Chapter 7

Summary and future scope

7.1. Summary

There are huge applications of magnetic materials and has been broadly used in various technologies like spintronic devices, solid-state cooling devices, magnetic resonance imaging, electromagnets, transformers, magnetic field screening, sensors, protein folding, memory applications, switching, and many more multi-functional applications, etc. In the present work, "Magnetic and Electrical Properties of perovskite Materials" have been carried out. The conclusions of the present work have been drawn below.

Firstly, the study on the double perovskite Eu_2CoMnO_6 has been carried out where some extraordinary magnetic state has been found. In this system, Co and Mn are in mixed valence states and it is electrically semiconducting. A long-range magnetic ordering emerges below 125 K, which is due to the dominant ferromagnetic phase transition. Other than that, this system shows the existence of a Griffith-like phase. Further, a strong meta-magnetic transition has been observed at low temperatures. Eu_2CoMnO_6 has a very high dielectric constant (ε') at a lower frequency near room temperature and shows strong frequency dispersion. Decreasing temperature to a lower value shows step-like behavior, which is attributed to extrinsic to intrinsic transition. The loss spectrum exhibits a frequency-dependent peak showing a thermally activated phenomenon.

Regarding disorder-driven spin frustration, we have prepared $Pr_{1.8}La_{0.2}CoFeO_6$ (PLCFO) double perovskite with a solid-state reaction method. XRD data identified the single-phase orthorhombic crystal structure (Pnma symmetry) for PLCFO. The electronic state of Fe and Co ion is revealed by the XPS tool which confirms the trivalent oxidation state of Co and Fe are present in mixed valence state. Further, above room temperature magnetic ordering along with low-temperature reentrant cluster glass state has been reported for the same sample by AC magnetic susceptibility measurement. Temperature-dependent Raman study shows spin-phonon coupling is present in this system. Field-dependent magnetization of this system shows a large conventional exchange bias ∼of 2.4 kOe at 5 K. AFM materials with colossal exchange bias that can be utilized in spintronic devices.

We have also studied the effect of hole (Ca^{2+}) doping on Y_2CoMnO_6 (YCCMO). The hole doping creates the mixed valance states of Co and Mn ions which was identified by the XPS technique. The Co ion has a mixed +2/+3 oxidation state and the Mn ion has a mixed +3/+4 oxidation state at room temperature. The Y_2CoMnO_6 has meta-magnetic properties. We doped Ca at the Y site to study the magnetic and electrical properties change. Ca^{2+} changed oxidation state at the Y^{3+} site and Ca has a larger ionic radius than Y. So it affects magnetic properties by arising ASD and lattice deformation of YCMO. The Rietveld analysis of the powder diffraction pattern of YCCMO25 shows a monoclinic phase with space group $P2_1/n$. The inverse DC susceptibility of YCCMO25 shows a Griffiths-like cluster phase in the

Paramagnetic region. Temperature-dependent Raman spectroscopy shows some deviation in Raman peaks near magnetic ordering temperature.

7.2 Future scope

- The study on ECMO shows a strong meta-magnetic state and MCE, which can be used for making solid-state cooling devices.
- Field-dependent magnetization of PLCFO10 shows a large conventional exchange bias ∼of 2.4 kOe and spontaneous exchange bias ∼of 1.8 kOe at 5 K and 5 T. Antiferromagnetic materials with Colossal exchange bias can be utilized in spintronic devices.
- We can also grow the thin film of these samples using the PLD technique to further explore their magnetic and electrical properties. Moreover, DFT calculation can also be performed on these samples to explore their magnetic and electrical properties.