Functional perovskite superlattices and nanostructures fabricated by pulsed-laser deposition

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Perovskite oxides are an extremely versatile class of materials, exhibiting a broad spectrum of appealing physical properties, such as (anti)ferromagnetism, (anti)ferroelectricity, superconductivity, and multiferroicity. As an illustrating example, $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) and $SrRuO_3$ (SRO) are both ferromagnetic perovskites with *bulk* ferromagnetic Curie temperatures of 370 K and 160 K, respectively. However, there are fundamental differences between these two ferromagnetic perovskites: LSMO is a 3*d* transition metal double exchange ferromagnet, whereas SRO is a rare case of a 4*d* itinerant metallic ferromagnet. Moreover, in contrast to LSMO, SRO shows exceptionally strong magneto-crystalline anisotropy. These differences make the interlayer coupling between LSMO and SRO epitaxial thin films an intriguing case. Herein we will report on LSMO / SRO superlattices (SLs) grown by pulsed-laser deposition on vicinal TiO_2-terminated $SrTiO_3$ (100) (STO) substrates. These SLs exhibit strong antiferromagnetic (AF) interlayer-coupling at temperatures below ≈140 K, where the ultrathin SRO layers order ferromagnetically. (1, 2)

Other examples presented in this talk will deal with SLs involving ferroelectric perovskites, such as $PbZr_xTi_{1-x}O_3$, highlighting how SLs can help us gain insight in fundamental condensed matter phenomena, such as the dynamics of the polarization switching in a ferroelectric material.

By employing removable stencil masks attached to the substrates, ordered arrays of large density epitaxial nanodots of multiferroic materials can be grown by pulsed-laser deposition (PLD), as already demonstrated for ferroelectric nanodots by our coworkers at MPI-Halle (3). First results on ordered ferroelectric/ferromagnetic and multiferroic nanostructures will be briefly presented.

1. M. Ziese, I. Vrejoiu et al., Phys. Rev. Lett. 104, 167203 (2010)
2. M. Ziese, I. Vrejoiu, and D. Hesse, Appl. Phys. Lett. 97, 052504 (2010)
3. W. Lee et al., Nature Nanotechnology 3, 402 (2008).