IMPROVED PIEZOELECTRIC RESPONSE IN LEAD FREE PIEZOCERAMICS

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Abstract

(K,Na)NbO_3 based perovskites are considered promising materials as alternative environmental friendly piezoelectrics, envisioned to replace current lead based materials Pb(Zr,Ti)O_3 [1, 2]. Sodium and potassium niobate ($K_{0.5}Na_{0.5}NbO_3$) is a ferroelectric perovskite that crystallizes at room temperature in the orthorhombic symmetry. For this compound, a series of temperature dependent phase transitions are known: rhomboidal → orthorhombic at – 150ºC, orthorhombic → tetragonal at 200ºC and tetragonal → cubic at 400ºC [3]. As some authors pointed out [4], the improvement of the piezoelectric properties can be achieved by shifting the polymorphic phase transition toward room temperature, or by using chemical alteration (doping, substitutions or sintering aids) near a morphologic phase transition. Since the chemical modifications leads to temperature independent piezoelectric properties [5], such techniques are often preferred for piezoelectric devices that operate at different temperature than room temperature.

Lead-free perovskite $(K_{0.5}Na_{0.5})_{1-x}Li_xNbO_3$ (with x=0.065) doped with 1 mol% (Gd-Sm)BO_3 (B=Co, Mn, Cr, Fe, Al) were prepared by a conventional solid-state method. The research was conducted with interests on the effects of (Gd-Sm)BO_3 content on the crystalline structure (x ray diffraction with PanAnalytical X'Pert Pro MPD diffractometer), dielectric and piezoelectric properties of the ceramics. The dielectric measurements (from room temperature up to 420º C, at 10 kHz, 100 kHz and 1MHz, with an Impedance/LRC meter TEGAM model 3550) reveals shifting of the orthorhombic to tetragonal phase transitions and Curie temperature. A full set of the piezoelectric properties were obtained using the resonance method with an impedance analyzer Agilent E5100A. Owning to the increase of the coupling factor and piezoelectric constants, such ceramics can be considered as viable candidates for piezoelectric devices used for electric energy generation.

References

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