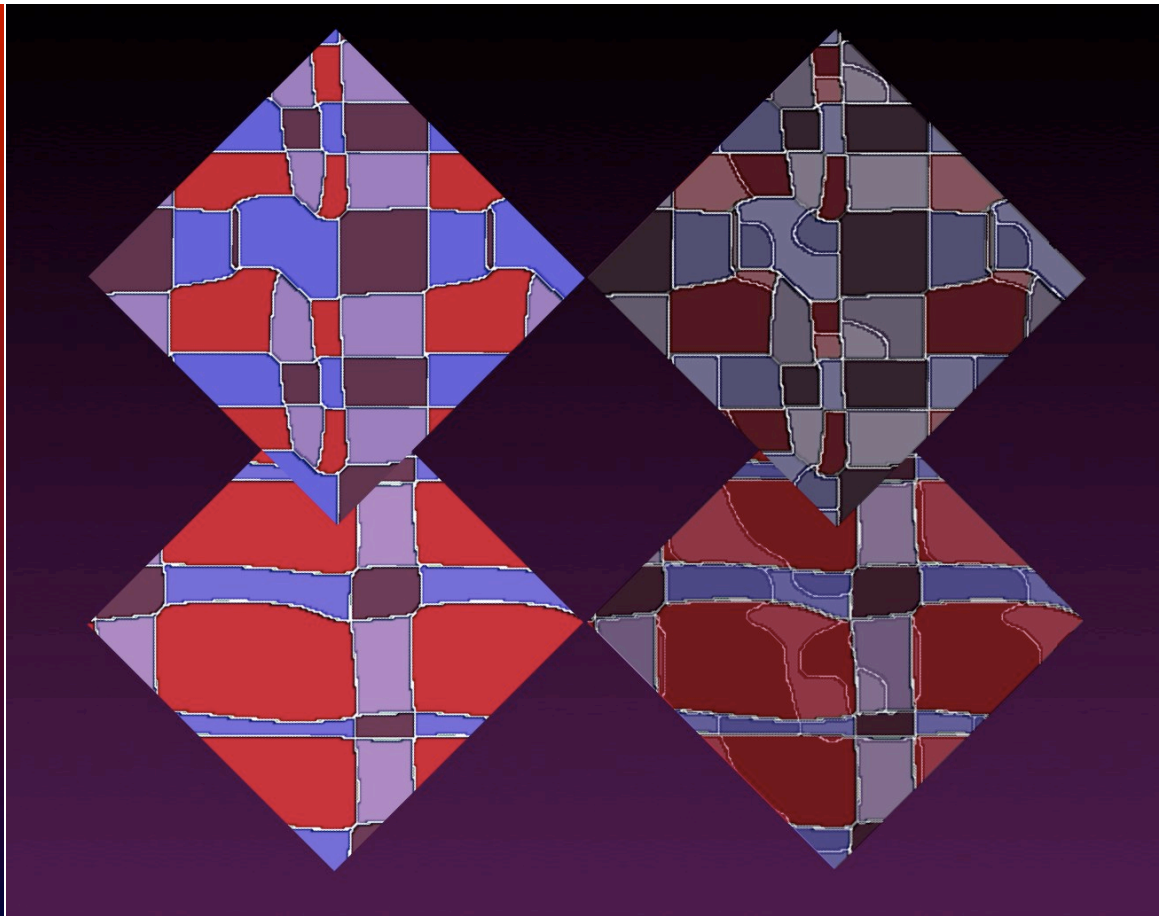
MULTIFERROICS

Penn State MRSEC



The ferroelastic domains (on the right) can assume two independent orientations for a single direction of the ferroelectric domain (on the left). PRL **97**, 257602 (2007)

Two-state lattice for one-state field
coupled elastic and electric

SEED

Multiferroic materials combine multiple electric, elastic and magnetic properties within the same material, often a complex oxide. These ambidextrous materials can show novel couplings between electric polarization, elastic distortion, and magnet domains: for example, electric fields could modulate magnetic properties or elastic distortions could control both magnetism and electric fields.

In ferroelectrics, the electric polarization is coupled to the lattice strain, and a stable distortion of the crystal lattice can create electric fields. MRSEC researchers have shown that $SrTiO_3$ which is *not* a ferroelectric in bulk form, can be made ferroelectric by stretching the lattice through growth as a thin film. Not only does this strain generate ferroelectricity, it also induces multiferroicity: the material is not only ferroelectric, but also ferroelastic, meaning that the lattice and the electric polarization can form *independent* distortions. Unlike in other ferroelectrics, the ferroelectric polarization and the antiferroelastic rotation of oxygen cages are independent, with two independent phase transitions and a coupled domain structure dynamics.