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Assessment of the functional properties stability in $(Ba_{0.85}Ca_{0.15})(Zr_{0.1}Ti_{0.9})O_3$ piezoceramics: Huge dielectric and piezoelectric nonlinearity

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Abstract

The (Ba,Ca)(Zr,Ti)O_3 ceramic system has received special attention in recent years because it may lead to promising lead-free piezoceramics. However, the stability of the functional properties of these materials is an important issue that requires greater attention. In this work, the $(Ba_{0.85}Ca_{0.15})(Zr_{0.1}Ti_{0.9})O_3$ compound (BCZT) is taken as a reference material for evaluating the variation of the functional properties when an external stimulus (e.g., electric field or dynamical stress) is applied, which may constitute an important drawback of piezoceramics. The results show that BCZT exhibits a huge nonlinear behavior, which notably limits this lead-free material for transfer to applications. The instabilities manifest at considerably low amplitudes of the applied electric field or dynamical stress due to a large extrinsic contribution from the irreversible motion of domain walls. Understanding and controlling the physical phenomena related to the domain wall motion presents a fundamental challenge for achieving an effective enhancement of the functional property stability of this system.

Keywords: BCZT; Lead-free piezoceramics; Nonlinear response; Property stability; Rayleigh analysis.

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