

Texturing of Potassium Sodium Niobate Based Oxides using Sodium Niobate Oxide Single Crystal Templates

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Lead-free and potassium sodium niobate (KNN) based piezoelectric materials are investigated as a replacement for lead zirconate titanate (PZT). The crystallographically textured solid solution of pseudo-ternary system potassium sodium niobate-lithium tantalite- lithium antimonite, $(\text{K},\text{Na})\text{NbO}_3\text{-LiTaO}_3\text{-LiSbO}_3$, was one of the first important example of a lead-free material matching the properties of PZT [1].

In this study, $(\text{K}_{0.44}\text{Na}_{0.52}\text{Li}_{0.04})(\text{Nb}_{0.86}\text{Ta}_{0.10}\text{Sb}_{0.04})\text{O}_3$ composition was fabricated using two different routes. Firstly, the composition was produced using mixed oxide method that all oxide source materials were used directly. Secondly, columbite precursor method was used to produce the powder. Disc-shaped pellets were prepared using uniaxial pressing. Sintering temperature was used as 1100°C for 4 hour. X-ray diffraction (XRD) analyses showed that samples fabricated using both method crystallized in pure perovskite phase. Beside this study, plate-like single crystal sodium niobate, NaNbO_3 -NN template particles were prepared by a two-stage molten salt synthesis (MSS) method [2]. $\text{Bi}_{2.5}\text{Na}_{3.5}\text{Nb}_5\text{O}_{18}$ (BNN) particles were synthesized and then this BNN phase is transformed into NaNbO_3 through topochemical microcrystal conversion method. The synthesis of the NN particles were done at 975°C -6 h with salt:powder ratio of 2:1 and NaCO_3 molar ratio of 1.5. According to XRD results this synthesis condition was found to give the highest I(001)/I(110) ratio and templates with 20 micron-wide were obtained. These NN template particles were used to texture the composition. A combination of tape-casting and template grain growth were used.

The structural and electrical properties of non-textured and textured ceramics were investigated. Ceramics were poled 80°C for 30 min at 30 kV/mm. Remnant polarization value of non-textured sample was measured $\sim 19 \mu\text{C}/\text{cm}^2$ at 40 kV/cm induced electric field. Electric field induced strain measurement was also carried out and strain level of the same sample was measured as 0.15% at 40 kV/cm.

References

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