Stress and charge- Routes towards synthetic magnetoelectric coupling across interfaces

Novel electric and magnetic properties can be achieved in materials engineered at nanometer dimensions. Examples include conducting or magnetic interfaces between materials that are neither conducting nor magnetic. New functionality stems from the atomic, magnetic or charge/orbital structure of the interface. With an understanding of interface structure, electric and magnetic degrees of freedom may be controlled, ideally at room temperature, to achieve synthetic magnetoelectric coupling in a nanocomposite.

In this talk I describe applications of polarized neutron reflectometry (PNR) and X-ray resonant magnetic scattering (XRMS) to probe magnetic interfaces in heterostructures and nanocomposites. One application reports the response of magnetism in (La$_{0.4}$Pr$_{0.6}$)$_{0.67}$Ca$_{0.33}$MnO$_3$ (LPCMO) and La$_{0.8}$Sr$_{0.2}$MnO$_3$ (LSMO) thin films to applied bending stress. We find compressive bending stress, exclusive of all other factors, favors ferromagnetism in LPCMO films. In addition, the metal-insulator-transition maybe a consequence of two-dimensional percolation, regardless of applied stress.

A second application illustrates the use of XRMS to test the hypothesis that magnetization can be changed through hole doping of a LSMO/ferroelectric interface. We find evidence to support the hypothesis, although our results are not fully consistent with a recently published study.

I conclude with a discussion of PNR and small angle neutron scattering experiments that demonstrate two methods to control electricity and magnetism by synthesizing magnetoelectric coupling across interfaces.


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