

Ferromagnetic Cluster on $\text{La}_2\text{FeMnO}_6$

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Abstract. The structural, magnetic and electrical transport properties of $\text{La}_2\text{MnFeO}_6$ bulk samples prepared by combustion synthesis were investigated. The X-ray powder diffraction patterns with Rietveld refinement at room temperature shows that samples prepared by combustion synthesis are formed in single phase with an orthorhombic structure space group $Pnma$ (62). The temperature dependent magnetization shows a formation of ferromagnetic cluster at 150 K with short range interactions and a long range ferromagnetic order below 75 K. The magnetic field dependence of the magnetization shows a typical paramagnetic behavior at room temperature and a ferromagnetic-like behavior at low temperatures. The low value of the magnetization at high magnetic field can indicate the formation of a weak ferromagnetism or a metamagnetic phase. Results of the temperature dependence of the resistivity show that the transport process in this material can be attributed to small polarons.

Introduction

Lanthanum manganites (LaMnO_3) and lanthanum ferrites (LaFeO_3) when doped can show very intriguing physic properties which are closely related to the interplay among spin, charge and lattice degrees of freedom [1,2]. The interaction between these degrees of freedom can lead to multifunctionality. Therefore these materials are good candidates for searching new properties such as coexistence of ferroelectric and magnetic orders, magnetocaloric effect and the colossal magnetoresistance. The lanthanum manganite and lanthanum ferrite have been studied since 1950 [3,4], these studies were intensified after the discovery of colossal magnetoresistance (CMR) in transition metal oxide La-Mn/Fe-O compounds doped with alkaline earth elements such as Ca, Sr and Ba [5-7]. In manganites, the CMR has been attributed to double exchange interaction between $\text{Mn}^{3+}/\text{Mn}^{4+}$ ions and the magnetic transition are accompanied by a metal-insulator transition.

LaMnO_3 and LaFeO_3 have a perovskite structure [8] with orthorhombic structure. Both are electric insulators and show an antiferromagnetic order with $T_N=140$ K and $T_N=740$ K, respectively [9,10]. In the structure of the LaMO_3 with $M=\text{Fe}$ or Mn , the Fe and Mn ions are placed in the corner of the lattice with eight oxygen ions as first neighbors forming MnO_6 or FeO_6 octahedras, which are fundamental in determining the physics properties of these compounds. Another important parameter that is crucial in governing the physic properties of oxides these materials with perovskite structure is the M-O-M angle. For example, the variation of this angle can induce a ferromagnetic order in the compound [10-12].

The substitution of the Mn by Fe can induce photocatalytic activity, a non-usual glassy state, and ferromagnetism at room temperature [13,14]. Usually these properties have been explained by the randomness distribution of the ions Fe^{3+} and Mn^{3+} in the site B of the perovskite structure [15]. Nevertheless there are some controversy on the origin of magnetism on $\text{La}_2\text{Mn}_{1-x}\text{Fe}_x\text{O}_3$ compounds. The ferromagnetism in $\text{La}_2\text{Mn}_{1-x}\text{Fe}_x\text{O}_3$ could be due to double exchange interaction between $\text{Mn}^{3+}-\text{O}-\text{Fe}^{3+}$ and $\text{Mn}^{3+}-\text{O}-\text{Mn}^{4+}$, the superexchange interactions between $\text{Mn}^{3+}-\text{O}-\text{Mn}^{3+}$, as well as by the defects induced in the structure of the compound $\text{La}_2\text{Mn}_{1-x}\text{Fe}_x\text{O}_3$ by the method of the sample preparation [13,16,17].