

MAGNETIC AND CRYSTALLINE STRUCTURE OF SOME DOPPED WITH Cr MANGANITES

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The $\text{La}_{0.54}\text{Ho}_{0.11}\text{Sr}_{0.35}\text{Mn}_{1-x}\text{Cr}_x\text{O}_3$ ($x=0.05, 0.10, 0.15, 0.20$) manganites were synthesized by starting from La_2O_3 and Ho_2O_3 (purity: 99.99%), SrCO_3 and the Mn and Cr acetates (purity: 99.00%). The presintered samples were again ground and finally sintered at 1200°C for 10 hours in air atmosphere. The phase composition, structure, lattice constants, positions of cations and anions in unit cell, BO distances, BOB bond angles, average size of mosaic blocks and microstrains were determinate by using Fullprof or PowderCell code. The variation of the specific magnetization with temperature, implicitly Curie temperature and molar magnetization, were determined by using a VSM type magnetometer, working at $H_{\text{max}}=1\text{T}$, between 77 and 400 K. The variation of resistance with temperature and magnetic field was performed with a close cycle refrigerator, working between 7 and 350 K, at $H_{\text{max}}=1\text{T}$, by means of four probe method, by using a magnetic field $H_{\text{max}}=1\text{T}$.

Table 1. Variation of the lattice constants (a, b, c), unit cell volume (V), average size of mosaic blocks (D) and microstrains (ϵ) for $\text{La}_{0.54}\text{Ho}_{0.11}\text{Sr}_{0.35}\text{Mn}_{1-x}\text{Cr}_x\text{O}_3$ manganites (one phase model)

x	a (Å)	b (Å)	c (Å)	V (Å ³)	D (Å)	ϵ
0.05	5.464 ₂	7.709 ₇	5.495 ₀	231.49	621	0.000298
0.10	5.466 ₇	7.711 ₉	5.497 ₅	231.77	664	0.000359
0.15	5.470 ₄	7.714 ₆	5.498 ₄	232.04	703	0.000149
0.20	5.467 ₃	7.708 ₅	5.495 ₈	231.62	698	0.000157

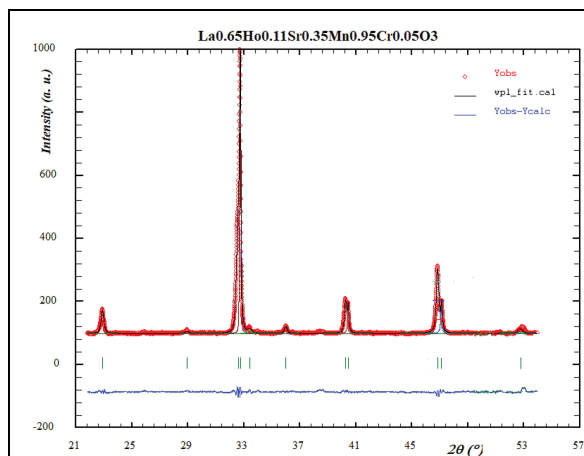


Figure 1. X ray diffractogram of $\text{La}_{0.54}\text{Ho}_{0.11}\text{Sr}_{0.35}\text{Mn}_{0.95}\text{Cr}_{0.05}\text{O}_3$

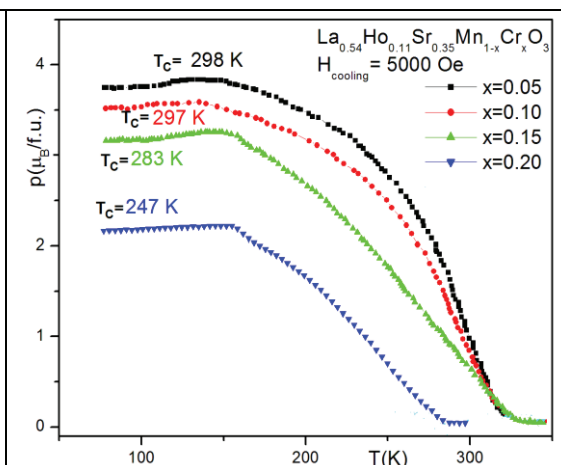


Figure 2. The variation of molar magnetization with temperature and Cr concentration

A large difference exists between the Mn^{3+} or Mn^{4+} and Cr^{3+} or Cr^{2+} behavior, concerning the contribution at the magnetic structure: only Mn^{3+} and Mn^{4+} contribute to the magnetic moment of the samples, apparently no exchange takes place between the Mn and Cr cations. Magnetic measurement, performed between 77 and 400 K indicate a decrease of the molar magnetization vs increase of Cr concentration in the samples for an intensity of 5000 Oe

(see Figure 2). At low intensity field the molar magnetization shows an unusual dependence of the temperature, especially with the increase of Cr concentration over $x=0.10$ (see Figure 2). For low Cr concentration the dependence of molar magnetization on temperature have a form close to those of ferromagnetic materials. However, at low temperature a maximum of the molar magnetization was observed (see Figure B). We attributed the observed maximum to a transition from the ferromagnetic to spin glass state, with the increase of the temperature.

Ferromagnetic to spin-glass transition.

The specific magnetization presents a strong dependence in the intensity of magnetic field and on thermal treatment of the samples.

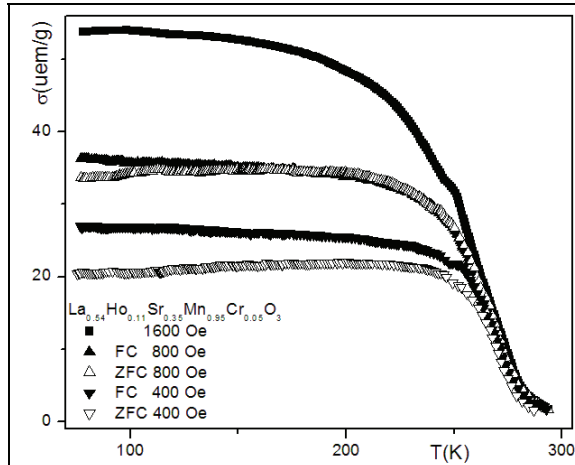


Figure 3. Variation of specific magnetization with intensity of magnetic field and temperature for $La_{0.54}Ho_{0.11}Sr_{0.35}Mn_{0.95}Cr_{0.05}O_3$

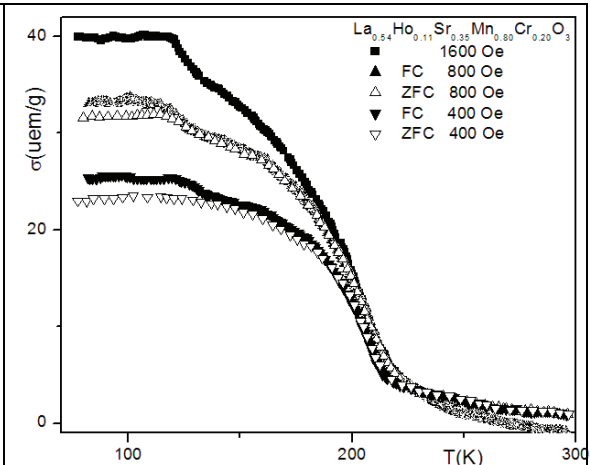


Figure 4. Variation of specific magnetization with intensity of magnetic field and temperature for $La_{0.54}Ho_{0.11}Sr_{0.35}Mn_{0.8}Cr_{0.2}O_3$

For the samples cooled in low magnetic field the magnetization ($H \leq 800$ Oe) remains practically constant for a large range of temperatures (see Figures 3 and 4). On other hand, we observed an increase of magnetization from low to higher temperature, close to transition temperature between spin-glass and ferromagnetic state. The behavior of specific magnetization is characteristic for the presence of the spin state. We concluded that at low temperatures the samples are formed by a mixture of spin glass and ferromagnetic state.

If the samples are cooled without magnetic field a partial transition from a ferromagnetic state (parallel magnetic moments) to a spin glass state (disordered magnetic moments) takes place, it means a decrease of the magnetic moment of the samples with temperature. If the samples are cooled in magnetic field at temperature lower as transition temperature some magnetic moments remain parallel with the direction of the applied magnetic field direction. The transition temperature strongly depends on the Cr concentration in the samples (see Figures 3 and 4). Such behavior can be attributed 1) to the presence of the B sites of an increase Cr concentration, which did not contribute directly to the magnetic moment of the samples and 2) to a decrease of the direct exchange interaction due the presence of Cr cations in B lattice.