The 3rd China-Russia Workshop on Dielectric and Ferroelectric Materials

Hubei University

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Processing and characterization of lead-free ceramics on the base of sodium-bismuth titanate and sodium-potassium niobate

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Lead-free piezoelectric materials are among the most intensively studied in order to replace widely used Pb-based ones. In this work, effects of modification of compositions by various donor and acceptor dopants in the A- and B-sites of perovskite lattice and influence of nonstoichiometry on structure, dielectric and ferroelectric properties of ceramics from Morphotropic Phase Boundaries (MPB) in the $(Na_{1/2}Bi_{1/2})TiO_3$ - $BaTiO_3$ (NBT-BT) and $(K_{0.5}Na_{0.5})NbO_3$ – $BaTiO_3$ (KNN-BT) systems have been studied.

Ceramic samples were prepared by the two-step solid-state reaction method at high temperatures of 920 – 1500 K. The samples NBT-BT and KNN-BT were additionally modified by Ni^{2+}, Fe^{3+}, and Mn^{4+} cations. The samples were characterized by the X-ray Diffraction, Scanning Electron Microscopy, Second Harmonic Generation (SHG), Dielectric Spectroscopy and Piezorespone Force Microscopy (PFM) methods.

Changes in the unit cell volume of the KNN- and NBT-based ceramics were observed depending on the A- and B-cation substitutions. Ferroelectric phase transitions marked by steps at ~ 300 - 400 K (NBT) and by peaks at ~ 550 K (NBT) and at ~700 K (KNN) were revealed in the dielectric permittivity versus temperature curves of the

compositions studied. Ferroelectric phase transitions near 300-400 K revealed typical relaxor-type behavior attributed to the presence of polar nanoregions in a nonpolar matrix.

Increase in the spontaneous polarization value was proved for modified ceramics using the SHG method. At the room temperature, non monotonous changes of the dielectric parameters ε_m and $\tan\delta_m$ and maximum effective d_{33} values were observed in modified BNT- and KNN-based compositions, thus confirming their prospects for new lead-free materials development.

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