## 5. CONCLUSION AND FUTURE SCOPE

The important findings of the work carried out with some vital observations are mentioned here.

- The Mg-Cu-doped in $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ pyrochlore LTCC ceramics were synthesized using well known solid state reaction technique by sintering at 693K.
- The x-ray diffraction study revealed the formation of monoclinic crystal because of lower sintering temperature and slow rate of cooling
- The microstructural images of $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ ceramics exhibited irregular grain shape.
- The temperature dependence $\rho_{dc}$ study conform the higher resistivity along with NTCR behavior.
- The temperature dependence dielectric study exhibited variation in dielectric constant values at lower frequency and remains constant at higher frequency.
- The frequency dependant tan δ plot depicted $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ as a low loss ceramic material.
- The real and imaginary part of permittivity was all most stable as a function of frequency and varied with temperature.
- The impedance plot of $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ as a function of frequency illustrated superior conducting behavior.
- In order to obtain the single phase monoclinic crystal of $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ ceramics, $Cu^{2+}$ and $Mg^{2+}$ ions doped in proportionally.
- The alkaline metal and transition metal ions doped $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ ceramics was obtained and conform using x-ray diffraction studies. The single phase monoclinic was obtained.

- The microstructural analysis characterized using scanning electron microscopy illustrated the variations in particle size of $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ ceramics after the substitution of $Cu^{+2}$ ions. The particle size of $Bi_{1.5}Mg_{0.6}Cu_{0.4}V_{1.5}O_7$ceramics was comparably less than other ceramics.
- The temperature dependence $\rho_{dc}$ also showed NTCR behavior as observed in $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ ceramics. However, as the $Cu^{+2}$ ion concentration increase in $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ ceramics the magnitude of the $\rho_{dc}$ decreases and approaches minimum when x=1
- The temperature dependence of dielectric study displayed moderate dielectric constant values with diffuse phase transition behavior. The substitution of $Cu^{+2}$ ions improved the phase transition temperature of the ceramics.
- The frequency dependant tan δ plot also proved $Cu^{+2}$ ions substituted $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ as a low loss ceramic material.
- The real and imaginary part of permittivity for all the $Cu^{+2}$ ions substituted $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ was all most stable as a function of frequency and varied with temperature. However the magnitude changed with $Cu^{+2}$ ions.
- The impedance plot of $Bi_{1.5}Mg_xCu_{1-x}V_2O_7$ as a function of frequency illustrated superior conducting behavior. Here, the impedance decreased as a function of frequency.

**FUTURE SCOPE**

Ceramic compounds synthesized by solid state reaction technique can be synthesized by chemical route so as to improve the structural parameters and thereof the important key parameters. There are a number of physical and chemical methods for preparing ceramic materials. Each technique is capable of producing functional

materials, at a relatively better synthesis temperature and time. The characteristics are primarily governed by the synthesis procedure and the structure.

Instead of more conventional methods of expressing the behavior of obtained data, innovative technique can be thought to express the calculated and or estimated parameters and to demonstrate their typical behavior in the particular range of conditions or limits.

In order to analyze and interpret experimental data and dielectric behavior of compounds can be studied at extended frequency spectrum so as to get more insight into polarization phenomenon and selecting a sample for possible device fabrication in microelectronic applications.

XRD and EDS characteristics will focus more light on the crystal structure and concentration of the chemicals taken after the final stoichiometric compound formed, respectively, which will help in understanding the ac/dc conductivity behavior in the compound.

An attempt can be made to have modeling simulation studies by suitable mathematical tools and operations on the experimental results of structural, and electrical measurements and microstructural investigations to form a model for a possible explanation of relevant mechanism and behavior in more effective way.

There is ample scope to synthesize LTCC by different methods and undertake the important characterization studies with a view to understand the structure-property relationship in LTCC ceramics and correlate the properties of HTCC and ULTCC ceramics for application purpose.