PREFACE

In recent years, low profile dielectric resonator antennas (DRAs) are under investigation for wireless communication. In the DRA structure, the ceramic material can find its place either as an antenna radiating element and/or as a substrate material. Wide range of microwave materials have been developed, which can find application in the design of different DRAs, covering wide microwave frequency range. However, only a limited variety of ceramic materials are commercially available for the development of DRA. The radiating element of the DRAs should meet the requirements low loss and low to medium dielectric constant and antenna substrate material must have low dielectric constant, low loss, low coefficient of thermal expansion (< 20 ppm/^{o}C) and not reactive with electrode material.

Both these requirements are met by low temperature co-fired ceramic (LTCC) materials. Therefore, in the present investigation effort has been made for the development of novel LTCC materials which have been utilised for the design of different DRAs. Two different material systems, i.e. Li_2O–(2-3x)MgO–(x)Al_2O_3–P_2O_5 (LMAP) (x = 0.00 – 0.08) ceramic and MgO–B_2O_3–SiO_2 (MBS) glass-ceramic have been prepared and characterized thoroughly.

The detailed analysis of phase, microstructure, thermal behaviour, density and dielectric measurements for these compositions are described in the respective chapters. The results show that a small addition of Al_2O_3 (x = 0.02) in LMAP ceramics lowers the sintering temperature. Dielectric constant for LMAP ceramic lies in the range 5.0 – 6.2 in X– band. The effect of TiO_2 on the properties of MBS glass-ceramic compositions is analysed. All the sintered MBS glass-ceramics exhibit low dielectric constant values of 3 – 5 and loss tangent values 0.002 – 0.006.

These materials are found to have good structural and dielectric properties and are suitable candidates for LTCC applications, which can be used for dielectric resonator antennas.. Further, investigations are extended to design and development of DRA implementing these materials. Extensive investigation has been done for the LMAP ceramic for its implementation in DRA. Three DRAs with different structures have been designed using High Frequency Structure Simulator (HFSS) software. The antenna designs are:

(1) Dual segment cylindrical dielectric resonator antenna (DS–CDRA) on LMAP ceramic substrate: A microstrip–fed aperture–coupled dual segment cylindrical dielectric resonator antenna (DS–CDRA) on the prepared LMAP LTCC substrate is designed and fabricated. The broadside radiation patterns are obtained in both E– and H– planes at the antenna resonant frequency and the simulated and measured values of gain lie in the range 6.76 – 7.02 dB and 6.13 – 6.87 dB respectively over the antenna operating bandwidth. Thus, the proposed DS–CDRA may find application in radar and radio navigation.

(2) 4 – element composite triangular dielectric resonator antenna (4-CTDRA) using LMAP as antenna radiating element: For the generation of monopole like radiation pattern, a coaxial probe-fed four element composite triangular dielectric resonator antenna (TDRA) is designed in which antenna resonating elements are made up of Li_2O–1.94MgO–0.02Al_2O_3–P_2O_5 (LMAP) ceramic and teflon. The proposed antenna has provided simulated and experimental -10 dB reflection coefficient bandwidth of 6.97 GHz (61.65 %) and 7.6 GHz (66.09 %) with an average gain of 5.14 dB and 4.66 dB over their operating frequency range, respectively. The proposed four elements composite TDRA can potentially be used in broadcast base-station, radar and satellite communication providing wide area coverage.

(3) Dual segment rectangular dielectric resonator antenna (DS–RDRA) on MBS glass ceramic substrate: The design and simulation study of a dual segment rectangular dielectric

resonator antenna (DS–RDRA) on $MgO–B_2O_3–SiO_2$ with 13 wt. % TiO_2 (MBST) glass-ceramic LTCC substrate is performed. The simulation results for the RDRA on MBST substrate is compared with those for similar DS–RDRA on FR4 substrate. The simulation study was also performed for the composite substrate configuration i.e. FR4–air (FR4C) and MBST–air (MBSTC). MBST substrate provides large impedance bandwidth of 680 MHz along with wide beam in E– plane. The proposed antenna can be used for X– band wireless communication applications.

Out of these three, the DS–CDRA and the 4-CTDRA antennas have been fabricated. The experimental measurement of antenna input and radiation characteristics have been made and the results are compared with the corresponding simulation results. The different antenna parameters like excitation technique, operating bandwidth, generated mode, radiation pattern and gain for the three dielectric resonator antenna designs described in their respective chapters.