Double-perovskite oxide heterostructures

Marta Gibert
Institute of Solid State Physics, TU Wien

Abstract

Atomically-engineered heterostructures constitute excellent model systems for investigating fundamental structure-property relations in transition metal oxides and their evolution as the thickness of the constituent layers is reduced to only a few unit cells. The double-perovskite $RE_2NiMnO_6$ ($RE=$ rare earth) family is characterized as being insulating ferromagnets, an unusual combination of properties. Ferromagnetism arises through oxygen-mediated superexchange in the rock salt-ordered Ni/Mn sublattice. The Curie Temperature of La$_2$NiMnO$_6$ is $T_c$=280K, and for the other members of the family, $T_c$ decreases linearly with the size of the ionic radius of the $RE$.

Here, we will show that epitaxial $RE_2NiMnO_6$ films ($RE=$La, Nd, Sm), grown by RHEED-enabled off-axis magnetron sputtering, display long-range Ni$^{2+}$ and Mn$^{4+}$ order and strain-independent bulk-like $T_c$ at a thickness of 30 unit cells [1,2]. We find that the ferromagnetic behavior occurs down to ultra-low thicknesses of (at least) 3 unit cells (~1.2 nm). However, below 10 unit cells, the magnetic properties deteriorate due to an interfacial charge transfer caused by the polar discontinuity at the $RE_2NiMnO_6$/SrTiO$_3$ interface [2,3]. For the case of Nd$_2$NiMnO$_6$, a detailed x-ray magnetic circular dichroism (XMCD) study allows us to separate the magnetic components into a robust ferromagnetic Ni/Mn sublattice and a paramagnetic Nd sublattice. We will also present our latest efforts in combining different $RE_2NiMnO_6$ double perovskites into potential multiferroic artificially-layered superlattices [4].