ANISOTROPY IN ELECTRONIC PHASE SEPARATION IN $La_{2/3}Ca_{1/3}MnO_3$ THIN FILMS UNDER ANISOTROPIC STRAIN

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Anisotropic properties in electronic phase separation (EPS) of optimally doped $La_{2/3}Ca_{1/3}MnO_3$ (LCMO) thin films under anisotropic strain have been investigated by transport and relaxation measurement. EPS refers to the spatial coexistence of multiple phases with different electronic or magnetic properties in the absence of compositional variations [1]. This phenomenon is prevalent in the mixed-valence manganites of the formula $A_{1-x}B_xMnO_3$, but manifests differently with varying composition, B-site cations, etc.

For optimally doped bulk LCMO, EPS exists near a characteristic metal-insulator transition (MIT) from a ferromagnetic metallic (FMM) to a paramagnetic insulating (PMI) phase around 270 K, and is believed to be the origin of the colossal magnetoresistance [1]. For LCMO thin films epitaxially grown on $NdGaO_3$ (NGO) substrate, strains of opposite signs are induced by the opposite lattice mismatches in the two in-plane directions between the LCMO film and NGO (001) substrate. The anisotropic strain can trigger the presence of antiferromagnetic insulating (AFI) domains in the background of FMM ground state, and result in another EPS at relatively low temperatures, which can be controlled by modulating the strain via post annealing as demonstrated previously [2].

We have studied three samples from a 48 nm thick LCMO/NGO(001) film, which were posted-annealed for 1.5 h, 5 h and 20 h to produce increasing degree of anisotropic strain, which promotes EPS. A lithographically patterned "L-bar" device enables the study the effects of the strain on the anisotropy of EPS via simultaneous measurements along the two orthogonal in-plane directions. Substantial anisotropy in the temperature and magnetic field dependent resistivity $\rho(T,H)$ was observed, implying the phase-separated AFI state has a preferred orientation under the anisotropic strain. This anisotropy in the EPS is significantly enhanced with increasing post-annealing time. Moreover, ρ is found to exhibit glass-like behavior, relaxing logarithmically in a certain temperature window. The relaxation behavior shows a systematic evolution with changing temperature. This time dependence of the resistivity has been analyzed within a phenomenological model to gain insight into the dynamics of the phase-separated AFI and FMM domains.

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