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Enhanced ferromagnetism in CuO nanowires on the top of CuO nanograins

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In the past few years, a considerable effort has been devoted in order to grow magnetoelectric nanostructured materials. Besides fundamental science, they are very attractive in the electronic/spintronic industry as well as magnetic storage media, solar energy conversion due to their nanometer scale. It is believed that CuO is a magnetoelectric multiferroic system where a ferroelectric order is induced by the onset of a magnetic coupling at low temperatures. Furthermore, its simplest composition is the bases of cuprates which bring about the well-known high-temperature superconductivity. Bulk samples of CuO (which has an unpaired electron in the *d*-shell) show two antiferromagnetic phase transitions – a commensurate collinear state with the magnetic moments along the monoclinic *b* axis at $T_N \sim 213$ K and an incommensurate spiral state with half of the magnetic moments in the *ac* plane at $T_N \sim 230$ K.

We have produced CuO nanostructured samples by using electrical resistive heating method. CuO nanowires of 50-90 nm in diameter and length up to 1.2 µm grew homogeneously and straightly on a 170 nm layer of CuO nanograins which are on the top of a diamagnetic Cu_2O layer. At low magnetic fields, the magnetization (ZFC/FC) as a function of temperature resembles superparamagnetic behavior. However, a long range antiferromagnetic ordering is induced by a magnetic field of 5 kOe in the sample with homogeneous distribution of nanowires. A very strong ferromagnetic-like contribution displaying remanent magnetization and coercivity was found to coexist in the system. Our results reveal clear experimental evidence that ferromagnetic-like behavior shows up along with the presence of long range AFM ordering. The ferromagnetic-like behavior is observed below and above the induced T_N, suggesting that this behavior is not dependent on the original magnetic state of the core, whether it is PM or AFM. The effective magnetic moment was estimated to be ~ 1×10^{-2} μ_B/f.u. producing a nearly temperature independent coercive field around 70 Oe.

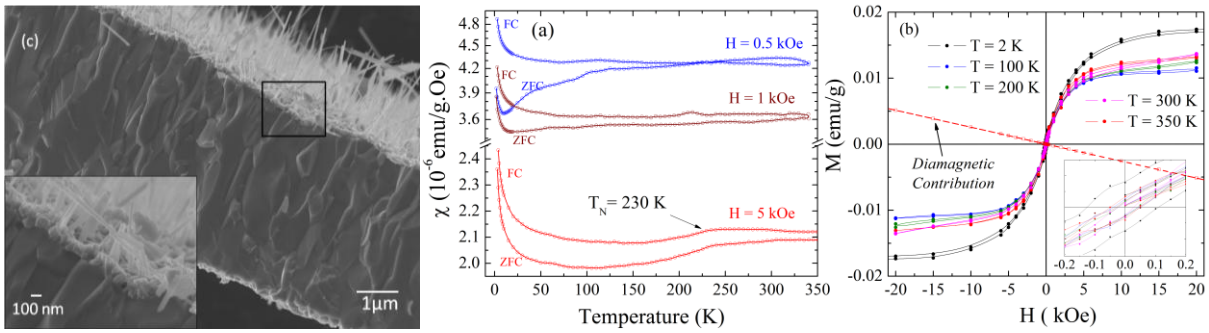

Fig.: (a) Image of scanning electron microscopy showing CuO nanowires/nanograins on Cu_2O layer. (b) Magnetization as a function of both temperature and magnetic field.

Keywords: CuO, nanowires, nanograins, enhanced magnetism

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