MAR10-2009-007535

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Atomic-Scale Chemical Imaging of Composition and Bonding at Perovskite Oxide Interfaces[1]

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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 3^{rd} order and now 5^{th} 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 $SrTiO_3$.

[1] D.A. Muller, L. Fitting Kourkoutis, M. Murfitt, J.H. Song, H.Y. Hwang, J. Silcox, N. Dellby, O.L. Krivanek, Science 319, 1073-1076 (2008).

[1] In 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.