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Structural and magnetic properties of the mixed oxide $CoFe_{0.5}Cr_{1.5}O_4$

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Abstract – Nanoparticles of $CoFe_{0.5}Cr_{1.5}0_4$ were prepared by using the solution-combustion method. X-ray diffraction data (Fig. 1) suggested the presence of only one crystalline phase, the cubic-spinel structure with lattice parameter, 8.347 Å. The average particle size determined by the Scherrer's equation is ~ 23 nm. The temperature dependence of the dc magnetization following the ZFC and FC cycles, suggested the presence of a ferrimagnetic phase below 175K (Fig. 2). Above this temperature, the magnetic behavior of the system looks like to be a superparamagnetic. At 5K the mixed chromite presents a quite high coercive field, 461.55 kA/m.

Nanosized spinel mixed oxides gain a considerable interest in a view of their applications us high density information, catalyst, and biomedical treatment [1]. Very recently it has been found that the cobalt chromite ($CoCr_2O_4$) nanostructured presents very interesting magnetic and catalytic properties. One of the possible applications is the elimination of NO_x gases produced in the emission exhaust from diesel vehicles [2].

The cobalt chromite compound belongs to the spinel structure family with general formula AB_2O_4 which crystallizes in the well known cubic-spinel structure which presents two possible arrangements. The first one known as normal spinel is characterized by A cations in the tetrahedral sites and B cations in the octahedral positions. A second possible arrangement known as inverse spinel, in which the A cations occupies one half of the octahedral coordination sites, the B cations occupies the other half of the octahedral sites as well as all of the tetrahedral positions. However, there are many possible intermediate distributions represented by the formula $(A_{1-\lambda}B_\lambda)^T(A_\lambda B_{2-\lambda})^O O_4$ where λ is called inversion parameter [3]. On the other hand, the transition temperature for the cobalt chromite is around 93K [4].

We have considered quite interesting the substitution of Cr^{+3} by Fe^{+3} in the cobalt chromite and carry out an study on the structural and magnetic changes because of the interactions between those three magnetic ions: Co^{+2}, Fe^{+3} and Cr^{+3}. For this reason, nanocrystalline $CoFe_{0.5}Cr_{1.5}0_4$ was prepared by using the solution-combustion method with nitrates of the cations and urea as the precursors.

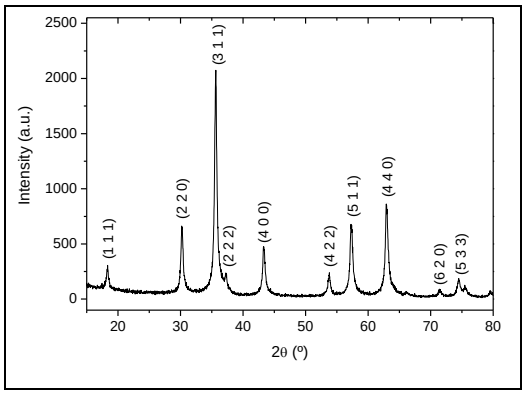

Figure 1: XRD pattern of $CoFe_{0.5}Cr_{1.5}0_4$ nanoparticles

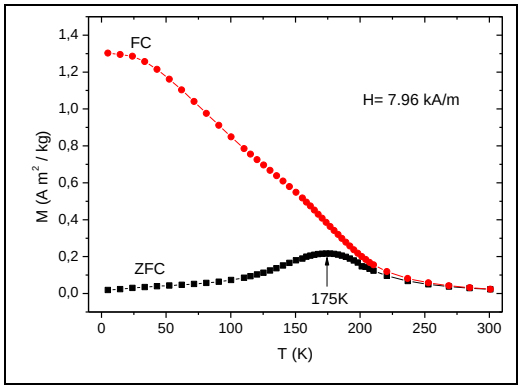

Figure 2: Temperature dependence of the magnetization obtained in ZFC and FC cycles in $CoFe_{0.5}Cr_{1.5}0_4$ nanoparticles

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