Interface effect on the magnetic anisotropy in Co nanoclusters embedded in a Cu matrix.

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Co and Cu are two inmiscible elements but a metastable solid solution of both can be obtained with the use of ultra-rapid quenching techniques such as melt-spinning. The microstructure of these alloys can be easily modified by thermal treatments that induce the segregation of the minority element (Co) embedded in the copper matrix. As a consequence, different annealing temperature means different microstructure.

Previous studies on Co_5Cu_{95} and $Co_{10}Cu_{90}$ have provided a concise microstructural view at each stage of annealing, between 400 and 650℃. The information gathered from X-ray diffraction, magnetic measurements and EXAFS spectroscopy can be summarized as follows [1]: i) the as-quenched samples contain a majority of Co nanoparticles of 2-3 nm size coexisting with a percentage of Co atoms diluted into the Cu matrix; ii) the thermal treatment induces the segregation of the Co atoms from the Cu matrix, changing the percentage of Co atoms in each phase. For T_{ann}<550℃ the diluted percentage diminishes on behalf of the Co nanoparticles. We have related these microstructural studies to the giant magnetoresistance (GMR) response of the samples and concluded that the GMR is strongly influenced by the Co nanoclusters' size, concentration and, especially, interfacial roughness [1].

We have performed a XMCD study on the Co_5Cu_{95} system. The XMCD has been monitored at the beamline BL25SU of the SPring8. Spectra were recorded at 30 K on as-quenched and annealed samples in total electron yield mode. Co $L_{2,3}$ and Cu $L_{2,3}$– XMCD spectra were recorded under an applied magnetic field of 10 kOe. Before the XMCD measurements all the samples were ion-bombarded during 1 hour in order to clean their surface and improve the X-ray penetration.

The Co dichroism signal depends on annealing temperature (see Figure 1) due to the changes in size and concentration of Co nanoparticles. At the same time, we observe an important Cu dichroism signal affected by the size and the interface of the Co particles.

We have applied the so-called XMCD sum-rules to get direct information on the modification of the orbital and spin magnetic moment of the Co clusters as both the number of Co nanoclusters and their size increase due to the thermal treatment. Our results indicate that the orbital and spin moments of the Co atoms increase with the annealing treatment. In this way we shall obtain information, at a

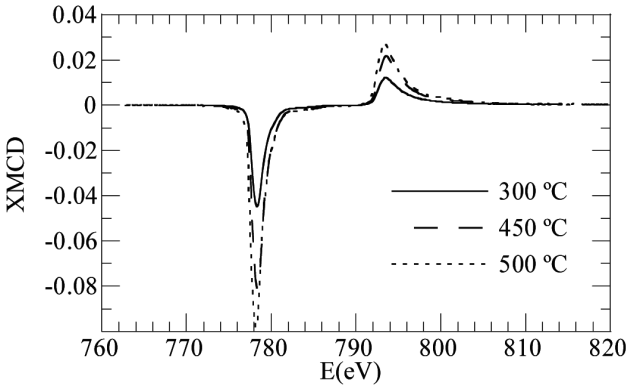

Fig. 1: Co $L_{2,3}$-edges XMCD spectra of samples Co_5Cu_{95} annealed at 300, 450 and 500 °C.

microscopic level, of how the magnetic anisotropy is affected by the particle size (and therefore by surface conditions) and by the interface disorder.

[1] A. García Prieto et al., Phys. Rev. B **67** (2003) 224415; M.L. Fdez-Gubieda et al., Europhys. Lett. **59** (2002) 855.