Effects of Epitaxial Strain and Oxygen Underdoping on Superconductivity in Manganite/Cuprate Thin-Film Heterostructures

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In the study of $La_{2/3}Ca_{1/3}MnO_3/YBa_2Cu_3O_{7-\delta}$ (LCMO/YBCO) heterostructures, it is purported that the long attenuation length scale of the superconducting transition temperature (T_c) is due to a long-range ferromagnet/superconductor proximity effect [1]. To distinguish the role of such a proximity effect from other factors that affect T_c, we grow and characterize various perovskite/YBCO/perovskite trilayers, using ferromagnetic LCMO, paramagnetic $LaNiO_3$ (LNO), and orthorhombic $PrBa_2Cu_3O_{7-\delta}$ (PBCO) as the sandwiching perovskite layers. LCMO/YBCO/LCMO and LNO/YBCO/LNO trilayers show similarly large T_c reductions with decreasing YBCO layer thickness, while this T_c reduction is not seen in the PBCO/YBCO/PBCO trilayers, which are best epitaxially-matched in both lattice parameter and symmetry. A similar trend is seen in trilayer samples where the YBCO layer is underdoped by reducing the oxygen content. Our results indicate that epitaxial strain and oxygen content have a stronger effect on the T_c of LCMO/YBCO heterostructures than any ferromagnet/superconductor proximity effect present. We discuss our results in the wider context of multiple competing orders, particular the recent observation by resonant x-ray scattering of robust charge-density-wave order in LCMO/YBCO multilayers [2].

[1] For references, see: H. Zhang *et. al.*, arXiv:1710.10668, (2018).
[2] A. Frano *et. al.*, Nat. Materials **15**:831 (2016).