



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS

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Program of Study : PhD.  
Thesis Title : Rare-earth elements based Perovskites: Bulk and Low Dimensional Superlattices.  
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Date of completion o Thesis Viva-Voce-Exam : 12-June-2023  
Key words for description of Thesis Work: : Rare-earth, Perovskites, Antiferromagnetism, Néel temperature, Spin-Dynamics, Raman modes.

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SHORT ABSTRACT

Perovskites have been a subject of extensive research due to their immense potential applications in magneto-electronics and photovoltaics, ever since the discovery of Calcium titanate ( $\text{CaTiO}_3$ ) in the Russian Ural Mountains by Gustav Rose in 1839. The mineral was named after the Russian mineralogist Lev Perovski. The present thesis delineates the investigation of thin films, including superlattices and bilayer, as well as polycrystalline perovskite oxides that comprise transition metal and rare earth elements. Bilayers comprising  $[\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3(5 \text{ nm})/\text{LaCoO}_3(15 \text{ nm})]$  were fabricated on  $\text{SrTiO}_3$  substrates using two different deposition sequences. Our findings indicate the presence of magnetic characteristics, specifically the pseudo antiferromagnetic (AFM) pinned character, in one bilayer, while the other exhibits solely ferromagnetic (FM) nature. Additionally, we observed that the lattice mismatch and lattice strain resulted in the suppression of the Curie temperature and other physical properties. The present study investigates the structural, morphological, electronic, optical, and magnetic properties of  $[\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3/\text{LaNiO}_3]_{10}$  superlattices that were deposited through pulsed laser deposition (PLD) on  $\text{SrTiO}_3$ -(001), (011), and (111) substrates. The study reveals that the mixed valence  $\text{Ni}^{2+/\beta+}$  and  $\text{Mn}^{3+/4+}$  electronic states are dominant at the core level. Furthermore, the relative intensity ratio of the Mn ions is found to be higher in the superlattices grown on (111) oriented  $\text{SrTiO}_3$  compared to the other two orientations. The calculated hopping energies, obtained from the variable range hopping mechanism, are of significant magnitude ( $\geq 40 \text{ meV}$ ). A noteworthy observation was made regarding the decrease in Curie temperature from 67 K to 110 K, coupled with a marked increase in the effective exchange interaction. Polycrystalline samples of  $\text{Dy}_{1-x}\text{Ce}_x\text{CrO}_3$  were prepared, where  $x$  ranged from 0.1 to 0.5. Our findings indicate that the tolerance factor increases while the octahedral distortion factor decreases with increasing Ce doping. This suggests that greater stability is achieved in samples with higher levels of Ce doping. The study also documented an increase in the Néel temperature from 156 K to 162 K in the heavily doped samples exhibiting G-type AFM character with  $\Gamma_4(G_x, A_y, F_z)$  spin-configuration. In contrast, samples with  $x = 0.2-0.5$  demonstrated a phase-transition across  $T_{PC} (< T_{N1})$  with  $\Gamma_2(F_x, C_y, G_z)$ , while samples with  $x = 0.1-0.3$  underwent another magnetic phase transition  $T_{SR} (< T_{PC})$  with  $\Gamma_{25}(F_x, C_y, G_z; F_x^R, C_y^R, G_x^R, A_y^R)$ . An increase in the magnetic entropy change ( $\Delta S_M$ ) was observed in the  $\text{DyCrO}_3$  system with 10% Ce substitution and improved refrigerant capacity (RCP) of approximately 360 J/kg. This was measured at a temperature of 5 K and a magnetic field strength of 40 kOe, suggesting potential advancements in magnetic refrigeration. Previous studies on  $\text{DyCrO}_3$  under the same conditions reported a  $\Delta S_M$  of 256 J/kg. The  $\text{Gd}_{1-x}\text{Sm}_x\text{CrO}_3$  samples were synthesized with varying Sm concentrations, specifically  $x = 0.1$  (GSO1), 0.5 (GSO5), and 0.9 (GSO9). Notably, GSO5 demonstrated multiple magnetization switching behavior across all three ZFCW, FCC, and FCW protocols, rendering it a promising candidate for magnetic switching applications. This phenomenon has not been previously reported in any perovskite oxide materials. The coexistence of metastable

magnetic phases  $\Gamma_4 (G_x, A_y, F_z)$  and  $\Gamma_2 (F_x, C_y, G_z)$  was observed in the GSO9 sample. This phenomenon resulted from the clustering of ferromagnetic islands within an antiferromagnetic matrix in the face-centered cubic case, which is referred to as a magnetic glass-like signature. The analysis of refined structural parameters obtained from X-ray diffraction indicates a fluctuation in the tilt angles, which can be attributed to the quasi-harmonic effect resulting from the exchange interaction between  $Gd^{3+}$  and  $Cr^{3+}$  ions. This effect causes a reduction in the stiffness of the  $A_{1g} (3)$  mode as the temperature increases.

