Poster

Exchange bias in core/shell ferromagnetic/antiferromagentic Co/Co-O nanoparticles of controlled size embedded in an insulating matrix

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Starting from the first report of exchange bias (EB) in fine particles, a huge amount of different EB system has been investigated [1]. Here we present the results of fabrication and characterization of core/shell Co/Co-O ferromagnetic/antiferromagnetic (FM/AFM) nanoparticles in an insulating zirconia matrix. These systems were prepared by pulsed laser ablation [2] at the room temperature in vacuum chamber in O2 presence. Depending on the target component ratio, it is possible to obtain metallic particles of different sizes, above or below the percolation threshold. The samples of this study have been grown well below percolation threshold in order to exclude as much as possible the interactions between particles.

We have prepared a variety of samples at different O2 chamber pressures (pO2) which resulted in different core-shell ratios. It is significant that the oxide shell forms while the Co particles fly from the target to the substrate. The investigated thin films were about 200-300 nm thick and were deposited onto different substrates according to the characterization technique to be used. The magnetic properties were measured by SQUID magnetometer. As pO2 increases, three interesting effects in zero field cooling/field cooling (ZFC/FC) and M(H) data can be observed (Fig. 1, Fig. 2): (i) the magnetization of the samples decreases due to decrease in the volume fraction of FM Co in the core of nanoparticles; (ii) the ZFC peak position moves from 6.5 K for pO2 = 0 to 12.5 K for pO2 = 10 · 10-7 bar, since the higher pO2, the larger the mean particle size, while it broadens since the size distribution also broadens; (iii) the EB field first increases with increasing pO2 (increase in the AFM shell thickness at the expense of the FM core), while it decreases at large pO2 when the whole particle becomes AFM. Comparing the behaviour between pure AFM and core-shell particles, it is evident that the AFM nanoparticles do not present hysteresis behaviour.

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References:

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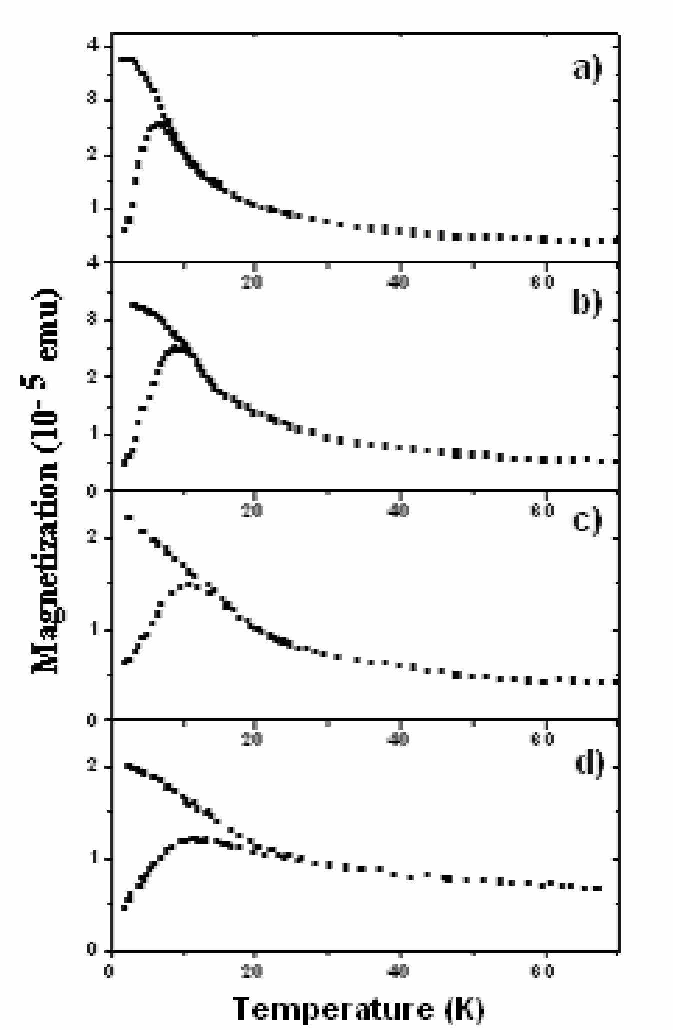

Fig. 1. Temperature dependence of the field cooled and zero field cooled magnetization.
The pressure of O_2 during preparation: a) 0, b) 2.5, c) 7, and d) 10 (in units of 10^{-7} bar);
Co volume fraction x_v: 0.30, 0.28, 0.27, and 0.25 correspondingly.

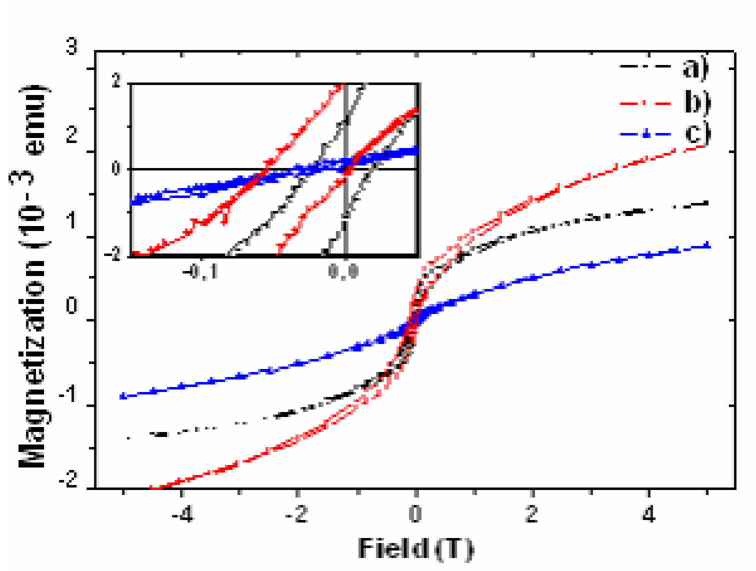

Fig. 2. Hysteresis loops.
The pressure of O_2 during preparation: a) 0, b) 0.25, c) 11 (10^{-6} bar).
The inset shows a low field magnification of the magnetization, the unit of the vertical scale is 10^{-4} emu.