XAS study of spin-state related percolative dynamics in magnetic cobaltites

Meng Wang^a

^aRIKEN Center for Emergent Matter Science (CEMS), Wako 351-0198, Japan

Mixed-valent cobaltite is a double-exchange ferromagnetic system, as analogous to the double-exchange manganite. However, the colossal magnetoresistance (CMR) associated with a magnetic-field-driven insulator-metal transition (IMT) at the phase boundary has not yet been reported in cobaltite. Combining magnetic transport, magnetization, magnetic-forcemicroscopy (MFM), and X-ray absorption spectroscopy (XAS) measurements, we conducted a systematic research on the $La_{0.7}AE_{0.3}CoO_3$ (AE = Ca, Sr, and Ba) films and unveiled the hidden mechanisms that dominate the phase transition dynamics in cobaltite. First, in contrast to utilizing the bulk crystal, we fabricated films on a SrTiO₃ substrate with tensile strain to drive it to the insulator-metal phase boundary. All films exhibit a ferromagnetic and nonferromagnetic phase separation, which is robust against an isothermal magnetic field sweeping, while a percolation induced insulator-to-metal transition can be achieved by a field-cooling process. Such a thermodynamic-history-dependent properties signify a nonergodic feature associated with the dynamics of magnetic domains. By further comparing the nonergodic properties and the spin-sates among La_{0.7}AE_{0.3}CoO₃ films by the transport and XAS measurements, respectively, we reveal that the mixed low-spin Co^{3+} forms a key factor to enhance the energy barrier for domain-wall motions during domain percolation. Such a spin-state degree of freedom is absent in manganites, probably resulting in the large difference of the phase evolution kinetics in the magnetic-field-induced IMT between cobaltite and manganite. [1]

REFERENCES

1. M. Wang,[†] K. Matsuura, M. Nakamura, M. Sawada, M. Kawasaki, and F. Kagawa, "Magnetic field control of insulator-metal crossover in cobaltite films via thermally activated percolation". *Phy. Rev. B* **106**, 155135 (2022).