Abstract

Project Code : MRG5680137

Project Title : Improvement Electrical Properties of Lead Free BZTs Based Ceramics

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The research project is divided into six main parts.

Part I, the properties of $Ba(Zr_{0.05}Ti_{0.95})_{1-x}(Fe_{0.5}Ta_{0.5})_xO_3$ ceramics with $0.00 \leq x \leq 0.07$ were investigated. The ceramics were fabricated by a solid state reaction technique. X-ray diffraction analysis indicated that all samples exhibited single phase perovskite. Examination of the dielectric spectra revealed that the Fe and Ta additives promoted a diffuse phase transition, and the two phase transition temperatures, as observed in the dielectric curve of pure $Ba(Zr_{0.05}Ti_{0.95})O_3$, merged into a single phase transition temperature for higher x concentrations. The transformation was confirmed by ferroelectric measurements. In addition, the doped ceramics exhibited high relative dielectric tunability, especially for higher x concentration samples.

Part II, Influence of processing parameters, calcination and sintering temperatures, on the properties of $Sr(Fe_{0.5}Nb_{0.5})O_3$ samples were investigated The $Sr(Fe_{0.5}Nb_{0.5})O_3$ ceramics were fabricated by a solid-state reaction method. X-ray diffraction analysis revealed that pure perovskite phase of SFN powders was observed for the calcination temperatures > 1000°C. However, all SFN ceramics showed the pure perovskite phase. Average grain size increased with increasing sintering temperature, where the hardness value was related with grain size. The dielectric properties examination indicated that increase of the sintering temperature is effective in improving dielectric constant of the SFN ceramics.

Part III, the $0.94Bi_{0.5}Na_{0.5}TiO_3$ –$0.06BiAlO_3$ ceramics were prepared by the conventional solid-state reaction and the two steps sintering. X-ray diffraction analysis revealed that both samples showed a pure perovskite phase. Scanning electron microscopy study revealed that both ceramics had similar microstructure. The two steps sintering affect the phase transition temperature of the ceramics. Dielectric and ferroelectric properties of the two steps sintering samples are better than that of the conventional sample. The results were related to the densification and the degree of crystallinity of the samples.

Part IV, The method of two-steps sintering was applied to $Ba(Ti_{0.82}Sn_{0.18})O_3$ ceramics to improve their electrical properties. The ceramics were sintered at T_1 (1350 °C) with a short time, followed by firing at T_2 (1100 °C) for 4-16h. Effects of dwell time at T_2 on the properties of the ceramics were investigated. The examination of dielectric spectra indicates that the ceramics exhibited a relaxor behavior. An improvement in density and dielectric constant at the transition temperature of the ceramics were observed for a longer dwell time. The dielectric behavior was confirmed by the ferroelectric behavior of the samples. The results were discussed in term of densification and chemical composition variation after sintering.

Part V, In the present work, molten salt method was applied to synthesize the $0.9875(K_{0.5}Na_{0.5})NbO_3$ - $0.0125BiScO_3$ (KNN-BS) powders. Pure phase of KNN-BS powder was obtained for a calcination temperature of 700 °C which lowers than a conventional mixed oxide method by 250 °C. The KNN-BS ceramics were fabricated by a solid-state reaction technique. Effects of excess Na and K on the properties of the ceramics were investigated. The excess Na and K produced an increase in dielectric constant at the ferroelectric to paraelectric transition temperature as well as change the transition temperatures. Further, the ferroelectric behavior was also improved by the additives.

Part VI, Potassium sodium niobate (KNN) powders were synthesized by a molten salt synthesis. The pure phase KNN was achieved for a calcination temperature of 500 °C which is lower than the conventional technique by 400 °C. The KNN ceramics were then fabricated by a two steps sintering technique. Effects of dwell time at T_2 on the properties of the ceramics were investigated. Although there was unchanged in microstructure, the dielectric results indicate that a longer dwell time produced a higher value of peak dielectric constant. However, the 8 h sample exhibited the densest ceramic and showed a better ferroelectric performance.

Keywords: lead-free ceramics, dielectric, ferroelectric