(1 – x)$Na_{0,5}Bi_{0,5}TiO_3$-x$CdTiO_3$ kietųjų tirpalų dielektriniai ir pjezoelektriniai tyrimai

Dielectric and piezoelectric properties in (1 – x)$Na_{0,5}Bi_{0,5}TiO_3$-x$CdTiO_3$ solid solutions

Eglė Martinaitytė[1,*], Eriks Birks[2], Šarūnas Svirskas[1], Jūras Banys[1]
[1] Faculty of Physics, Vilnius University, Vilnius, Lithuania
[2] Institute of Solid State Physics, University of Latvia, Kengaraga 8, Riga, Latvia
egle.martinaityte@ff.stud.vu.lt

There is a plethora of piezoelectric ceramics' applications in electronics, telecommunications and medicine. Ceramics containing lead were the most widely used, as they seemed to have the best ferroelectric properties [1]. The problem with lead containing materials is that lead is toxic, which causes the search for lead-free ceramics. One of the most promising lead-free piezoelectric materials is $Na_{0,5}Bi_{0,5}TiO_3$ (NBT). Pure NBT ceramics with their ferroelectric properties hardly reach lead-based materials and are therefore doped with other materials. In this work doping is done with cadmium titanate. The aim of this work is to investigate dielectric and piezoelectric properties (1-x)$Na_{0,5}Bi_{0,5}TiO_3$-x$CdTiO_3$ solid solutions.

Materials under test with different concentrations of $CdTiO_3$ were prepared by solid state reaction from chemical grade oxides [2]. We examined samples containing 10 %, 20 %, 35 %, 40 % and 45 % of $CdTiO_3$. Dielectric properties were obtained by cooling samples in a temperature range from 500 K to 100 K with a HP4284A LCR meter, network analyzer AGILENT 8714ET and waveguide system. A rate of the temperature change was approximately 1 K/min. Polarization hysteresis and electromechanical properties were measured with AixaCCT TF 2000 analyzer applying 4 kV external field. Samples were cooled down to 200 K.

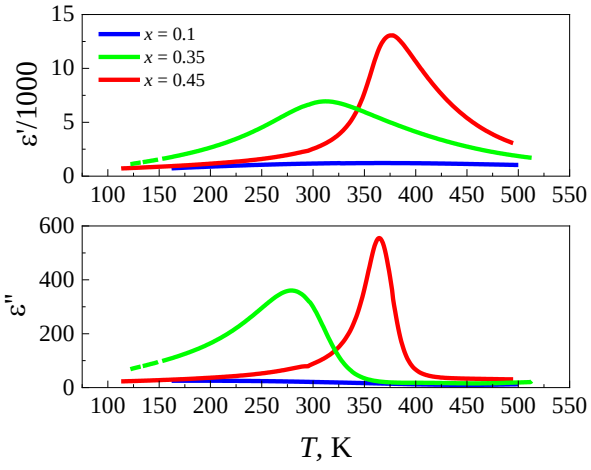

Fig. 1. Temperature dependences of complex dielectric permittivity.

Temperature dependences of dielectric permittivity (Fig. 1) shows that increasing $CdTiO_3$ concentration gives higher dielectric constant values. Comparing it to pure NBT ceramics maximum of dielectric permittivity can be obtained at lower temperatures. Typical ferroelectric properties are only observed for a composition x = 0.45 (Fig. 2). Same results can be seen for sample where x is equal to 0.35 but only at lower temperatures. Behavior of sample with 10 % of $CdTiO_3$ is very similar to linear dielectric and stays the same over the whole temperature range.

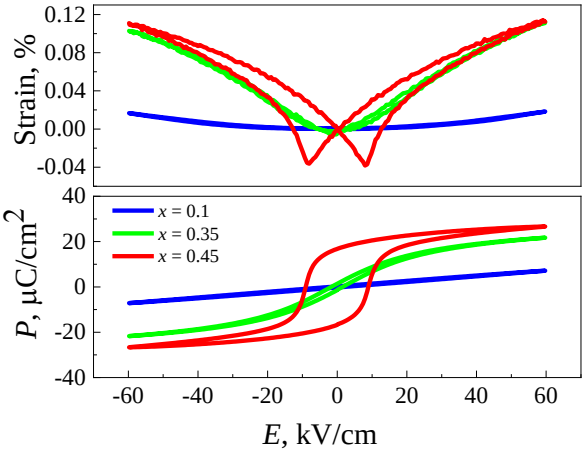

Fig. 2. Electric field dependence of strain and polarization at room temperature.

Keywords: solid solutions, NBT, perovskites, ferroelectrics, relaxor ferroelectrics.

Literature

[1] X. Wang, Y. Huan, S. Ji, Y. Zhu, T. Wei, and Z. Cheng, Ultra-high piezoelectric performance by rational tuning of heterovalent-ion doping in lead-free piezoelectric ceramics, *Nano Energy* **101**, 107580 (2022).
[2] M. Dunce, E. Birks, M. Antonova, V. Zauls, M. Kundzinsh, and A. Fuith, Structure and physical properties of $Na_{1/2}Bi_{1/2}TiO_3$-$CdTiO_3$ solid solutions, *Ferroelectrics* **417**, 93–94 (2011).