

Superparamagnetism in pure and Mn doped CuO nanofibers, originated by oxygen vacancies.

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The room temperature ferromagnetism (RTFM) observed in several CuO (metal oxide semiconductor, MOS) nanostructures [1,2] has been associated with the oxygen vacancies presence (Ov), over the surface of material or with cationic site defects [1,2]. In addition, with transition metals as dopants in little amount, CuO may be applied as a diluted magnetic semiconductor (DMS) in spintronics [1]

In this work, pure (A-NFs) and 2.5 % Mn doped CuO (B-NFs) nanofibers (NFs) have been synthesized by electrospinning method, in accordance with reference [3]. The samples were studied at two different temperatures, 2K and 300 K, to compare the magnetic behavior, using a Magnetic Property Measurement System (MPMS3), applying a field of ± 65 KOe for all the samples. In addition, an ESCALAB 250Xi ThermoScientific TM XPS (X ray photoelectronic spectroscopy) equipment was used to detect Cu+1 and Cu+2 cations. Finally, the material morphologies were obtained from transmission electron microscopy (TEM) (TEM, JEM2200FS model).

The Figure 1 (a) and (b) exhibits the patterns of X-ray diffraction(XRD) of pure and Mn doped CuO nanofibers, respectively, (b), corroborating the presence of Tenorite structure by (c) the PDF 80-1268 (Power Diffraction File).

The Figure 2 (a) and (b) displays MPMS3 results for both samples at 2K and 300K. Fig. 2 (a) shown for the A-NFs sample a higher superparamagnetism at 300K than at 2K, with the same remanence of -0.0068×10^{-3} emu/g for both temperatures, while for the B-NFs sample, (Fig. 2 (b)) were measured remanences of -0.364×10^{-3} emu/g at 2K and -0.010×10^{-3} emu/g at 300K. In this case, may be observed that the Mn doping creates a higher curve at 2K than at 300 K, showing more superparamagnetic behavior. This effect is associated to Cu+1, Cu+2 and Ov presence [2]. In addition, for both A-NFs and B-NFs, the XPS spectra, at 300K, are displayed in Figure 2 (c) and (d), respectively, showing pikes associated with the Cu+1 and Cu+2 cations, as well as Ov presence, for both materials. The A-NFs sample exhibits more presence of Cu+2 cation but less Ov than B-NFs. Cu+1 cation effect seems to be similar for both samples. In addition, in last M&M, our work group reported charge transfer, associated with the DMS magnetic properties [3]. The micrographs presented by Fig. 2 (e) and (f) display fragments of a necklace shape for both samples, A-NFs and B-NFs, with an average size less than 100 nm.

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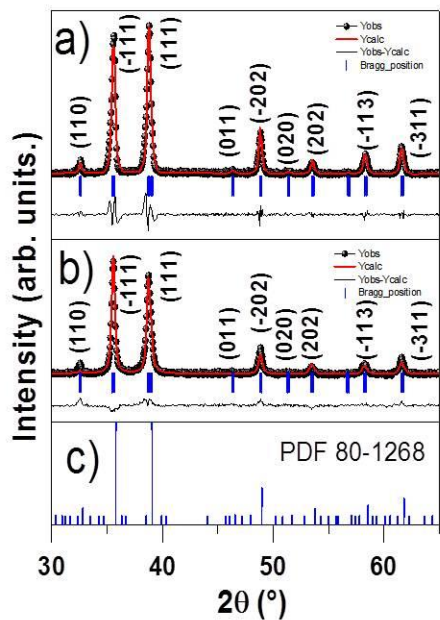


Figure 1. XRD corresponding to (a) A-NFs (b) B-NFs spectra, showing Tenorite phase with monoclinic structure, corroborated by (c) the PDF 12-1268.

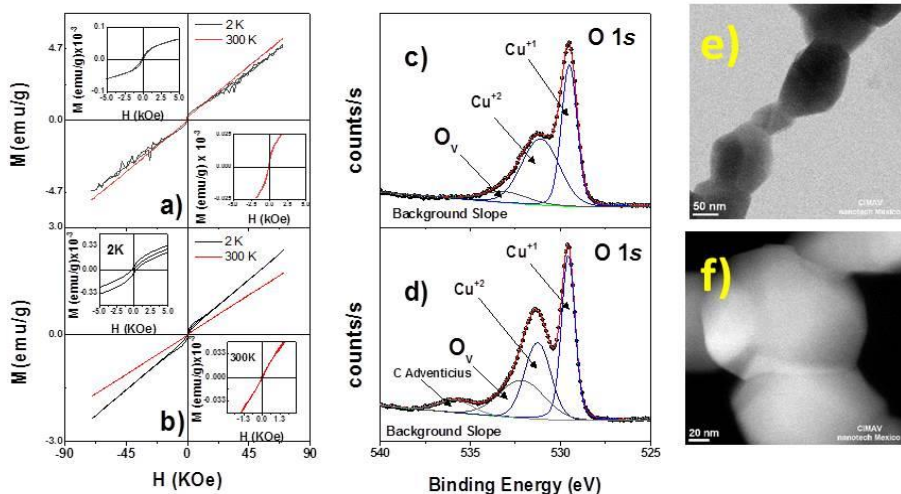


Figure 2. The (a) and (b) panels exhibit a superparamagnetic behavior for both A-NFs and B-NFs samples, at 2K and 300K, respectively. (c) and (d) show the XPS spectra showing the O 1s pike, where can be distinguished the superparamagnetism contributions corresponding to cations Cu+1 Cu+2 and Ov, for both samples. Finally, (e) and (f) panels show fragments of the NFs necklace morphology, formed by nanoparticles with an average size less than 100 nm.

References

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