CHAPTER 1

INTRODUCTION

1.1 Background

Research works in high dielectric materials have been developed and grown for more than half a century. Although they were initially developed for military purposes, then they have been used in many commercial applications, such as electrical, telecommunications, computing, aerospace, microelectronics, radio technology, laser technology and microwave devices [1]. Dielectric materials can be categorized into two major types: non-ferroelectric and ferroelectric materials. A ferroelectric material possesses a spontaneous polarization below the Curie temperature (T_c) or transition temperature. This polarization can be reoriented or reversed completely or partially through the application of an external electric field [2]. Further, the ferroelectric materials can be classified as normal ferroelectric and relaxor ferroelectric. Normal ferroelectrics have sharp first or second order phase transition at T_c. In addition, they are weakly dependent on frequency and their dielectric characteristics above transition temperature obey the Curie-Weiss law. While, relaxor ferroelectrics are distinguished from normal ferroelectrics by broad maxima in the permittivity-temperature curve and shifting of transition temperature with frequency. The spontaneous polarization of relaxor type is also gradually decreased with rise in temperature [3].

Barium titanate ($BaTiO_3$) is one of the perovskite-based ferroelectric materials. It has been observed that the properties and structure of $BaTiO_3$ can be tailored by substitution, replacement and doping of suitable elements at different atomic sites [4-7]. The introduction of homovalent on the A-site can shift Curie temperature; however, it does not have a significant effect on the value of dielectric constant [8, 9]. For homovalent substitution in the B-site, the value of dielectric constant can be noticeably controlled [10, 11].

Barium stannate titanate ($BaTi_{1-x}Sn_xO_3$): BTS is a binary solid solution of $BaTiO_3$ and $BaSnO_3$. The B-sites of this solid solution (Ti^{4+} ion) are randomly occupied by larger ionic radius (Sn^{4+} ion). It has been reported that the Curie temperature and the maximum value of dielectric constant can be changed by varying the tin content [12]. Moreover, there is only one ferroelectric phase transition and no other structural phase transitions when the tin content is larger than 10% [13]. Due to its unique characteristics, much attention has been paid on the study of the effects of various tin contents on the properties of the ceramics from this system.

1.2 The scope of thesis

As mentioned in the previous section, $Ba(Ti_{1-x}Sn_x)O_3$ ceramics continue to be one of the leading materials for dielectric and ferroelectric applications. However, there is also much improvement that is needed for several demanding applications. In the present study, $Ba(Ti_{0.9}Sn_{0.1})O_3$: BTS10 system was chosen as the studied material due to its high performance. However, the fabrication of $BaTiO_3$ based ceramics such as this matter used very high sintering temperature. Consequently, sintering aids were used to solve this problem. In this work, boron oxide powder (B_2O_3) was selected as sintering aid and then the aims of this research can be summarized as follows:

- To fabricate the system of BTS10 doped with various amount of B_2O_3 by conventional mixed oxide method.
- To characterize the effects of sintering temperature on dielectric and piezoelectric properties of BTS10 ceramics doped with various amount of B_2O_3.
- To identify the roles of B_2O_3 on electrical properties and phase transitions of BTS10 ceramics.
- To improve in the electrical properties of B_2O_3-doped BTS10 ceramic system using annealing treatment.
- To distinguish the grain and grain boundary response of B_2O_3-doped BTS10 ceramic system using impedance spectroscopy.

1.3 References

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