CHAPTER 2

OBJECTIVES OF THE PRESENT INVESTIGATIONS

Materials having desired properties are in ever increasing demand for sustainable technological growth. Ferroelectrics are one of the very important materials that have been widely used for various devices. Ferroelectric ceramics such as those derived from perovskite $BaTiO_3$ are very useful materials having wide variety of applications such as PTC thermistors, piezoelectric devices , microwave phase shifters etc. These ceramics have been in demand for technological applications as well as basic research because of the fact that their properties can be suitably tailored by substitutions at Ba and Ti sites and by changing the processing variables. However, for successful development of applications, an understanding of the overall behavior of the system is of great help. During the fabrication process , the ceramic piece has to be integrated to the whole system. For designs aiming at optimum power transfer, an equivalent circuit model representing its behavior would be highly useful during simulations. Such models can be developed by using technique of impedance spectroscopy. This essentially involves measurement of impedance as a function of frequency. An equivalent circuit is arrived at by comparing the experimental plots with the ones simulated for various models representing the processes thought to be possibly present in the system. Therefore , in the present study, preparation of some doped $BaTiO_3$ systems and characterization by using XRD, SEM, P-E hysteresis measurements, dielectric studies as function of temperature and frequency in the RF range, dielectric studies at microwave frequencies and equivalent circuit modeling

was taken up. Attempt was also made to explore the possibility of applications of the systems studied .

The objectives of the present work are as follows:

(1) Development of equivalent circuit models using CPE for impedance spectroscopy of electronic ceramics

(2) Preparation of materials

Synthesis of a few compositions (mentioned below) in the following barium titanate based ceramic systems by solid state reaction method:

(i) $Ba_{1-x}Sr_xTiO_3$ (x = 0.15, 0.20, 0.25, 0.30 and 0.35)

(ii) $BaFe_xTi_{1-x}O_3$ (x=0.03, 0.05 and 0.10)

(iii) $BaTi_{1-x}Sn_xO_3$ (x = 0.05, 0.10 and 0.15)

(3) Structural characterization

1. Powder X-ray diffraction of the above mentioned materials to identify phase/phases formed and determining crystal structure and the lattice parameters using Rietveld analysis.
2. Scanning Electron Microscopy (SEM) of the above mentioned materials, to study the microstructure . Elemental analysis of the materials using EDS.

(4) Electrical Characterization

1. Dielectric measurements (in radio frequency range) of all the materials as a function of temperature and frequency.
2. Complex Impedance Analysis of all the materials to determine the contributions of the grains, grain boundaries and electrode specimen

interface, to the overall electrical behavior and develop equivalent circuit models.

3. Study of P-E hysteresis loop at room temperature for the ferroelectric compositions
4. Dielectric measurements of all the materials in microwave frequency range, 8-12 GHz (X-Band).

(5) To explore applications

Designing of a Rectangular Dielectric Resonator Antennas (RDRA) and simulate the radiation behavior by using ANSYS HFSS software to explore the possibility of using suitable compositions for the same.