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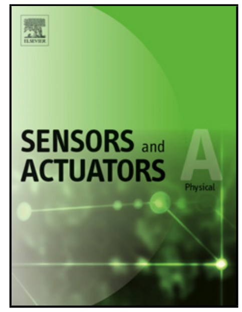

Title: Anomalies of the dielectric and electromechanical responses of multicomponent ceramics on the basis of PMN–PT near the morphotropic phase boundary

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Anomalies of the dielectric and electromechanical responses of multicomponent ceramics on the basis of PMN–PT near the morphotropic phase boundary

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The dielectric and electromechanical responses of ceramics mPbMg$_{1/3}$Nb$_{2/3}$O$_3$–nPbNi$_{1/3}$Nb$_{2/3}$O$_3$–yPbZn$_{1/3}$Nb$_{2/3}$O$_3$–xPbTiO$_3$ (m = 0.1298–0.4844, n = 0.1266–0.4326, y = 0.0842–0.130, x = 0.25–0.40) compositions near the morphotropic phase boundary have been studied. The evolution of the dielectric constant and the longitudinal strain dependences of studied ceramics on an electric field with increasing content x from those typical for relaxor ferroelectrics to those typical for classic ferroelectrics is observed. The occurrence of plateau-like anomalies in the dependences of the dielectric constant and the longitudinal strain of heterophase ceramics ($x \approx$ 0.30–0.35) on the electric field has been established. It has been revealed that the reason for the observed anomalies in the bipolar regime on the application of an electric field is termination of non-180°-domain switching due to high mechanical stresses caused by induced phase transition of the heterophase (tetragonal and pseudocubic) into single-phase (tetragonal) state. It is found that there are no plateau-like anomalies in the unipolar regime of electric field changes. It is shown that ceramics with x = 0.275 have high performance (d_{33} = 1600 pm/V at E = 4 kV/cm) for application in actuators and tunable devices.

Keywords: relaxor ferroelectrics; morphotropic phase boundary; electric-field-induced phase transition; dielectric constant; longitudinal strain; actuators.

1. Introduction

Solid solutions on the basis of relaxor ferroelectrics, PbMg$_{1/3}$Nb$_{2/3}$O$_3$ (PMN), PbZn$_{1/3}$Nb$_{2/3}$O$_3$ (PZN), and PbNi$_{1/3}$Nb$_{2/3}$O$_3$ (PNN), and classical ferroelectrics, PbTiO$_3$ (PT), are of great interest due to the high values of piezoelectric, dielectric, optic and pyroelectric parameters [1–5]. Monocrystals of these solid solutions near the morphotropic phase boundary (MPB), which divides the tetragonal (T) and rhombohedral (Rh) fields of x-T phase diagrams, are characterized by very high values of piezoelectric responses (d_{33} > 2500 pC/N) and the electromechanical coupling coefficient (k_{33} > 0.90) [1]. This gives the possibility of using these materials in different devices: actuators and piezomotors [6–11], underwater transducers and hydrophones