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Interface engineering in manganites: from diodes to transistors

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Perovskite manganites show strong coupling between charge, spin, and lattice degrees of freedom as exemplified by 'colossal magnetoresistance'. The recent advances in thin film growth techniques have enabled the generation of novel phases at oxide heterointerfaces, the atomic control of their interface electronic structure, and their incorporation in novel device platforms. We apply these techniques to manganite thin films, first emphasizing the subtleties in optimizing the growth kinetics and stoichiometry [1,2], which has enabled us to create atomically precise heterostructures exhibiting room temperature metallic ferromagnetism in superlattices composed of just 5 unit cell layers [3]. The interface electronic structure was examined using Schottky junctions formed between $La_{0.7}Sr_{0.3}MnO_3$ and Nb-doped $SrTiO_3$, where the band offset (Schottky barrier height) can be controlled by the termination layer at the interface [4]. This band engineering technique was applied in making a metal-base transistor [5], which takes advantage of the strong internal electric field at interfaces. An analysis of many devices enables the quantitative understanding of the evolution from a hot-electron transistor to a permeable base transistor. This structure provides a platform for developing devices incorporating the exotic ground states of perovskite oxides and their interfaces.

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