Microscopic Study of c-axis Proximity Effect in Cuprate-Manganite Heterostructures

H. ZHANG, I. FRIDMAN, University of Toronto, N. GAUQUELIN, G.A BOTTON, Canadian Centre for Electron Microscopy and McMaster University, J. Y.T. WEI, University of Toronto and Canadian Institute for Advanced Research — Recent studies have reported long-ranged proximity effect in epitaxial thin-film heterostructures of ferromagnetic manganites and superconducting cuprates, with possible origins in novel spin-triplet correlations [1]. A key evidence for this effect is the suppression of the superconducting $T_c$ observed in multilayer films of La$_{2/3}$Ca$_{1/3}$MnO$_3$/YBa$_2$Cu$_3$O$_{7-\delta}$ (LCMO/YBCO). However, scanning tunnelling spectroscopy on c-axis LCMO/YBCO bilayers have not seen direct evidence for proximity-induced pairing down to 5nm LCMO thickness [2]. We re-examine the $T_c$ suppression by performing atomically-resolved transmission electron microscopy and resistivity measurements on c-axis YBCO/LCMO films grown by pulsed laser deposition, and relating the microstructure in YBCO with the layer thickness and $T_c$. The microscopy revealed double CuO-chain intergrowths forming non-stoichiometric YBCO-247 regions that do not appear in x-ray diffraction, but can be related to the $T_c$ suppression. We attribute these intergrowths to heteroepitaxial strain, by comparing all the lattice parameters and symmetries involved. [1] Z. Sefrioui et al., PRB 67, 214511 (2003); C. Visani et al, Nat. Phys. 8, 539 (2012). [2]I. Fridman et al, PRB 84, 104522 (2011).

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