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Stress and magnetism in $LaCoO_3$ films[1]

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Cobaltates exhibit a wide variety of exciting electronic properties resulting from strong electron correlations; these include superconductivity, giant magnetoresistance, metal-insulator transition, and strong thermoelectric effects. This makes them an excellent platform to study correlated electron physics, as well as being useful for various applications in electronics and sensors. In the ground state in the bulk, the prototypical complex cobalt oxide $LaCoO_3$ is in a spin-compensated low-spin state (t_{2g}^6), which results in the ground state being nonmagnetic. In a recent experiment, Fuchs *et al.* (*Phys. Rev. B* **75**, 144402 (2007)) have demonstrated that a ferromagnetic ground state could be stabilized by epitaxial tensile strain resulting in a Curie temperature (T_C) of ~90 K when $LaCoO_3$ (LCO) is grown on $SrTiO_3$ (STO) using pulsed laser deposition. In this talk I will discuss our recent successful attempt to integrate a LCO/STO heterostructure with Si (001) using molecular beam epitaxy. We have grown strained, epitaxial $LaCoO_3$ on (100)-oriented silicon using a single crystal STO buffer (Appl.Phys. Lett. **98**, 053104 (2011)). SQUID magnetization measurements confirm that the ground state of the strained $LaCoO_3$ is ferromagnetic with a T_C of 85 K. Our first-principles calculations of strained $LaCoO_3$ using the LSDA+U method show that beyond biaxial tensile strain of 2.5% local magnetic moments, originating from the high spin state of Co^{3+}, emerge in a low spin Co^{3+} matrix. Ferromagnetism found in tensile-strained $LaCoO_3$ is tightly coupled to the material's orbital and structural response to applied strain. Theoretical calculations show how $LaCoO_3$ accommodates tensile strain *via* spin state disproportionation, resulting in an unusual sublattice structure.

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