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Effect of BNT content on the properties of KNN-based nanopowders obtained by combustion reaction

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Abstract – (1-x)($K_{0.5}Na_{0.5}$)NbO_3-x($Bi_{0.5}Na_{0.5}$)TiO_3 (with x=0~0.1) nanopowders, were synthesized by combustion reaction. The compositions were prepared by a single-step solution combustion reaction using urea/glycine (50/50) ratio as fuel. Stoichiometric compositions of metal precursors and fuels were calculated using the total oxidizing and reducing valences of the components, which serve as the numerical coefficient for the stoichiometric balance, so that the equivalence ratio Φ_C is equal to unity and the energy release was maximum. Nanopowders with homogeneity and phase purity were achieved. The resulting powders were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and by transmission electron microscopy (TEM).

Ceramics with lead element cause a crucial environmental pollution underground water during the processing and waste of products. In recent years, some countries have required all new electronic products to be lead-free for the environmental protection and human health. Recently, much attention for lead-free piezoelectric ceramics has been paid to ($K_{0.5}Na_{0.5}$)NbO_3 (KNN)-based ceramics because of its environmental harmony, good electrical properties, and high Curie temperature [1].

However, the major drawback of KNN ceramics is the need for special handling of the starting powders, sensitivity of properties to non-stoichiometry, and complex densification process [2]. One of the reasons for the poor sinterability of the KNN system is the low melting point of $KNbO_3$, approximately at 1058ºC, moreover alkaline metal elements that were included in these materials easily evaporated at high temperatures. On the other hand, Sodium bismuth titanate, $Bi_{0.5}Na_{0.5}TiO_3$ (BNT), is a kind of lead free material with perovskite structure, large coercive field and relatively large conductivity; pure BNT is difficult to polarize and its piezoelectric properties are not desirable.

In this work, solid solution between these two typical lead-free perovskite materials, were investigated. For this, powders with (1-x)($K_{0.5}Na_{0.5}$)NbO_3-x($Bi_{0.5}Na_{0.5}$)TiO_3 (with x=0~0.1) composition were synthesized by combustion reaction, using a mixture of urea/glycine in 50/50 ratio as fuel. Stoichiometric compositions of metal precursors and fuels were calculated using a equivalence ratio Φ_C equal to unity where the energy release was maximum. Were obtained agglomerated of nanometric sized powders, as shown in Fig.1. For X=0 is obtained nanopwders with perovskite phase, this phase is modified by BNT addition, as shown in Fig 2.

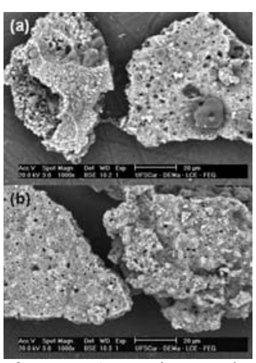

Figure 1: SEM micrographs of (1-x)KNN-xBNT for: (a) x=0 and (b) x=0.04

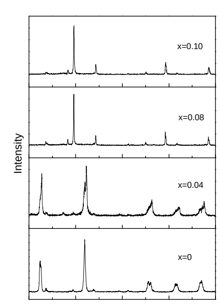

Figure 2: X-ray diffraction patterns of powders of (1-x)($K_{0.5}Na_{0.5}$)NbO_3-x($Bi_{0.5}Na_{0.5}$)TiO_3 obtained by combustión reaction

References

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