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Electronic, magnetic, and structural coupling across oxide interfaces

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Many complex oxide materials exhibit a strong interplay between spin, charge, and lattice effects. This coupling leads to a variety of novel electronic and magnetic properties, including charge ordered and magnetic states, "colossal" magnetoresistance (CMR), and a range of electron transport behavior. The possibility of integrating these different kinds behavior with other types of functionalities has motivated the development of new, artificially structured complex oxide-based materials systems, such as composite multiferroic heterostructures. In certain cases, the atomic-scale interface of these structures can dominate the observed behavior, with new physical properties emerging. For example, in epitaxial ferromagnetic/ferroelectric heterostructures, it is possible to achieve large magnetoelectric coupling that is controlled directly by the charge degrees of freedom. We have studied this coupling using a variety of techniques, including magnetization, magneto-optic Kerr effect magnetometry, and x-ray absorption spectroscopy. In addition, structural distortions that arise exclusively at the interface can influence simultaneously the interfacial electronic transport and magnetic properties. Using high resolution synchrotron scattering, we have determined the interplay between new interfacial structural motifs and the resulting electronic and magnetic function at the interface.