Magnetoelectric coupling through exchange bias at $La_{0.7}Sr_{0.3}MnO_3$/ $BiFeO_3$ interfaces

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Multiferroics exhibiting simultaneously multiple order parameters, such as magnetism and ferroelectricity, offer an exciting way to explore coupled phenomena in solids. These investigations are driven by the prospect of magnetoelectric coupling in which charges are controlled by applied magnetic fields and spins by applied voltages. The recent availability of high-quality thin-film samples of hexagonal manganites and Bi-based perovskites, has improved the ability to accurately characterize multiferroic behavior, and has opened the door to the fabrication of practical devices based on magnetoelectric coupling. Currently, bismuth ferrite $BiFeO_3$ (BFO) is being intensely explored since both ferroelectric (~820 ^oC) and antiferromagnetic (~370 ^oC) ordering temperatures are much higher than room temperature, which make it appealing for ambient applications. Recent studies have demonstrated the existence of strong coupling between ferroelectricity and antiferromagnetism. Since the intrinsic canted ferromagnetism in BFO is too small in magnitude to be useful, current approaches have focused on heterostructures consisting of a ferromagnet in intimate contact with the multiferroic. These studies have used a conventional metallic ferromagnet such as $Co_{0.9}Fe_{0.1}$ to couple to the BFO through exchange coupling at the interface. The existence of double exchange coupled