INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	Ph.D.

Thesis Title: Magnetic and Dielectric Properties of Ba Based M- and Y-type Hexaferrites.

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Thesis Submitted to the Department/ Center	:	PHYSICS
Date of completion of Thesis Viva-Voce Exam	:	17/ 02/ 2020
Key words for description of Thesis Work	:	Hexaferrites, Ferrimagnets, Impedance Spectroscopy, Magnetic and Dielectric Properties.

SHORT ABSTRACT

Hexaferrites are one of the important class of materials in the family of permanent magnets due to their potential applications in various electronic and microwave devices. Based on chemical formula and crystal structure, hexaferrites are classified into six types such as: M, Y, Z, W, X and U. The present thesis describes the structural, dielectric and magnetic properties of Ni, Ti, Al substituted M-type hexaferrites and Zn and Mg substituted Y-type hexaferrites. M-type hexaferrite with composition $BaFe_{12-y}M_yO_{19}$ (y = Ni and Ti) were successfully prepared in single-phase form with $P6_3/mmc$ space group. The substitution of Ni at Fe site enhances the ferrimagnetic transition temperature (T_c) from 720 K for $y = 0$ to 759 K for $y = 0.5$ but the T_c value is suppressed upon Ti. However, the saturation magnetization (M_s) and coercivity (H_c) values are found to decrease upon the substitution of above two elements. These substitutions give rise to increase in conductivity. The impedance spectra show two relaxation peaks for both Ni and Ti substitutions and these peaks are assigned to the relaxation of charge carriers across both grains and grain boundaries. Similarly, $BaFe_{12-x}Al_xO_{19}$ samples were prepared in single-phase form by solid-state route with $P6_3/mmc$ space group. Increase in coercivity is observed due to Al substitution. The real parts of permittivity and permeability are found to decrease upon Al substitution with considerable reduction in their respective loss components. Y-type hexaferrite ($Ba_2Co_{2-x}M_xFe_{12}O_{22}$) with M = Zn and Mg were successfully prepared in single-phase form by solid-state route. All the samples crystallize in rhombohedral structure with R-3m space group. The temperature variation of magnetization measurements show two magnetic transitions such as spin-reorientation (T_s) and ferrimagnetic (T_c) transitions. Both T_s and T_c values are found to decrease upon Zn and Mg substitutions and they are assigned to the decrease in magnetocrystalline anisotropy and superexchange interaction. The impedance spectra were analyzed based on Nyquist (Z" vs Z') plots. The asymmetric and depressed nature of semicircles in Nyquist plots reveal the non-Debye type relaxation behavior. The analysis of conductivity spectra for Zn and Mg doped samples are found to follow the overlapping large polaron and small polaron tunneling models respectively. The obtained results indicate that magnetic and dielectric properties of hexaferrites can be tuned by suitable cationic substitutions and the observed high value of permeability with low magnetic loss in Al and Zn substituted samples can be suitable for radio frequency (RF) and antenna device applications in ultra-high frequency (UHF) band.