IMPROVED PIEZOELECTRIC PROPERTIES IN (K, Na)NbO_3 LEAD FREE CERAMICS

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Abstract

Piezoelectric ceramics are nowadays used in many applications like medical, communication or aerospace. However, lead oxide based materials are the most widely used ferroelectrics. Because of the toxicity of lead oxide, researchers are now focusing on to substituting this compound with newer, environmental friendly materials [1]. Of considerable interest is the (K,Na)NbO_3 based group of materials (doped potassium sodium niobate), which possesses a relatively high Curie temperature and good piezoelectric properties [2]. Also, the temperature independence of the morphologic phase boundary implies good temperature stability of the piezoelectric and ferroelectric properties [3, 4].

New results related to $GdXO_3$ (where X= Al, Co, Cr, Fe) doped $(K_{0.5}Na_{0.5})NbO_3$ ferroelectrics are presented in this paper. Pure $(K_{0.5}Na_{0.5})NbO_3$ and $(K_{0.5}Na_{0.5})NbO_3$ doped with 0.25, 0.5, 0.75, 1, 2.5, 5 mol% $GdXO_3$ were produced by the conventional solid state synthesis. The ceramics obtained were structurally characterized using x-ray diffraction with a PANalytical X'Pert Pro MPD diffractometer. A morphological phase transition was observed, from orthorhombic to tetragonal crystalline symmetry. The frequency dependence (100 Hz – 5MHz) of the real part of the dielectric constant was studied using a LCR meter TEGAM model 3550. The dielectric constant decreases with the increase off frequency. Such behavior is to be explained based on the dispersion of polarization with frequency. The microstructure of the samples was analyzed using a scanning electron microscope Inspect S - FEI Company. Before piezoelectric measurements, the samples were poled at 60 KV/ cm, at 100 ˚C. A complete set of the piezoelectric constants was obtained using the resonance method with a network analyzer Agilent E5100A. The improvement of the piezoelectric properties is to be related to the decrease of the grain size and the presence of the orthorhombic – tetragonal phase transition. The results show that such materials can be successfully used for new environmental friendly piezoelectric applications.

References

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