Strain-control of local magnetism in manganite films on $BaTiO_3$ substrates

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The local magnetic properties of ferromagnetic manganite films grown epitaxially on ferroelectric BaTiO3 substrates can be controlled either electrically via strain, or magnetically via strain mediated feedback. The resulting magnetoelectric and magnetocaloric effects depend dramatically on the strength of electron lattice coupling in the film, as revealed by 2D magnetic maps constructed from photoemission electron microscopy (PEEM) images with x-ray magnetic circular dichroism (XMCD) contrast. For $La_{0.67}Sr_{0.33}MnO_3$ films with relatively weak electron lattice coupling, strain due to thermally driven structural phase transitions in the substrate modifies the local magnetic anisotropy and forces sharp changes in the orientation of the local magnetization, permitting magnetoelectric effects. For films of $La_{0.7}Ca_{0.3}MnO_3$, stronger electron lattice coupling yields coexisting ferromagnetic and paramagnetic phases that may be interconverted by thermally driving phase transitions in the substrate. Magnetic cycling reveals that this interconversion may be driven via strain-mediated feedback to yield reversible changes in film entropy that are as large as the best magnetocaloric materials.