



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS

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Thesis Title: Investigations of magnetic and structural properties of rare earth substituted  $\text{NdCrO}_3$

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**SHORT ABSTRACT**

This thesis comprises magnetic and structural studies of substituted  $\text{NdCrO}_3$  compounds. The prepared samples exhibit high quality and their magnetic properties yield remarkable outcomes. The first work incorporates the synthesis of polycrystalline  $\text{Nd}_{1-x}\text{Eu}_x\text{CrO}_3$  ( $x = 0.0-1.0$ ) samples. The dc magnetization measurements show decreased antiferromagnetic transition temperature ( $T_N$ ) and spin-reorientation transition ( $T_{SR}$ ) with Eu substitution. The exchange bias (EB) effect is observed and the EB field decreases with increasing Eu content. The non-monotonic behavior of the EB field around  $T^* \sim 90$  K between the  $T_N \sim 225$  K and  $T_{SR} \sim 35$  K is observed for low substitution. The strong spin-phonon coupling for  $x = 0.0-0.20$  samples is described via the evolution of Raman modes in 80-300 K temperature range. Importantly, the  $T^*$  found from the non-monotonicity of the EB is imprinted with the additional phonon anomaly. The magnetoelastic coupling was explored by the variation of structural parameters in 3-300 K temperature range. The electron density distribution using the maximum entropy method around  $T^*$  is studied. The study emphasizes lattice modulations near  $T^*$  between  $T_N$  and  $T_{SR}$  for the first time in pure and substituted  $\text{NdCrO}_3$  by exploring spin-phonon induced exchange bias and magneto-structural imprints. The second work involves the investigations of  $\text{Nd}_{1-x}\text{Pr}_x\text{CrO}_3$  ( $x = 0.0-0.30$ ) samples. In contrast to Eu, here the substituent Pr is magnetic with larger ion size. The significant magnetization value with slightly increased  $T_N$  and vanishing of  $T_{SR}$  is observed. The Griffiths-like phase is seen for substituted samples. Compared to Eu substitution, here the larger value of EB field is achieved. The behavior of EB field below and above  $T_{SR}$  with Pr substitution displayed interesting trends linked with structural parameters. These findings highlight the interplay of spin reorientation and EB in  $\text{Nd}_{1-x}\text{Pr}_x\text{CrO}_3$  compounds. The last work is dedicated to the study of  $\text{Nd}_{1-x}\text{Ce}_x\text{CrO}_3$  ( $x = 0.0-0.175$ ) compounds for the first time. The presence of mixed Ce valency on the Nd-site and its influence on  $\text{NdCrO}_3$  are discussed. The  $T_N$  and  $T_{SR}$  exist for all the samples. For the first time, a demonstration to obtain different magnitudes of magnetization at same applied field in opposite directions revealing different magnetic states is presented. Overall, the discovery of the spin-phonon induced exchange bias effect, structural reorientations, and magnetic states in compounds of  $\text{Nd}_{1-x}\text{R}_x\text{CrO}_3$  (R = Eu, Pr, and Ce) are witnessed. This thesis shows the magnetic transition can be coupled to crystalline lattice modulations near liquid nitrogen temperatures for potential applications as multifunctional material.