Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Understanding polarity compensation across polar $LaAlO_3$ films
G. SINGH-BHALLA, LBL, UC Berkeley, P. ROSSEN, UCB, S. JAGANATH, G. PALSSON, D. YI, LBL, A. DASGUPTA, J. RAVICHANDRAN, UCB, V. RUIZ, U Munich, J. HERON, UCB, C. FADLEY, LBL, A. YADAV, UCB, R. PENTCHEVA, U Munich, R. RAMESH, UCB, LBL — Dipole screening mechanisms for polar crystals can manifest in a variety of ways depending on bandgaps, surface energies and environmental conditions. Here we study the polarity compensation process in $LaAlO_3$ thin film grown on the two different surface terminations of [001] $SrTiO_3$ crystals (SrO and TiO_2). An electron gas that appears at the interface between $LaAlO_3$ and TiO_2-$SrTiO_3$ surface (n-type) potentially screens the $LaAlO_3$ polarity, while the interface between $LaAlO_3$ and SrO-$SrTiO_3$ (p-type) remains insulating. To understand this asymmetry, we probed the $LaAlO_3$ surface using a variety of element-specific probes and observe a change in the $LaAlO_3$ stacking structure in the p-type geometry. Tunneling measurements reveal remnants of a built-in field reflective of $LaAlO_3$'s intrinsic polarity across the n-type structure, but no such signatures are detected for the p-type structure. When combined with density functional theory simulations, the results suggest that while free charge screens the $LaAlO_3$ dipole in the n-type geometry, a change in $LaAlO_3$'s structure during growth nullifies the dipole in the p-type geometry. In essence, $SrTiO_3$ surface layers drastically affect $LaAlO_3$ polarity compensation and in turn the electronic properties.

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Date submitted: 20 Nov 2012 Electronic form version 1.4