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Improvement in Electrical Properties of $(Bi_{0.5}Na_{0.5})TiO_3$ (BNT) Ceramics Using the Seed-Induced Method

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ABSTRACT

$(Bi_{0.5}Na_{0.5})TiO_3$ (BNT) lead-free ceramics were prepared by the seed-induced technique using different particle sizes of $BaTiO_3$ (BT) powder as seeds. The BT seeds was synthesized by the molten-salt method and then calcined at different temperatures of 750 (750BTs), 800 (800BTs) and 850 °C (850BTs). The pure perovskite seeds (5 mol%) were mixed with the starting materials of the BNT system for conventional mixed oxide method. After that, the mixture was calcined and sintered at 900 °C for 2 h and 1100 °C for 2 h, respectively. From results it was found that the particle size of BT seed increased with calcine temperature increase from 750 to 850 C. The samples of non-BT seed (S0) and BT seed-added (S1, S2 and S3) showed pure perovskite phase. Average density values were in the range of 5.53-5.77 g/cm^3. Dielectric constant (ε_r) measured at room temperature (at 1 kHz) was in the range of 732.04-788.59. The dielectric loss (tanδ), remnant polarization (P_r) and coercive field (E_c) values decreased with the addition of BT seed. The highest piezoelectric coefficient (d_{33}) ~156 pC/N was obtained for the sample of 850BTs (S3).

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1. Introduction

Sodium bismuth titanate ($Na_{0.5}Bi_{0.5}TiO_3$ or NBT) is considered to be an important ceramic for lead-free fabrication and a promising candidate for piezoelectric applications because of its high Curie temperature (~320 °C) and high remnant polarization (38 μC/cm^3) [1–5]. However, this ceramic has a large coercive filed and large conductivity, resulting in a difficult poling process. It was found that the data on piezoelectric properties especially d_{33} values of BNT ceramic are scarce and also showed low values (less than 100 pC/N). To improve the electrical properties of lead-free BNT ceramics for applications, several processing method have been used. The doping of rare earth elements into the BNT based ceramics is one of the methods to improve the electrical properties of this ceramic such as La doped BNT [6], $Bi_{0.5}Na_{0.44}K_{0.06}TiO_3$ [7] and Nd doped BNT ($Bi_{1-x}Nd_xNa_{0.5}TiO_3$) [8]. Moreover, it is well known that the physical and electrical properties of piezoelectric ceramics not only depend on the composition but

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