In-situ TEM Analysis and Transport in Manganites \( \text{La}_{5/8-y}\text{Pr}_y\text{Ca}_{3/8}\text{MnO}_3 \) Exhibiting Phase Separation below Metal-Insulator Transition

V. VOLKOV, J. HE, T. OSAKA, Y. ZHU, Brookhaven National Laboratory, S. CHAUDHURI, R. BUDHANI, Indian Institute of Technology — Epitaxial films of doped \( \text{La}_{5/8-y}\text{Pr}_y\text{Ca}_{3/8}\text{MnO}_3 \) (LPCMO: \( y = 0.275\text{-}0.375 \)) manganites were examined by in-situ Lorentz microscopy and other TEM methods below the metal-insulator transition point \( T_{MI} \sim 164 \text{ K} \). Such films are known for colossal magneto-resistance effect (CMR). Clear evidences were obtained for mesoscale two-phase separation process involving antiferromagnetic charge-ordered (AFM/CO) and ferromagnetic (FM) phases, coexisting below \( T_{MI} \) in LPCMO films. The first-order CO-FM phase transition is accompanied by partial magnetic melting of the CO phase at CO/FM interfaces thereby creating charge-disordered spin-glass metastates. In contrast, FM phase shows specific “zig-zag” magnetic domains coupled with dense (101) crystal twins. This allows refining relations for charge-orbital and spin-ordering vectors in films. Transport resistance data show that \( T_{MI} \) point is decreased with \( \text{Pr}_y \) growth in LPCMO. On cooling films below \( T_{MI} \) their resistance drops by several orders in magnitude. The observed M-I transition shows striking linear relation for log-conductance curve versus FM fraction measured by TEM, which does not follow typical percolation equations, suggesting that percolation transport model in manganites needs further revisions.

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