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Magnetic ordering and low field CMR in La(Mn, Cr)$O_{3+\delta}$ ($\delta \approx 0.09, 0.12$) compounds

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Cr^{3+} substituting Mn^{3+} in $LaMnO_3$-based compounds can be viewed as a ''big'' immobile hole, since it has the same electronic configuration ($t_{2g}^3 e_g^0$), as Mn^{4+} and an ionic radius r_{Cr}^{3+} = 0.615 Å almost equal to that of Mn^{3+}. It has been claimed that Cr^{3+} participates to the DE mechanism, while it is known to aid the long range ferromagnetic (FM) ordering in the low doping regime.

In the present work, electrical resistivity, ρ(T) (80<T<1100K), χ_{ac}(T) and LFMR(T) (H=2kG) (80<T<300K) measurements were carried out on O_2-enriched $LaMn_{1-x}Cr_xO_{3+\delta}$ specimen. The powders were prepared by solid state reaction from high purity La_2O_3, $Cr(NO_3)_3 \cdot 9H_2O$ and MnO_2 and the specimen were sintered at T=1300^{0}C in air. In order to obtain high O_2 excess they were heated in O_2 and in air (T=900^{0}C/t=100h). XRPD patterns confirmed that the specimen were single phased with the O_2 treated specimen having $R\bar{3}c$ symmetry.

Specimen show small polaron semiconducting behavior at 80<T<1100K. The Cr^{3+} substitution for Mn^{3+} increases the ρ(T) and the activation energy, Ea, due to the gradual decrease of the delocalized electrons concentration and increase of (Mn, Cr)-O bond distance. According to the χ_{ac}(T) measurements, long range FM order is established in all samples at T<170K. The Curie temperatures,$T_{C,}$ vary non-monotonously with x, displaying a maximum value close to x=0.12, caused by the competition of the DE FM Mn^{3+}-Mn^{4+} with SE AFM Mn^{3+}-Cr^{3+} interactions. LFMR(T) show low negative magnetoresistance approximately of the order of 2-3%. The broad peaks of –MR observed close to the corresponding $T_{C'}$s, are attributed to intrinsic DE CMR. The progressive decrease of –MR versus x, implies that Cr^{3+} does not participate in the DE mechanism.