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ABSTRACT:

PIEZORESPONSE FORCE MICROSCOPY STUDY OF FERROELECTRIC-RELAXOR TRANSITION IN Na0.5Bi0.5TiO3-BaTiO3 CERAMICS

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One of the most interesting relaxor systems are environmentally friendly lead-free solid solutions of sodium bismuth titanate and barium titanate (1-x)Na0.5Bi0.5TiO3-(x)BaTiO3 (NBT-BT) with a range of potential applications from high-power ultrasonic generation to electric energy storage and electrocaloric cooling. Macroscopic behavior in these materials is determined by the interplay between ferroelectric and relaxor state. In this research we directly studied transformation between the field-induced ferroelectric state and relaxor state. We report a detailed piezoresponse force microscopy (PFM) study of NBT-BT ceramic samples with different composition and grain size. Non-poled, macroscopically poled, and locally PFM-poled states were studied, paying close attention to the decay of the induced ferroelectric state at the depolarization temperature. In pure NBT ceramics the observed domain morphology is grain size-dependent. However, room temperature measurements show no correlation between grain size and PFM hysteresis loop parameters. We show that, in spite of dependence of the depolarization temperature on sintering temperature, it is not directly related to the grain size. The significant asymmetry of the PFM hysteresis loops at elevated temperatures is attributed to the internal field created by oxygen vacancies accumulated at the internal boundary of the polarized region. Both macroscopically poled (in the ferroelectric state) and depoled (in the NE relaxor state) NBT-05BT ceramics show qualitatively different ac-voltage dependences of the PFM response. For the depoled samples the pronounced hysteresis character of these dependences indicates that ac poling can also induce a ferroelectric state. We also observed that local mechanical stress promotes the transition to the ferroelectric state in the depoled sample.