Electronic and Structural Characterization of Cobalt Ferrite (CoFe2O4) Nanofibers.

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Cobalt ferrite (CoFe2O4) belongs to the group of ferromagnetic materials. Recently, a great interest has arisen because of the magnetostrictive properties presented by this material. The presence of magnetostriction in this kind of material has enabled applications in the aerospace industry to give supporting surfaces on the wings of airplanes, in the control of the helicopter blades, sensors, corrosion in pipes and structures in space for vibration damping.

The aim of this work is to provide a summary of the electronic, as well as structural characterization of the material. The synthesis was carried out by using the sol-gel method. The nanofibers were synthesized by the electrospinning [1] technique and finally, the material was sintered at a temperature of 750 º C for 1 hr. The size of particles that make up the fibers was found between 27 and 41 nm (see Figures 1 and 2).

The structural characterization was carried out using scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The characterization of the electronic structure was performed using the Electron Energy Loss Spectroscopy (EELS) technique, analyzing both the low-loss and high-loss regions. From the low-loss part of the spectrum,

we obtained optical properties of the material via the complex dielectric function. From the high-loss region, we have verified the replacement of Co^{+2} ion in one of the iron ions Fe^{+3} in the ferrite Fe_3O_4 to form cobalt ferrite $CoFe_2O_4$.

EELS spectra were acquired using a Gatan Parallel Electron Energy Loss Spectrometer (PEELS model 766) in diffraction mode with 0.1 eV/ch dispersion, an aperture of 2 mm and a collection semi-angle of about 2.7 mrad. The resolution of the spectra was determined by measuring the full width at half-maximum (FWHM) of the zero loss peak and this was typically close to 1.5 eV, when the TEM was operated at 200 kV.

Figure 3 shows the energy loss function Im(-1/ε). The most prominent signal comes from the plasmon peak, whose maximum is at 24.0 eV, as well as interband transitions at 7.8 and

36.4 eV. The peaks at 53.0 and 57.4 eV are the Fe and Co M_{23} ionization edges, respectively. Figure 4 shows the imaginary part of dielectric function and the peaks indicate the energies at which absorption occurred and give us information directly from and interband transitions and therefore, the electronic structure of the material.

Figures 5 and 6 show the ionization edges of the $CoFe_2O_4$ nanofibers and Fe_3O_4, respectively. It is observed a remarkable similarity between the two spectra, which allows us to conclude that the cobalt ferrite arises after substitution of one Fe atom by a Co in the original Fe_3O_4structure.

[1] S. Ramakrishna et al., materials today ,V.9,Iss 3(2006) 40.

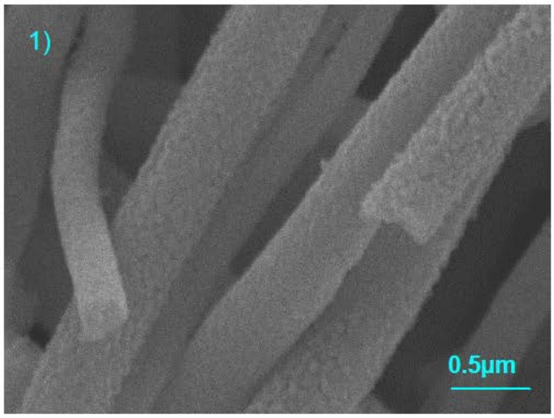

Figure1. SEM micrograph of $CoFe_2O_4$ nanofibers after calcination at 750°C for 1 h Tthese fiber were produced whit 0.5mL/h feeding rate

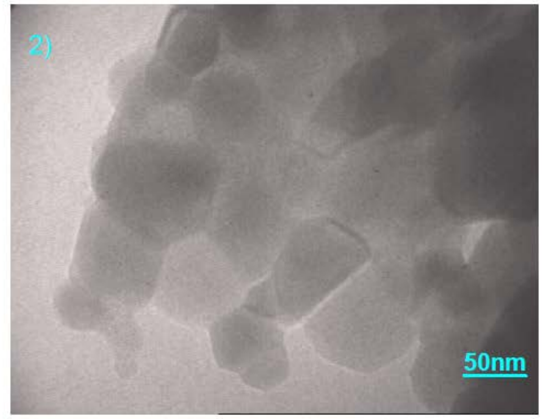

Figure2. TEM micrograph of $CoFe_2O_4$ nanofibers showing the different particle size after calcination at 750°C for 1 h.

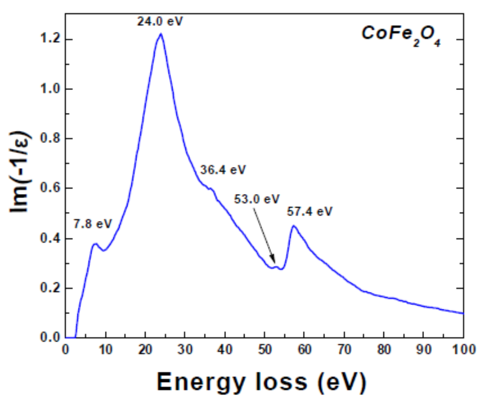

Figure 3. Energy Loss Fuction taken from cobalt ferrite

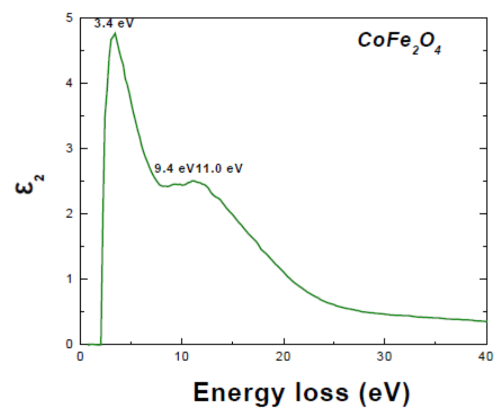

Figure 4. Imaginary part of the dielectric function taken from

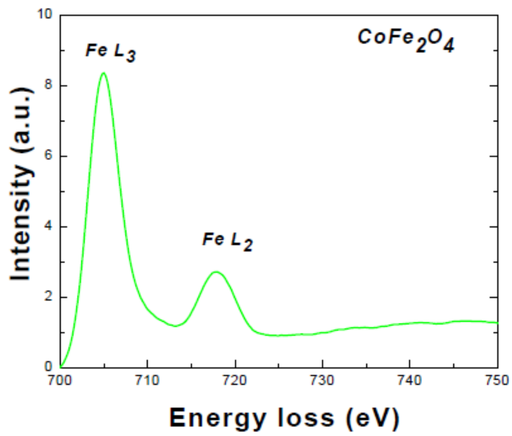

Figure 5. Fe L_{23} white lines taken from cobalt ferrite

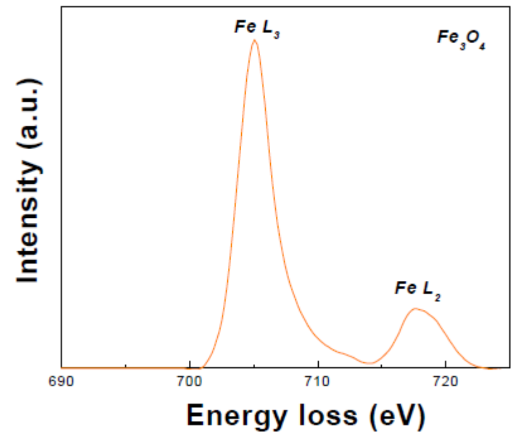

Figure 6. Fe L_{23} white lines taken from ferric oxide Fe_3O_4.