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Doped Cobaltites: Phase Separation, Intergranular Giant Magnetoresistance, and Glassy Transport

CHRIS LEIGHTON, University of Minnesota

We have used magnetometry, transport, Nuclear Magnetic Resonance (NMR), Small Angle Neutron Scattering (SANS), and Transmission Electron Microscopy (TEM) to investigate magnetoelectronic phase separation in $La_{1-x}Sr_xCoO_3$. This material shows a crossover from a glassy phase at low doping to ferromagnetism (F) above x = 0.18, as well as a simultaneous transition from insulator to metal. NMR confirms magnetic phase inhomogeneity with low spin non-magnetic, glassy, and F regions coexisting spatially. SANS reveals 25 Å F clusters forming in a matrix of non-F insulator at low doping, eventually leading to a percolation transition to long-range F order at x > 0.18. In single crystals, this formation of isolated clusters leads to a hysteretic negative MagnetoResistance (MR) at low temperatures, which has field, temperature, and doping dependencies consistent with an intergranular Giant MagnetoResistance (GMR) effect. We argue that this system is a naturally forming analog to the artificial structures fabricated by depositing nanoscale F particles in a metallic or insulating matrix, i.e. this material displays an intergranular GMR effect without the deliberate introduction of chemical interfaces. The formation of nanoscopic F clusters also gives rise to glassy transport phenomena that are reminiscent of relaxor ferroelectrics. The transport properties show a bifurcation of field cooled and zero field cooled temperature traces, slow response to changes in magnetic fields, and, most notably, a "waiting time" effect that can be observed directly in the resistivity. **Acknowledgements:** ACS Petroleum Research Fund, UMN NSF MRSEC. **Co-Authors:** J. Wu, J. Lynn, C. Glinka, J. Burley, H. Zheng, J. Mitchell, W. Moulton, M. Hoch, P. Kuhns, A. Reyes, C. Perrey, N. Munoz, R. Thompson and B. Carter.