ESRF	**Experiment Title:** **Element Sensitive Magnetometry in Co nanogranular monolayer capped with Pt and Pd with Perpendicular Magnetic Anisotropy**	**Experiment number:** HE-3136
Beamline: ID12	**Date of experiment:** from: September 30th, 2009 to: October 7th, 2009	**Date of report:** February 23rd, 2010 Received at ESRF:
Shifts: 18	**Local contact(s):** Dr. Alevtina SMEKHOVA	

Names and affiliations of applicants (* indicates experimentalists):

Dr. Juan BARTOLOME*
Dr. Fernando BARTOLOME
Dr. Luis-Miguel GARCIA VINUESA*
Adriana Isabel FIGUEROA GARCIA*
ICMA and Departamento de Física de la Materia Condensada
CSIC-Universidad de Zaragoza, Pedro Cerbuna 12, 50009 Zaragoza, Spain

In experiment HE-3136, we carried out element selective magnetometry at the Pt and Pd $L_{2,3}$ edges, and in Co K edge in samples of Pt and Pd - capped Co nanoparticles following the formula $(Al_2O_3/Co_{tCo}/M_{tM})_{25}$, with M=Pt and Pt, $t_{Co,M}$ being the nominal thickness of Co or metal deposited on the samples. These granular systems are of special interest in magnetism since metallic layer covering the nanoparticles modify their surrounding matrix so that their magnetic properties are modified [1]. These samples in particular have shown a strong perpendicular magnetic anisotropy (PMA), observed by conventional SQUID magnetometry, as well as a double step feature in the hysteresis loops measured at low temperature [2,3]. The aim of this experiment was to disentangle the different contributions to this double step behavior, following the hypothesis of a soft Co core in the particles, surrounded by a hard magnetic phase of Co:Pt alloy. Moreover, by angular dependent XMCD measurements we intend to deeply understand the character of the PMA in these systems.

Performed measurements included typical XANES and XMCD at T=10K and 150K at the Pt $L_{2,3}$ and Co K edges in two Pt – capped samples (t_{Co}=0.4 and 0.7nm, both with t_{Pt}=1.5nm) and at the Pd $L_{2,3}$ and Co K edges in one Pd – capped sample (t_{Co}=0.7nm and t_{Pd}=1.5nm); hysteresis loops at the Pt L_3 and Co K edges energies in the Pt – capped samples at both temperatures, with applied magnetic field of $-20kOe \leq H \leq 20kOe$, and at the Pd L_3 and Co K edges in the Pd – capped sample, under the same magnetic field conditions and a temperature of T=12K; finally, angular dependent XMCD measurements at the Pt $L_{2,3}$ edges in the two Pt capped samples at T=10K were also completed.

Fig 1a shows the XMCD signal at the Pt $L_{3,2}$ edges in the sample with t_{Co}=0.4nm and t_{Pt}=1.5nm. XMCD integrals were calculated in order to apply the magneto-optical sum rules [4] to obtain the magnetic moments in Pt. These values were used to scale the magnetic response measured in the hysteresis loops for this sample. Fig 1b shows one of these hysteresis loops measured at the energy where the maximum of XMCD signal at the Pt L_3 edge appears (11571.48eV), at T=10K. High coercitivity obtained in this measurement show that Pt is in a hard magnetic phase, which could be a Co:Pt alloy. The hysteresis curve measured for the same sample at Pt L_3 edge at T=150K (inset in Fig. 1b.) show a reduction in the coercive field with temperature, which is in agreement with SQUID measurements performed on the samples.

XMCD data collected at the Co K edge at T=10K for sample with t_{Co}=0.4nm and t_{Pt}=1.5nm is presented in Fig. 2a. Fig. 2b shows the hysteresis loop measured at the energy where the maximum of the Co K edge XMCD signal is present (7723.96eV). Saturation of this signal was normalized to the magnetic moment obtained from sum rules [3] applied to Co $L_{2,3}$ XMCD data measured in ID08-ESRF for the same sample, at the same temperature. If we compare this loop with the one obtained at the Pt $L_{2,3}$ edges under the same temperature and field conditions, it is evident a difference in coercitivity between them. Apparently the Co magnetization, as observed in soft x-ray XMCD, originates in a soft magnetic Co phase present in the sample.

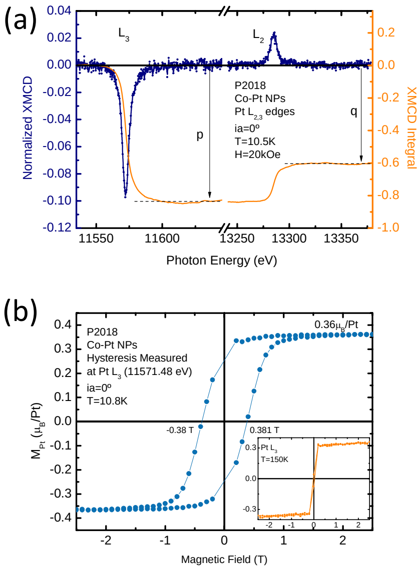

Figure 1. (a) XMCD signal and integral at Pt $L_{2,3}$ in t_{Co}=0.4nm and t_{Pt}= 1.5nm sample. Arrows show the energy where integrals were estimated to calculate the magnetic moments in Pt. (b) Hysteresis loop measured at the Pt L_3 in the same sample at 10K; inset: M(H) at Pt L_3 and 150K.

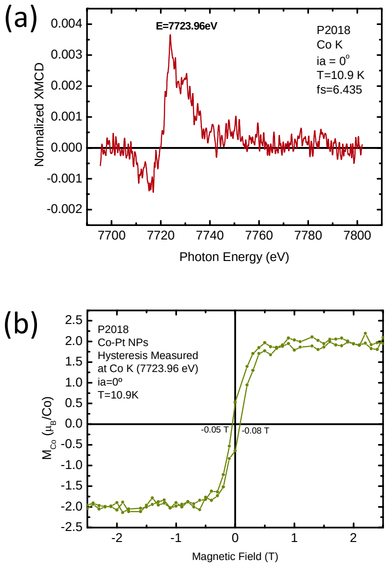

Figure 2. (a) XMCD signal at the Co K edge in the same sample in Fig 1 measured at 10K (b) Hysteresis loop measured at the energy where the maximum of the Co K edge XMCD signal in (a) appears.

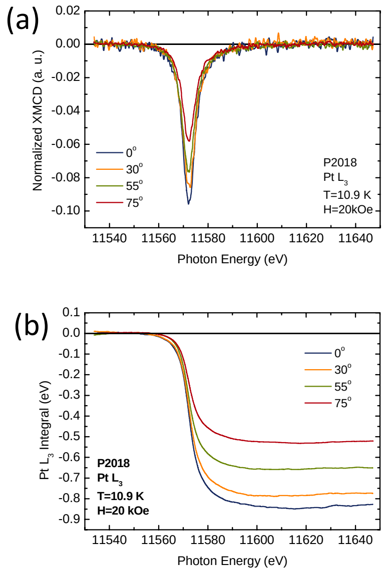

Figure 3. (a) Angular dependent XMCD signal at the Pt L_3 edge in the same sample in Fig 1. (b) XMCD integrals calculated from each data shown in part (a).

Angular dependent XMCD signal at the Pt L_3 edge in sample with t_{Co}=0.4nm and t_{Pt}=1.5nm is shown in Fig. 3. There is a clear trend in the signal evolution as we change the angle with respect to the incident beam, so that its intensity decreases as it reaches the grazing angle of 75º. This is an evidence of the PMA that was previously identified by SQUID magnetometry. Further analysis of XMCD data obtained in this experiment will allow quantifying the intra-atomic dipolar term for the interactions between the particles in the samples studied.

Similar results were obtained for the Pd $L_{2,3}$ and Co K edges XMCD measurements on Pd-capped Co-nanoparticles.

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