DIELECTRIC SPECTROSCOPY AND PIEZOELECTRIC PROPERTIES OF LEAD-FREE (1-x)(0.8NBT-0.2BT)-xNN SOLID SOLUTIONS

Tomas Kudrevičius[1], Šarūnas Svirskas[1], Marija Dunce[2], Eriks Birks[2], Jūras Banys[1]

[1]Faculty of Physics, Vilnius University, Sauletekio 9/3, LT10222 Vilnius, Lithuania.
[2]Institute of Solid State Physics, University of Latvia, Kengaraga st. 8, 1063, Riga, Latvia
tomas.kudrevicius@ff.stud.vu.lt

Because of environmental regulations against high amounts of lead used in piezoelectric materials (RoHS directive in EU) there have been made a lot of studies trying to find the best lead-free alternatives. Morphotropic phase boundary (MPB) compositions in $Na_{0.5}Bi_{0.5}TiO_3$-$BaTiO_3$ (NBT-BT) offers high electromechanical strain [1]. In this work $NaNbO_3$ (NN) was used as a secondary material for 0.8NBT-0.2BT ceramic. This material changes dielectric spectrum and phase of ceramic. There have not been many publications about this composition except for M. Dunce *et al.* [2] and Y. Wu *et al.* [3] studies but they were investigating MPB composition of NBT-BT with NN impurities.

In this work five different concentrations were investigated: x = 0, 0.04, 0.05, 0.06 and 0.08. Dielectric properties were measured at a temperature range 250 K - 500 K on cooling with a rate of 1 K/min. Piezoelectric properties were measured using commercial aixaCCT TF 2000 analyzer.

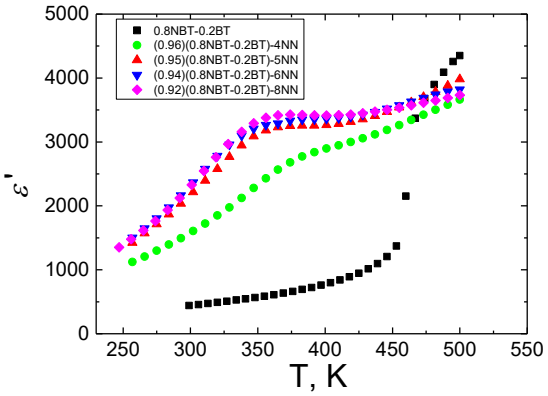

Fig 1. Temperature dependence of dielectric permittivity of all tested concentrations at 0.5 kHz frequency

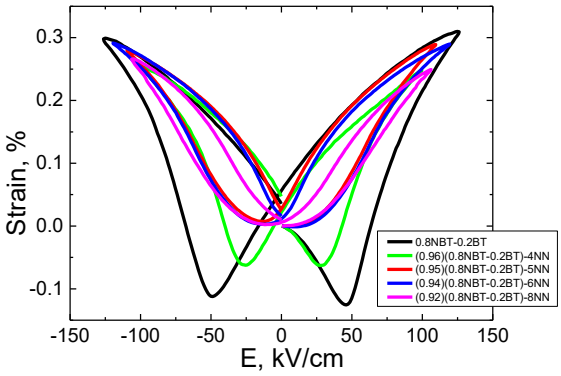

Fig 2. Electromechanical properties of all tested concentrations at room temperature

Fig. 1 shows temperature dependence of dielectric permittivity of all tested concentrations at 0.5 kHz frequency. Concentrations containing $NaNbO_3$ have dielectric anomaly occurring at a temperature interval 330 K – 370 K and there is no sign of phase transition which is monitored in 0.8NBT-0.2BT ceramic. Fig. 2 shows electromechanical properties of all tested compositions at a room temperature. Electromechanical stress in x = 0 and 0.04 concentrations are caused because of piezoelectricity and stress in x = 0.05, 0.06 and 0.08 concentrations occur because of antiferroelectricity.

[1] V. V. Shvartsman and D. C. Lupascu, "Lead-Free Relaxor Ferroelectrics," *Journal of the American Ceramic Society*, vol. 95, no. 1, pp. 1–26, Jan. 2012.

[2] M. Dunce *et al.*, "Dielectric and Polarization Properties of $Na_{0.5}Bi_{0.5}TiO_3$-$BaTiO_3$ Solid Solutions with Na and K Niobates," *Ferroelectrics*, vol. 485, no. 1, pp. 80–88, Aug. 2015.

[3] Y. Wu, H. Zhang, Y. Zhang, J. Ma, and D. Xie, "Lead-free piezoelectric ceramics with composition of (0.97−x)Na1/2Bi1/2TiO3-0.03NaNbO3-x BaTiO3," p. 8.