INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:		Study of Magnetic and Dielectric Properties of Rare Earth Iron Garnets
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The current Ph.D. thesis presents the investigation and characterization of magnetic and dielectric properties of $Y_3Fe_5O_{12}$ (YIG) and $Gd_3Fe_5O_{12}$ (GIG) by substituting trivalent Sm and Bi at Y and Gd site, and Cr and Mn at Fe site respectively. The polycrystalline samples of the mentioned materials were synthesized by conventional solid-state reaction method. All the samples are found to be in single phase form as per the Rietveld refinement of XRD patterns using cubic space group Ia-3d. All samples exhibit ferrimagnetic (FIM) transition. However, GIG undergoes a magnetic compensation (T_{comp}) behaviour near room temperature. Sm and Bi substitution enhances the FIM transition temperature (T_C) while the Cr and Mn substitution reduces the FIM T_C. The increment (reduction) in bond angle strengthens (weakens) the superexchange interaction in (Fe^{3+}-O^{2-}-Fe^{3+}) networks, thereby increases (reduces) the FIM T_C. Cr substitution in YIG reduces the FIM T_C from 550 K to 494 K while Bi substitution in GIG enhances it from 560 K to 594 K, which is highest among all of the samples. Furthermore, an interesting negative magnetization is observed in $Gd_1Sm_2Fe_5O_{12}$ sample below T_{comp}=70 K due to high magnetic anisotropy of Sm^{3+} ions. In addition to magnetic properties, these samples are also examined for dielectric properties using impedance spectroscopy. The impedance spectroscopy analysis were carried from the frequency variation data of real (Z') and imaginary (Z'') components of impedance. Further, the grains (G) and grain boundaries (GB) contributions were determined from Nyquist plots (Z'' vs Z'). These plots were explained based on an equivalent circuit having resistance, capacitance and constant phase element components arranged parallel to each other. From the analysis, both G and GB are found to contribute towards conduction process at lower temperature however, GB contribution is found to be dominant at higher temperature due to the long-range hopping of charge carriers. Cr substituted YIG samples show the increase in dielectric constant from 12 to 52 determined from analysis based on Havriliak–Negami equations. Garnets exhibit centrosymmetric nature, which limits them from ferroelectricity. But in our case, Bi substitution at Gd site gives rise the presence of relaxor type ferroelectric behavior due to the inclusion of nano-polar region associated to the Bi^{3+} and Fe^{2+}/Fe^{3+} ions. The Kohlrausch-Williams-Watts (KWW) function is used to explain the modulus spectra in Cr-substituted GIG compound and they exhibit relaxation peak associated to grains. All the samples possess magnetoelectric coupling in the vicinity of FIM T_C. So, the presence of negative magnetization, relaxor ferroelectric behavior and magnetoelectric coupling in these samples may pave for exploration for memory storage and multiferroic applications.