Magnetic Domain Structures in Perovskite Oxide Superlattices.

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Perovskite oxide superlattices composed of alternating layers with different order parameters, have attracted considerable attention due to the possibility for novel properties associated with interactions at the interfaces. In one notable example, metallic conductivity, magnetism, and superconductivity have been reported at the interface between two non-magnetic and insulating oxides, SrTiO3 and LaAlO3. [1] Recently, we have shown that in a superlattice consisting of the antiferromagnetic (AFM) insulator La0.7Sr0.3FeO3 (LSFO) and the ferromagnetic (FM) metal La0.7Sr0.3MnO3 (LSMO), a delicate balance exists between different magnetic interactions (exchange coupling, electronic reconstruction, and long-range interactions) at these interfaces. At a sublayer thickness of six unit cells, a robust spin-flop coupling is observed such that the AFM spin axis re-orients upon the application of an in-plane magnetic field in order to maintain a perpendicular alignment between the FM and AFM moments. [2] In this work, we present a detailed study of the FM and AFM domain structures in perovskite oxide thin films and superlattices as a function of sublayer thickness by photoemission electron microscopy (PEEM) and soft x-ray magnetic spectroscopy. These techniques offer the unique capability for element-specific and surface–sensitive investigation of the magnetic domain structures for FM and AFM materials and the coupling mechanism between the two order parameters. Contrast analysis of the PEEM images with varying orientation of the linear polarization of the x-rays allows the determination of the orientation of the AFM axis. We find that for a single layer LSFO film the AFM spin axis cants out-of-plane. In superlattices regardless of sublayer thickness, the spin axis lies in-the-plane of the film due to the high density of interfaces and the 2D nature of the superlattice structure. Control of the sublayer thickness allows us to independently vary the magnetization of LSMO sublayers and the magnetic anisotropy of the LSFO sublayer. Within the series of superlattices, we observe a change in the type of FM and AFM domain structures due to the competition between the magnetic interactions at the interfaces. Understanding the competition between these interactions and the origin of magnetic domain formation provide essential information to better define the physics of perovskite oxide interfaces.

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