CHAPTER 1

INTRODUCTION

1.1 Overview

Lead-based perovskite compounds are one of the most technologically demanding electronic materials in the present advanced technology and also for the future owing to their unique electrical characteristics [1-3]. The properties of these materials are decided not only by the composition and crystal structure of the phase present but also by the arrangement of the phase i.e., microstructure and their features relationship. In recent years, the advances in the materials science and engineering have been focused on expanding the limits of our understanding of materials behavior to ever shrinking length scales using a complimentary array of atomic-scale model techniques and micro/nanometer scale characterization methods. These efforts have resulted in numerous successes, most notably including the advent of nanomaterials which is just beginning to impact numerous facets of our society. The excellent device potential of these materials to date remains largely unexploited. Many processing and fabrication problems still exist which prevent the widespread use of these materials [4,5]. The key properties of these materials depend strongly on the purity of the raw materials and method of preparation, since dielectric constant can be affected by second-phase pyrochlore which forms upon processing.

The development of ceramic-nanocomposites is currently a research area of great interest. They often have properties that are superior to conventional microscale composites such as mechanical and electrical properties and can be fabricated using different techniques [6,7]. Their key properties are often related to particle size effect, arrangement of phases and morphology [3]. The study of nanocomposites requires a multidisciplinary approach, involving novel processing techniques and understanding of physics and chemistry.

In this study, a solid-state reaction method has been developed and modified for the fabrication of both starting precursors and end-products of ceramic-nanocomposites in the perovskite $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ or PMN-PT system. The effect of key processing parameters on the phase formation, microstructure, thermal expansion and electrical properties of these materials will be quantitatively evaluated.

1.2 Objectives of this work

In this study, attention is given to the fabrication and characterization of ceramic nanocomposites in the PMN-PT system. These materials have been examined in terms of the concept of processing-structure-property relationships.

Therefore, the main objectives of this research are developing appropriate solid-state reaction route for the fabrication of ceramic nanocomposites in the PMN-PT system. The relationships between processing conditions, microstructures and electrical properties of PMN-PT ceramic nanocomposites will be established, and compared with those obtained from the conventional solid-solution approach. The effect of processing parameters on the arrangement of phases, microstructural evolution and properties of the ceramics will be carefully investigated.