CHAPTER 2

OBJECTIVES OF THE WORK

2.1 Motivation and Problem Definition

Literature review on dielectric resonator antenna (DRA) indicates that various complex configurations using different kinds of commercial and laboratory synthesized dielectric materials are available for obtaining the desired characteristics i.e. wide impedance bandwidth, broadside and monopole like radiation pattern and good gain. However, search is still continuing for simpler configurations, innovative materials with low manufacturing cost. Limited numbers of ceramic materials are commercially available for use as DRAs. These have high sintering temperatures, complex processing route or high manufacturing cost. For instance, Al_2O_3 is widely used as dielectric resonator for the design of cylindrical or rectangular DRA [Table 1.3]. However Al_2O_3 is very difficult to shape and also its sintering temperature is above 1500 ^oC. As for as the design of DRA is concerned, the shape of DRA play a major role in its performance. Whenever a new material is chosen for the fabrication of DRA, it is designed in reference to various characteristics of the material.

Ferroelectric ceramics with high value of dielectric constant and low loss both in ferroelectric as well as in paraelectric state find numerous applications in fabrication of different devices/components including microwave devices/components. The ferroelectric to paraelectric transitions can easily be tailored in barium – strontium titanate ceramic system by a suitable choice of composition. These types of ceramics have high sintering temperatures. To make processing of these ceramics cost effective, an effort is made to

lower its sintering temperature with the help of addition of fluxing compounds or a low melting glass.

The theme of the present investigation is shown in figure 2.1. In the present investigation, it is aimed to synthesize and characterize barium – strontium titanate (BST) (50Ba:50Sr) which was sintered using a few low melting glasses as sintering additives. Further, filleted rectangular DRA (FRDRA) and cylindrical DRA (CDRA) are designed and fabricated using these materials and their input and radiation characteristics are studied through simulation and experiment in X-/Ku- band(s).

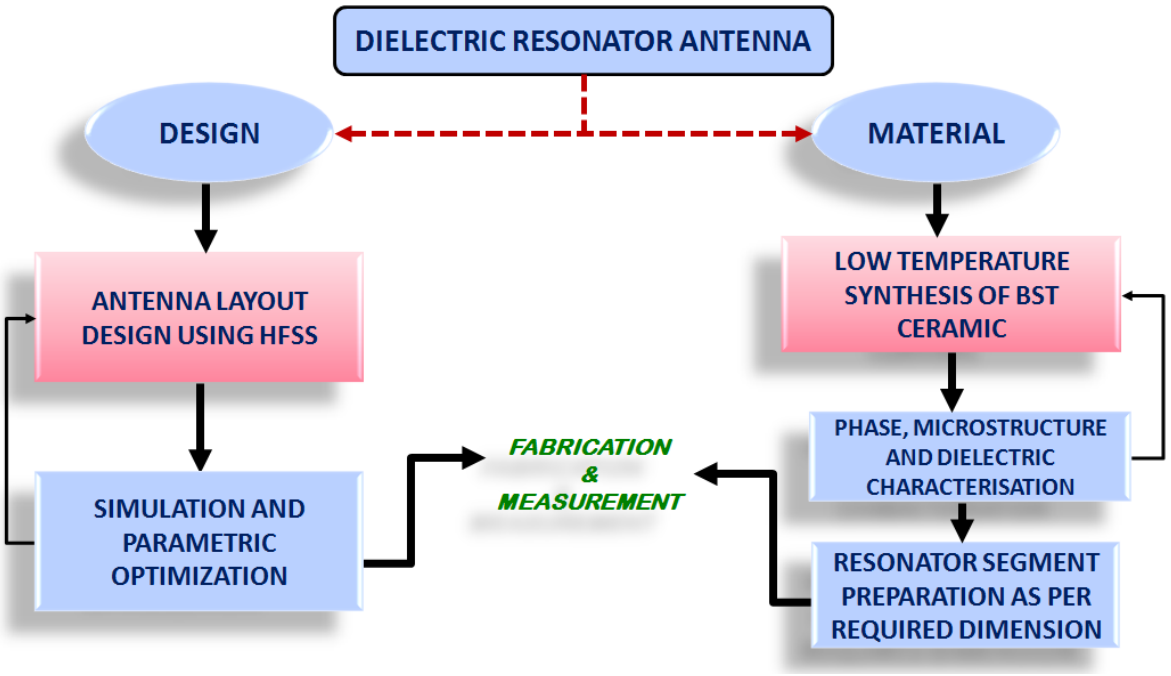

Figure 2.1 Layout of present investigation.

2.2 Objective of Proposed Research Work

The thesis includes two stage investigations as shown in Figure 2.2 for the successful design and development of DRAs with desirable antenna characteristics. The objective is to synthesize ceramic materials, study there microstructural and dielectric properties and use these materials for design and development of filleted RDRA and cylindrical dielectric resonator antennas. The investigation comprises of the following two stages:

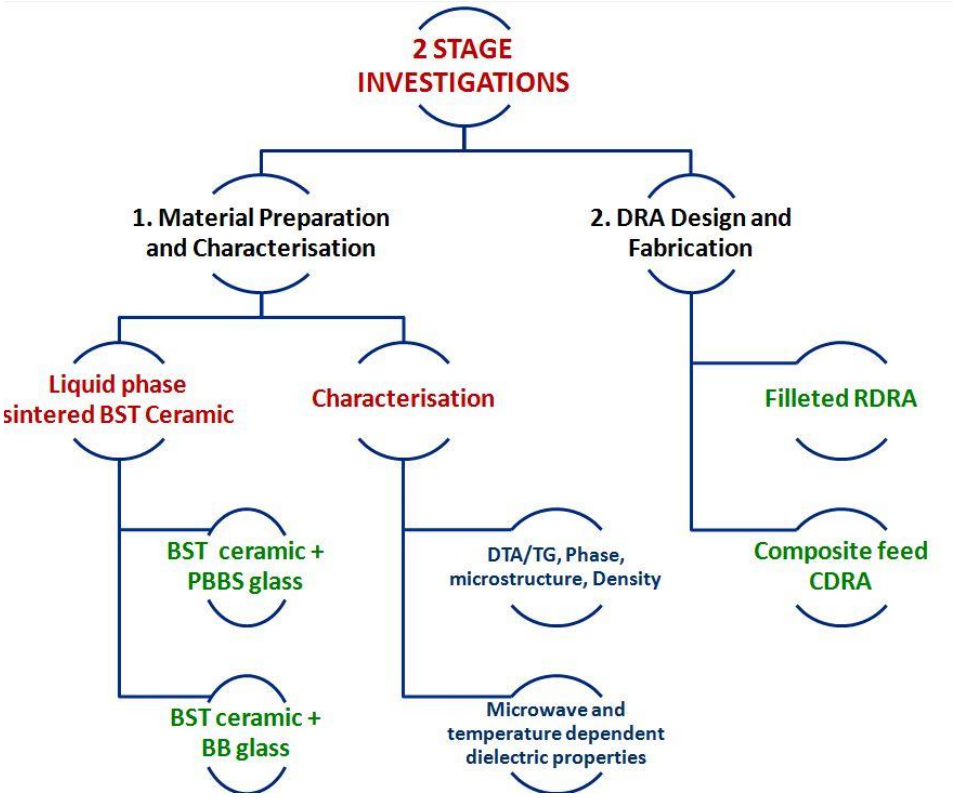

Figure 2.2 The objective of the work (Flow chart).

(a) Material preparation and characterization

(b) Design, fabrication and study of dielectric resonator antenna

The detailed objectives of the present investigation are as follows:

2.2.1 Material preparation and characterization

The stage-I investigation emphasizes on the development of novel ceramic dielectric materials with low sintering temperatures and medium dielectric constant ($12< \varepsilon_r <35$) so that these can be utilised for the design of low profile DRAs for X-/Ku- band(s) applications. $Ba_{0.5}Sr_{0.5}TiO_3$ ceramic is formulated and synthesized initially, which got high sintering temperature of 1300^oC. To reduce its manufacturing cost, two different glasses described below are used as sintering aid. The raw materials limit the usage of rare earth materials, and only the widely available cheap raw materials are used for the formulation of the following compositions and study their structural and dielectric properties. The related work is listed below.

(a) To formulate $Ba_{0.5}Sr_{0.5}TiO_3$ ceramic and study the effect of $PbO\text{-}B_2O_3\text{-}BaO\text{-}SiO_2$ (PBBS) glass additive on structural and dielectric behaviours of $Ba_{0.5}Sr_{0.5}TiO_3$ ceramic

(b) To formulate $Ba_{0.5}Sr_{0.5}TiO_3$ ceramic and study the effect of $B_2O_3\text{-}Bi_2O_3$ (BB) glass additive on structural and dielectric behaviours of $Ba_{0.5}Sr_{0.5}TiO_3$ ceramics

2.2.2 Design, simulation and experimental studies

The stage-II investigation focuses on the design and development of simple configurations of DRAs i.e. rectangular and cylindrical DRAs with modification in the shape of resonator element/feeding machenism to obtain improved impedance bandwidth and broadside/monopole like radiation pattern. The synthesized materials mentioned in section 2.2.1 are used as resonator elements. Antennas were designed using these materials and their simulation study was performed using Ansys High Frequency Structure Simulator (HFSS) software. Parametric study was carried out by varying

different antenna parameters, such as feed dimensions, resonator dimensions etc. After optimization of antenna geometrical parameters and simulation study of antenna characteristics, the DRAs were fabricated and then measurements of input and radiation characteristics were performed. Experimental results are compared with the respective simulation results as well as with DRAs reported in literature.

Investigations for different types of DRAs comprise the following:

(a) Design of filleted rectangular dielectric resonator antenna using $PbO\text{-}B_2O_3\text{-}BaO\text{-}SiO_2$ (PBBS) glass added $Ba_{0.5}Sr_{0.5}TiO_3$ (BST-3P) and its simulation and experimental studies.

(b) Design of cylindrical dielectric resonator antenna using $B_2O_3\text{-}Bi_2O_3$ (BB) glass added $Ba_{0.5}Sr_{0.5}TiO_3$ (BST-3B) excited by novel composite feed and its simulation and experimental studies.