Independent Behavior of the Antiferromagnetic and Ferromagnetic Properties in Perovksite Oxide Superlattices

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Abstract Body: Recent studies of perovskite oxide superlattices have demonstrated enhanced or completely unexpected properties when compared to the individual constituent materials. These effects are attributed to structural distortions as well as band or charge discontinuities at these interfaces. We have examined superlattices of two perovskite oxide layers, the antiferromagnetic insulator $La_{0.7}Sr_{0.3}FeO_3$ (LSFO) and the ferromagnetic metal $La_{0.7}Sr_{0.3}MnO_3$ (LSMO). We used a combination of structural, magnetic, and electrical characterization techniques to probe both the *global* and *interfacial* properties of the superlattices. In particular, x-ray magnetic dichroism provided chemically selective information on the electronic structure and the magnetic (ferromagnetic and antiferromagnetic) characteristics of each layer. As single layer thin films, the easy magnetization direction of LSMO and the direction of the antiferromagnetic axis, ***A***, of LSFO both lie in the plane of the film. However, when incorporated in superlattice structures, the ferromagnetic and antiferromagnetic orders act independently with decreasing superlattice period. In the case of the ferromagnetic LSMO layers within the superlattices, the magnetic and electrical properties behave as expected, gradually approaching the case of the solid solution with decreasing superlattice period, namely decreasing saturation magnetization and Curie temperature, and increasing resistivity. In contrast, the Néel temperature of the LSFO layers is almost independent of the superlattice period and the orientation of the ***A*** axis differs from the solid solution film irrespective of superlattice period, by canting out of the plane of the film. This diverging behavior illustrates how the neighboring LSFO and LSMO layers respond differently to a charge transfer between the Mn and Fe ions across the interfaces and provides an interesting new means to control of the global magnetic properties of the superlattices.

The Advanced Light Source is supported by the Director, Office of Science, Office of Basic Energy Sciences, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.