$

LANE MARTIN, University of Illinois, Urbana-Champaign

There has been great interest in the emergence of novel phenomena at the heterointerface between $SrTiO_3$ and $LaAlO_3$ including the observation of two dimensional conductivity, superconductivity, magnetism, and more. Despite extensive work in the field there is still a debate about the mechanism for and how to deterministically control these exotic states of matter. In this talk we will explore the implications of variations in cation stoichiometry for the crystal structure, dielectric, thermal, and electronic properties of such materials. We will demonstrate a strong link between the growth process, the stoichiometry of the $LaAlO_3$, and the resulting interfacial electrical properties. Varying the La-cation stoichiometry by a few atomic percent in films grown at 1 x 10^{-3} Torr results in a 2 and 7 order-of-magnitude change in the 300K and 2K sheet resistance, respectively, with highly conducting states occurring only in La-deficient films. Further reducing the growth pressure results in an increase of the sheet carrier density and a dramatic change in the carrier mobility. We will highlight the relative contributions of *intrinsic* and *extrinsic* effects in controlling the properties of these heterointerfaces and how these factors are controlled by the growth process. We will explore the effect of the growth process on the evolution from 2D to 3D conductance via high magnetic field transport measurements of the Shubnikov-de Haas effect and will explore the thickness evolution of the conducting interface. Overall we will demonstrate a strong link between the growth process, the stoichiometry of the resulting materials, the desired properties of the system, and the implications for understanding the physics and how to engineer these and other materials including nickelates, ferroelectrics, and more.