MS034.O05

Crystal structure and ferroelectric properties of (1-x)$Na_{0.5}Bi_{0.5}TiO_{3-x}BaTiO_3$ ceramics

Dillip K. Pradhan[1], Hari Sankar Mohanty[1], Tapabrata Dam[1], Hitesh Borkar[2], K. K. Mishra[3], Ashok Kumar[2], Shrabanee Sen[4], Balaram Sahoo[5]

[1]*National Institute Of Technology Rourkela Odisha India, Rourkela, India,* [2]*CSIR-National Physical Laboratory, Dr. K. S. Krishnan Marg, New Delhi-110012, India, New Delhi, India,* [3]*Condensed Matter Physics Division, IGCAR, Kalpakkam-603102, India, Kalpakkam, India,* [4]*Sensor and Actuator Division, CSIR-CGCRI, Kolkata-700032, India, Kolkata, India,* [5]*Materials Research Centre, Indian Institute of Science, Bangalore, 560012, India, Bangalore, India*

E-mail: dillip.pradhan79@gmail.com

Ferroelectric systems having perovskite structure triggered the attention of the scientific community for the fundamental physics and their practical device applications such as actuators, transducers, filters, resonators and storage devices. At present most devices are made of lead based ferroelectric materials, however due to the toxic nature of lead, there is an urge for the environmental friendly lead-free materials with properties better or comparable with lead based ferroelectric materials. The (Na0.5Bi0.5)TiO3 (NBT) attracts special attention in recent years as the potential candidate for the lead free ferroelectric materials due to its relatively better ferroelectric and dielectric properties. For successful realization of device applications, there are several issues associated with NBT-based systems that need to address prior to marketing the product: (i) high dielectric loss, (ii) large conductivity, and (iii) high coercive field (~73 kV/cm). It has been well established that fabrication of solid-solution of two similar types of perovskites with composition near the morphotropic phase boundaries (MPB) is the most suitable approach to improve its properties to meet the requirements for practical uses. In the present investigation, we have studied the composition and temperature driven phase transition behaviour of NBT-BaTiO3 solid solution near the MPB.

The solid solutions of (1-x) Na0.5Bi0.5TiO3- x BaTiO3 (0.00≤ x ≤ 0.10) ceramics have been synthesized using sol gel auto combustion method and sintered using microwave sintering technique. The x-ray diffraction, in-situ temperature dependent dielectric, Raman scattering studies, ferroelectric properties, current-voltage (I-V) characteristic were studied over wide range of experimental conditions. On the addition of BaTiO3 into parent compound Na0.5Bi0.5TiO3, induces a structural phase transition from a single phase R3c (x = 0) to a dual phase R3c+P4mm close to x = 0.06 and 0.07 and transform to another single phase P4mm at higher composition (x = 0.08 to 0.10) as observed from our Rietveld refinement and Raman spectroscopic results. A discontinuous change in the Raman mode frequencies and line width across these structural transitions are observed. Also an anomalously enhancement of polarization (2Pr) was observed for x = 0.06 and 0.07. The anomaly in 2Pr values have been explained based on the existence of morphotropic phase boundary due to complex mixed crystal structure. The leakage current behaviour follows space-charge conduction mechanism with Ohmic nature at low applied electric fields and trap assisted conduction at high electric fields. The electric-poling effectively reduces the leakage current, which, in turns, improves the concave shape of the hysteresis loops and the saturation polarization.

[1] Haertling, G. H. (1999). J. Am. Ceram. Soc., 82, 797–818.
[2] Ma, C., et al. (2012). Phys. Rev. Lett., 109, 107602 -1-5
[3] Rao, B. N. et al. (2015) Phys. Rev. B, 92, 214107-1-11

Keywords: : Morphotropic phase boundary, Ferroelectric properties, NBT-BT solid solution.