



	<b>Experiment title:</b> Induced magnetism of Rh 4d states in CoRh bimetallic nanoparticles	<b>Experiment number:</b> HE – 2703
<b>Beamline:</b> ID12	<b>Date of experiment:</b> from: 25/06/2008 to: 01/07/2008	<b>Date of report:</b> 28.08.08
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## Report:

The experiment HE – 2703 proposed to investigate the 4d induced magnetic moment of Rh atoms in core (Co) - shell (Rh) nanoparticles (Co@Rh) embedded in an organic matrix. We have already studied CoRh NPs with Rh core and Co shell (Rh@Co). In this case the experiments revealed an increased magnetic moment and MA which could be related mainly to the chemical arrangement in these NPs. The aim of the present experiment was to study how the magnetic properties of NPs are influenced by reversing the chemical order (Co@Rh).

Three different compositions of core-shell Co@Rh nanoparticles were prepared by one-pot synthesis in Argon atmosphere via an organo-metallic approach [1]. A strong care was taken to prevent any oxidation process since these NPs are highly oxygen and water sensitive. The average size of NPs has been detected by TEM and was about 1.7nm for all compositions. The crystallographic structure of the nanoparticles was characterized by WAXS as polytetrahedral.

To get deeper inside the nature of magnetic properties we measured X-ray absorption (XAS) and XMCD spectra in the XANES region of the Rh L<sub>2,3</sub> absorption edges. The spectra at the Rh L<sub>2</sub> edge are presented in Fig.1 (left, middle), the same XAS spectra behavior was observed at the Rh L<sub>3</sub> edge (not shown). Spectra were performed in L-MOKE geometry with magnetic field ±6T and at low temperature (6.5K) in the backscattering geometry using a fluorescence yield detection technique on the ID12 beamline. The XMCD spectra were corrected for an incomplete polarisation and branching ratio. To be sure that there wasn't any Co oxidation in the investigated compositions, X-ray absorption spectra at the Co K edge (Fig.1(right)) at room temperature were also measured.

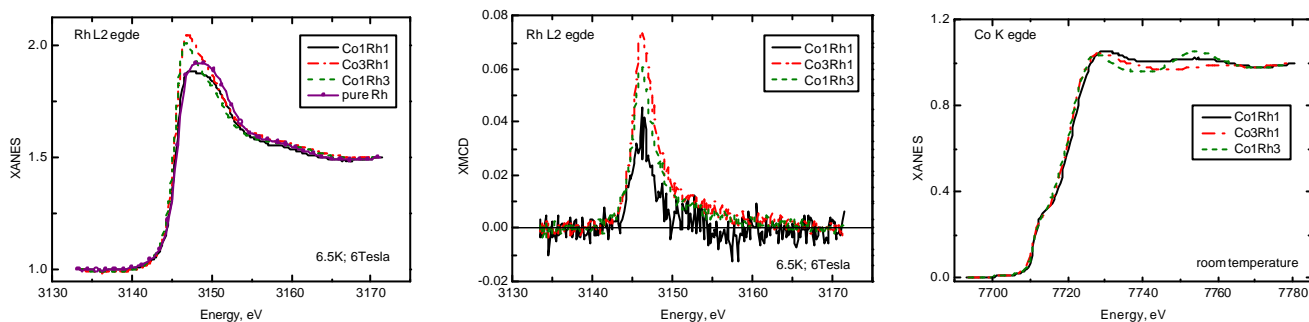


Fig. 1 XAS (left) and XMCD (middle) spectra measured at the Rh L2 absorption edge for Co1Rh1, Co3Rh1 and Co1Rh3 compositions. The XAS spectra for pure Rh nanoparticles is also presented (left) for comparison. The absorption spectra at Co K edge for CoRh NPs are presented at the right panel

The shape of XANES spectra at the Co K edge demonstrates the absence of Co oxidation in NPs for all investigated compositions and is in agreement with the shape expected for these NPs of polytetrahedral structure.

The XANES spectra at Rh L2,3 edges were recorded for pure Rh NPs and all CoRh NPs of different compositions. They significantly differ from the spectra expected for metallic Rh atoms. However, in comparison to the XANES spectra of pure Rh NPs in the same chemical environment, the XANES spectra recorded at the Rh L2 edge show that the Rh atoms in the CoRh NPs present a strong interaction with the chemical species in agreement with their location at the surface of the NPs.

The preliminary analysis of the experimental XMCD data shows that all compositions of Co@Rh nanoparticles with Rh shell exhibit a sizeable 4d induced magnetic moment at low temperature. The magnetisation curves measured at the Rh L2 edge at 6.5K confirm that our NPs are almost magnetically saturated at 6Tesla. (Figure 2)

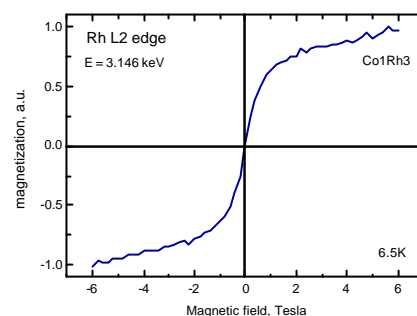


Fig. 2 Magnetisation curve for the Co1Rh3 core-shell nanoparticles measured at the Rh L2 edge at low temperature (6.5K)

The polarization of Rh atoms confirms the bimetallic character of the particles.

The preliminary treatment of the XMCD data shows that the absolute values for 4d Rh magnetic moment are much weaker in comparison with NPs with Rh core and Co shell, which we investigated earlier (HE-2538) [2]. There may be two reasons for such weak induced 4d magnetic polarisations of Rh atoms. First, it is well known that ligands at the surface of NPs can induce a decrease of the magnetisation of surface atoms (in our case that is Rh atoms). The second reason may be a lower polarisation transfer from the Co core as already observed for the FeRh system when studying Fe@Rh and Rh@Fe NPs (HE-2538) [3].

The Sum Rules analysis for determination of spin and orbital contributions into the total 4d induced magnetic moment on Rh atoms is in progress.

[1] B. Chaudret, *Comptes Rendus Physique*, **6**, p.117-131 (2005)

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[3] A. Smekhova, D. Ciuculescu, P. Lecante, F. Wilhelm, C. Amiens, A. Rogalev, B. Chaudret, *IEEE*, accepted (2008)