Functional Heterostructures that Harness Frustration

P. Chandra and L. Palova, T. Yusufaly, V. Cooper, M. Dawber, K.M. Rabe

Center for Materials Theory, Department of Physics and Astronomy, Rutgers University, NJ 08854, USA.

Artificially structured oxides present exciting opportunities for the design of functional materials with specified and/or novel properties. With dramatic advances in epitaxial growth techniques allowing atomic-scale controls, experimental and theoretical attention has focussed on multicomponent strained-layer superlattices and laterally-patterned heterostructures ("nanocheckerboards") that have desirable characteristics distinct from those of their bulk constituents. Here we present two examples of novel functional heterostructures that. In one case, exploiting magnetic frustration, we identify and characterize a multiferroic nanocheckerboard with a combination of first-principles calculations and magnetic modelling that has a coexisting large moment and a large polarization. In another case, using integrated experimental, ab initio and phenomenological approaches, we discuss a two-component superlattice with enhanced piezoelectricity where electrostatic "compromise" occurs. Finally we present current work where we use metallic magnetic oxides as nanoscale dielectrics in heterostructures. These materials, mainly perovskites, are metallic in bulk but become insulating when grown in ultrathin layers; furthermore their magnetic properties are very sensitive to external boundary conditions. Preliminary results on the behavior of these alternative insulating phases embedded in titanium perovskite superlattices will be discussed.

INVITED PAPER