

Influence of Cation Substitution on Magnetic Transitions and Ordering in $\text{La}_2\text{Ni}_x\text{Co}_{1-x}\text{MnO}_6$ Compounds ($x = 0.2 - 0.8$)

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Abstract : This study explores the structural and magnetic characteristics of newly synthesized double perovskite oxides, $\text{La}_2\text{Ni}_x\text{Co}_{1-x}\text{MnO}_6$, with x ranging from 0.2 to 0.8. Utilizing X-ray powder diffraction and SQUID magnetometry, we analyzed the compounds that consistently exhibit a monoclinic structure with the $P2_1/n$ space group at ambient temperature. Our findings reveal that as Ni^{2+} is progressively substituted by Co^{2+} , there is a corresponding decrease in cell parameters, attributable to the smaller ionic radius of Ni^{2+} (0.69 Å) compared to Co^{2+} (0.74 Å). The crystal structure features octahedrally coordinated $(\text{Co}/\text{Ni})^{2+}$ and Mn^{4+} cations with oxygen, forming $(\text{Co}/\text{Ni})\text{O}_6$ and MnO_6 octahedra linked via oxygen atoms along different crystallographic axes. Magnetic characterization conducted over a temperature range of 2 to 300 K in both DC and AC magnetic fields, showed a predominant paramagnetic to ferromagnetic transition between 232 K and 260 K, with the Curie temperature notably increasing with higher x values. Samples with $x=0.2, 0.25,$ and 0.5 exhibited a secondary PM-FM transition between 200 K and 208 K. Cation ordering was quantitatively assessed, indicating a higher ordering in Ni^{2+} -rich samples ($x=0.75$ and 0.8) at over 96%, whereas the sample with $x=0.25$ showed minimal ordering. Furthermore, the out-of-phase component of the AC susceptibility displayed frequency-dependent transitions between 65 K and 110 K, suggesting the presence of superparamagnetic domains across all samples.

Keywords : double perovskite oxides, magnetic transitions, cation ordering, squid magnetometry

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