Structural properties and phase transitions in $KNbO_3$ based ceramics

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Ferroelectrics ABO_3 with the perovskite-type structure and their solid solutions are of considerable importance for technological applications [1-4]. Nowadays, ABO_3 ceramics become the "heart" of smart systems in many electronic devices with high level of intelligence. Up to now, lead-containing materials such as $PbTiO_3$, $Pb(Zr,Ti)O_3$ or PZT and $Pb(Mg,Nb)O_3$ or PMN have dominated the market of electronics [5, 6]. Nevertheless, lead (Pb) is known to be toxic and may seriously affect human health and natural environment. Therefore, extensive research is actually oriented towards the replacement of lead-based ceramics with lead-free materials. Alkaline niobates and, in particular, potassium niobate $KNbO_3$ and its solid solutions have been found to be the most promising lead-free ferroelectric compounds [7, 8]. In this study, we report the effect of 20 mol. % of $KMgF_3$ on the structural properties and phase transitions in $KNbO_3$.

$KNbO_3$ and $KMgF_3$ powders were prepared by solid state reaction at 850 and 700 °C, respectively. 80 mol. % of $KNbO_3$ were then mixed with 20 mol. % of $KMgF_3$ and dry-ground in a glove box. This powder mixture was pressed into pellets and the tablets were sintered at 900 °C for 15 h in gold sealed tubes under dry helium. The obtained oxifluoride $K(Nb_{0.8}Mg_{0.2})O_{2.4}F_{0.6}$ was investigated by X-ray diffraction (XRD), differential scanning calorimetry (DSC) and dielectric measurements performed in a wide temperature range (200-800 K).

Like $KNbO_3$, the prepared oxifluoride is orthorhombic at room temperature and undergoes three phase transitions corresponding to various structural changes. These ones occur at T_1 = 293 K, T_2 = 448 K and T_C = 544 K, respectively. The ferroelectric Curie temperature of the fluorinated ceramic (T_C = 544 K) is much lower than that of pure potassium niobate (T_C = 708 K). A maximum of the dielectric permittivity ε of about 1800 and a dissipation factor $\tan\delta$ of 43 % are observed at T_C. The ceramic $K(Nb_{0.8}Mg_{0.2})O_{2.4}F_{0.6}$ could be of interest for electromechanical conversion in piezoelectric devices owing to its high values of T_C and $\tan\delta$.

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