Atomic-Scale Chemical Imaging of Composition and Bonding at Perovskite Oxide Interfaces

L. FITTING KOURKOUTIS, Cornell University

Scanning transmission electron microscopy (STEM) in combination with electron energy loss spectroscopy (EELS) has proven to be a powerful technique to study buried perovskite oxide heterointerfaces. With the recent addition of 3rd order and now 5th order aberration correction, which provides a factor of 100x increase in signal over an uncorrected system, we are now able to record 2D maps of composition and bonding of oxide interfaces at atomic resolution [1]. Here, we present studies of the microscopic structure of oxide/oxide multilayers and heterostructures by STEM in combination with EELS and its effect on the properties of the film. Using atomic-resolution spectroscopic imaging we show that the degradation of the magnetic and transport properties of La$_{0.7}$Sr$_{0.3}$MnO$_3$/SrTiO$_3$ multilayers correlates with atomic intermixing at the interfaces and the presence of extended defects in the La$_{0.7}$Sr$_{0.3}$MnO$_3$ layers. When these defects are eliminated, metallic ferromagnetism at room temperature can be stabilized in 5 unit cell thick manganite layers, almost 40% thinner than the previously reported critical thickness of 3-5 nm for sustaining metallic ferromagnetism below $T_c$ in La$_{0.7}$Sr$_{0.3}$MnO$_3$ thin films grown on SrTiO$_3$.


1In collaboration with J. H. Song, H. Y. Hwang, and D. A. Muller. This work was supported by the Cornell Center for Materials Research (NSF No. DMR0520404 and No. IMR-0417392) with additional support from the ONR EMMA MURI.