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Influence of $BaSnO_3$ additive on the energy storage properties of $Na_{0.5}Bi_{0.5}TiO_3$-based relaxor ferroelectrics

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Abstract: (1-*x*)NBT-*x*BSN (0.1≤ *x* ≤0.35) ceramics were prepared by solid state methods and their energy storage properties and high-temperature capacitor applications were systematically investigated. All samples showed a perovskite structure and the structure transformed to lower symmetry orthorhombic phase (x≥0.1) from rhombohedral phase (x<0.1) to with the addition of BSN. The more addition content of BSN significantly decreases phase transition temperature T_m of NBT ceramics. The x=0.25 sample exhibits a stable relative permittivity of 1605±15% in a broad temperature range of 38 °C to 319 °C. With increasing BSN concentration, the slope of the ***P-E*** loops and the energy loss gradually decreases. When x=0.25, a high breakdown strength of 190 kV/cm and the maximum discharge energy density of 1.91 J/cm^3 were obtained, of which the energy efficiency was as high as 86.4%. Thus, it was believed that our work could provide a significant guidance for designing the new system for energy storage.

Keywords: solid state reaction; relaxor behavior; energy density; lead-free

Introduction

Capacitors play a key role in most power electronics used to deliver very large amounts of energy in a very short time. The exploration of high energy storage density dielectric materials has become a research hotspot recently, mainly driven by the increasing demands for miniaturization of power electronics [1]. Generally, lead-contained dielectric materials have larger energy storage density [2-4]. However, increasing environmental awareness will limit the use of this material. Therefore, it is necessary to develop lead-free materials with high energy storage density [5-7].

Recently, advances in high-energy-density dielectrics have focused on $Na_{0.5}Bi_{0.5}TiO_3$ (NBT) based relaxor ferroelectrics because of the high maximum polarization (P_m=43 μC/cm^2) under its dielectric breakdown strength (E_b) of 12 kV/mm, low sintering temperature (~1100 °C) [8]. However,

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