CHAPTER 8

CONCLUSION

In the present work, the $Ba(Ti_{0.9}Sn_{0.1})O_3$ ceramics doped with various amount of B_2O_3 compositions (1.0, 2.0 and 3.0 wt.%) were successfully fabricated by the conventional solid-state route. The properties of BTS10 doped with B_2O_3 sintered at various temperatures (1250-1450 °C) were investigated. It was found that all samples exhibited the perovskite structure; some secondary phases were found at sintering temperature higher than 1400°C. However, SEM surface morphologies display the high sintering temperature is beneficial for the densification and grain size of the samples. The large dielectric constant and high tunability were found in the samples sintered at 1350°C. The Curie temperature decreased slightly with the increasing sintering temperature. In addition, high sintering temperature samples showed a significant fall in d_{33} coefficient due to the porosity effect.

The effects of B_2O_3 on the electrical properties and phase transition behavior of $Ba(Ti_{0.9}Sn_{0.1})O_3$ ceramics were also demonstrated. The XRD results suggested that the solid solution was maintained the perovskite structure with amount of B_2O_3 concentration, and also presented the small traces impurities which caused an enlargement of the unit cell. The density and dielectric constant were enhanced by adding B_2O_3 content up to 2.0 wt.%. This dielectric result indicates that high B_2O_3 content produced a reduction in the FE-PE transition temperatures. In addition, B_2O_3

addition enhanced the ferroelectric relaxor behavior in the ceramics. The modification of B_2O_3 significantly improved the mechanical properties of the BTS10 ceramics.

Heat treatment process was then applied to the B_2O_3 doped-BTS10 ceramics in order to alter the physical and electrical properties. The ceramics of BTS10 doped with 1.0 wt.% of B_2O_3 were annealed at 1100°C for various times of 4, 8, 16 and 32 h. The improvements of many electrical properties such as dielectric constant, tunability, and ferroelectric were observed. The high dielectric constant of 27000 was obtained for 4h-annealed sample. However, it also produced a sharper phase transition. It is proposed that the improvements can be related to the decrease of chemical heterogeneity in the samples after annealing. This method may be an effective method for improving the electrical properties of other lead free ceramics.

The ferroelectric relaxor behavior in the B_2O_3-doped BTS10 ceramics was investigated by an IS technique. At high temperature impedance and electric modulus were found to be temperature dependent and showed distributed relaxation phenomena which provided the evidence of typical relaxor properties. The complex impedance plots revealed the existence of grain and grain boundary contributions. The relaxation time followed Arrhenius behavior and showed different activation energies for grain and grain boundaries.