Anisotropic transport in phase-separated $La_{0.67}Ca_{0.33}MnO_3/NdGaO_3(100)$ film

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Electrical transport anisotropy, as a reflection of strong coupling among spin, charge, lattice and orbital degrees of freedom, has been widely investigated in strong correlated materials like cuprates[1] and manganites[2]. In this work, strong transport anisotropy was observed in epitaxial $La_{0.67}Ca_{0.33}MnO_3$ (LCMO) thin films grown on orthorhombic $NdGaO_3(100)$ substrates. Due to the enhanced orthorhombic lattice distortion induced by the pseudomorphic strain, the films show phase separation (PS) with coexistence of ferromagnetic-metal (FM) and antiferromagnetic-insulator (AFI) below ∼250 K (Bulk LCMO is safely doped in FM ground state). More strikingly, the temperature dependent resistivity $[\rho(T)]$ is strongly dependent on the current direction (along [010] or [001] axes). Especially in the PS temperature region, the in-plane resistivity anisotropy $[\rho(T)_{I\|[010]}/\rho(T)_{I\|[001]}]$ exceeds ∼100, demonstrating that PS and the strong phase competition should play an important role in the transport anisotropy. And this speculation can be further confirmed by the measurements of magnetic hysteresis loops and the low-temperature X-ray diffraction. Specifically, we argue that the highly oriented FM domain walls between the different AFI domains could be responsible for the transport anisotropy in the epitaxial manganite films.

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