University of California, Davis
Department of Materials Science & Engineering
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2:00 – 3:00 pm, 1003 Kemper Hall

PhD EXIT SEMINAR

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Tuning Electronic Interface Reconstruction and Magnetic Reversal in Perovskite Oxide Exchange Spring Heterostructures

Perovskite ABO_3 oxides, where A is typically a rare-earth or alkali-earth metal and B a transition metal, are attractive candidates for implementation in next generation microelectronic devices. They combine a wide range of technologically-relevant functional properties such as ferromagnetism (FM), ferroelectricity, and superconductivity, with a unique sensitivity to external stimuli. Their charge, orbital, lattice, and spin degrees of freedom are readily manipulated by factors such as chemical doping, external magnetic and electric fields, lattice strain, and reconstruction at thin film interfaces. Within the broad field of magnetism, exchange spring magnets comprise a class of materials that combine the high saturation magnetization of soft FMs with the high coercivity of hard FMs. These materials were initially investigated towards creating improved permanent magnets and later for use in heat-assisted magnetic storage devices.

While metallic exchange spring systems have been extensively studied, their oxide counterparts remain relatively unexplored. To this end, my talk is focused on all-oxide exchange spring bilayers containing $La_{0.7}Sr_{0.3}CoO_3$ (LSCO) as the hard FM layer and $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) as the soft FM layer. Soft x-ray magnetic spectroscopy was performed on a wedge bilayer geometry of varying LSCO thickness, and an interface model was developed to explain the divergent trends between the exchange bias shift and coercivity of the coupled soft FM layer. Polarized Neutron Reflectometry was further applied to LSCO/LSMO bilayers to obtain quantitative depth profiles of the sample magnetization, and how they correlate to the magnetization reversal in the system.

The sensitivity of LSCO/LSMO bilayers to the valence state of B-site cations suggests that manipulating charge transfer is an effective means toward controlling the functional properties of oxide multilayers. To further investigate these effects, an additional layer with an intentional mixture of Co/Mn ions on the perovskite B-site was grown and incorporated into the LSCO/LSMO magnetic system. This added $La_{1.4}Sr_{0.6}CoMnO_6$ (LSCMO) layer demonstrates a unique tunability of its saturation magnetization and coercivity. In both a single layer and an LSCMO/LSMO bilayer it displays high saturation magnetization and low coercivity, while in an LSCO/LSCMO bilayer it has low magnetization and higher coercivity. Perovskite systems such as these demonstrate the promise of interface engineering as a means towards controlling the functional behavior of future oxide devices.

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