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Comparative study on structure, dielectric, and piezoelectric properties of $(Na_{0.47}Bi_{0.47}Ba_{0.06})_{0.95}A_{0.05}TiO_3$ (A=Ca^{2+}/Sr^{2+}) ceramics: effect of radii of A-site cations

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Abstract

Lead-free ceramics $(Na_{0.47}Bi_{0.47}Ba_{0.06})TiO_3$, $(Na_{0.47}Bi_{0.47}Ba_{0.06})_{0.95}Ca_{0.05}TiO_3$, and $(Na_{0.47}Bi_{0.47}Ba_{0.06})_{0.95}Sr_{0.05}TiO_3$ (BNBT, BNBT-Ca, and BNBT-Sr, respectively) were obtained via solid-state sintering. Due to the different radii between Ca^{2+} and Sr^{2+}, the mean radii of the A-site cations in BNBT-Ca, BNBT, and BNBT-Sr are different. Effects of radii of the A-site cations on crystallite structure, microstructure, piezoelectric, and dielectric properties of the ceramics were investigated comparatively. X-ray diffraction and Raman spectroscopy results reveal the lattice distortion due to the doping. With the increase in the mean radii of the A-site cations, lattice parameters, tolerance factor, band-gap energy, average size of grains, dielectric constant, and piezoelectric constant of the ceramics increase. The results imply that structure and electrical properties of BNBT-based ceramics are associated with radii of the A-site cations, which provides a possible route to tune structure and electrical properties of BNBT-based materials by changing radii of the A-site cations.

Keywords: Ceramic; Microstructure; Dielectric properties; Piezoelectric properties