



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS

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**SHORT ABSTRACT**

Chromium-based spinels are a potential class of magnetic materials that exhibit multiferroic, magnetodielectric and magnetostructural coupling, exchange bias, and magnetization reversal etc. The discovery of such multifunctional properties in spinel chromites has opened up the possibilities of potential application in magnetic storage, magnetic switching, sensors, recording media and read-write head, magneto-dielectric devices, spintronics etc. In addition to the spinel chromites, spinel ferrites are also a well-known type of magnetic materials due to their appealing magnetic and dielectric properties. In the present thesis work, magnetic properties of nickel chromite and nickel ferrite spinels are tuned by substituting magnetic (Mn, Co) and nonmagnetic (Mg, Cd) ions. In the bulk  $\text{Ni}_{1-x}\text{Mg}_x\text{Cr}_2\text{O}_4$  ( $x = 0 - 0.50$ ) system, a crossover from ferrimagnetic to cluster glass like phase is observed for the doping concentrations  $x = 0.10, 0.20$  &  $0.30$ . However, antiferromagnetic dominant phase is observed for  $x = 0.40$  &  $0.50$  samples. Exchange bias, magnetic frustration, cluster glass and their magnetic dynamics have been studied in detail for this system. In an attempt to understand the interplay between geometric spin frustration and particle size, we have carried out an in-depth investigation on static and dynamic magnetic properties of 15 atm % Mg substituted  $\text{Ni}_{0.85}\text{Mg}_{0.15}\text{Cr}_2\text{O}_4$  nanoparticles as well. In the Mn substituted  $\text{Ni}_{1-x}\text{Mn}_x\text{Cr}_2\text{O}_4$  ( $x = 0 - 0.50$ ) system, entropy and critical behavior have been studied. With Mn substitution, the entropy changes ( $-\Delta S_M^{\max}$ ) found to be increased from  $1.5 \pm 0.1 \text{ JKg}^{-1}\text{K}^{-1}$  for  $x = 0.0$  to  $2.9 \pm 0.2 \text{ JKg}^{-1}\text{K}^{-1}$  for  $x = 0.50$  sample. The estimated critical exponents are found to deviate from known theoretical models. In the Cd substituted  $\text{Ni}_{1-x}\text{Cd}_x\text{Cr}_2\text{O}_4$  ( $x = 0 - 0.30$ ) series, enhancement of canting nature of spin structure has been observed from various magnetic measurements. We have observed a very high exchange bias field value of 7477 Oe for  $x = 0.15$  sample. Additional magnetic measurement suggests reversible magnetocaloric effect for  $x = 0.20$  sample. Low temperature ac conductivity and impedance spectroscopy also have been investigated in this Cd substituted nickel chromite system. Importance of cation distributions and their different ionic states on structural and magnetic properties have been investigated in Co substituted nickel ferrite system.