Abstract

A material's ability to electrically polarize under a mechanical deformation is a highly desirable property with extensive applications in sensing and actuation. Current technologies rely heavily on piezoelectricity, which places a symmetry limitation on materials selection, and often involves the use of lead-based components. Flexoelectricity, the coupling of polarization to strain gradient, offers a solution to these issues since it exists independent of material symmetry. Beginning in 2001, experimental measurements of unexpectedly large flexoelectricity in high-κ ceramics drew significant attention to the flexoelectric field. Most of the later work has focused on the flexoelectric effect in single crystal oxides; their structural and chemical homogeneity make them ideal systems for studying the basic physics of flexoelectricity. However, expanding functionality enabled by flexoelectricity will almost certainly involve ceramics, which requires understanding the role played by microstructure.

In this work, the impact of ceramic microstructure on flexoelectricity was explored using the model cubic perovskite strontium titanate $SrTiO_3$. Polycrystalline $SrTiO_3$ samples were prepared by a solid-state sintering process. The average grain size was varied from 2-12 μm by controlling the sintering time. Structural characterization by X-Ray diffraction and dielectric measurements with impedance spectroscopy showed the samples to be cubic $SrTiO_3$ as expected. Polycrystalline samples with short sintering times displayed flexoelectric responses an order of magnitude greater than that of single crystal $SrTiO_3$, while samples with longer sintering times approached the single crystal values. Incidentally, the flexoelectric response was found to decrease over time. It is speculated that this decrease comes from a combination of factors related to sample degradation.