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Intrinsic uniaxial stress induced by co-doping and its influence on piezoelectric performance of $PbZr_{0.45}Ti_{0.55}O_3$ ferroelectric

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Abstract

Intrinsic uniaxial stress along the $[001]_{pc}$ (pseudo-cubic [001]) direction in tetragonal $PbZr_{0.45}Ti_{0.55}O_3$ polycrystal is obtained via A-site acceptor-donor (Li^+-Al^{3+}) co-doping. In-situ X-ray diffraction results demonstrate that local A-site cations ordering of donor-acceptor (along the $[001]_{pc}$ direction) should be responsible for the intrinsic uniaxial stress. The diffuse tetragonal-cubic phase transition and enhanced piezoelectricity are achieved in the doped ferroelectric. Based on the phenomenological theory, enhanced piezoelectricity is related to local low symmetry and stress-driven flattening of free-energy profile. The present study provides a promising method to obtain intrinsic uniaxial stress in $Pb(TiZr)O_3$ polycrystal via donor-acceptor co-doping, and reveal the relationship between this doping route, chemical stress and corresponding properties.

Keywords: piezoelectric; codoping; intrinsic uniaxial stress; phenomenological theory

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