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Multilength scale investigation of the Perovskite-Bownmillerite topotactic phase transition in La0.7Sr0.3MnO3-δ thin films

Oxygen vacancies play a crucial role in controlling the physical properties of complex oxides. In La0.7Sr0.3MnO3-δ, the introduction of oxygen vacancies induces a topotactic phase transition from the perovskite phase (ABO3) to an oxygen-vacancy–ordered Brownmillerite phase (ABO2.5), accompanied by a transformation from a ferromagnetic metal to an antiferromagnetic insulator. In our study, this coupled magnetic and structural evolution during the phase transition is investigated across multiple length scales. Through plasma-assisted annealing, excellent surface quality is preserved during the transition. Wide Angle X-ray Scattering (WAXS) reveals the phase transition process and confirms the formation of a superlattice. The influence of oxygen vacancies on near-surface magnetic domains is probed via Nitrogen-Vacancy (NV) magnetometry. Polarized Neutron Reflectometry (PNR) and X-ray Resonant Magnetic Reflectivity (XRMR) provide depth-resolved magnetization profiles and oxygen stoichiometry. Scanning Transmission Electron Microscopy (STEM) elucidates the atomic structure and depth-dependent oxidation states.

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