ESRF	**Experiment title:** Magnetization profile study in Ce/Fe multilayer by x-ray resonant magnetic scattering at L_2	**Experiment number:** HC 217
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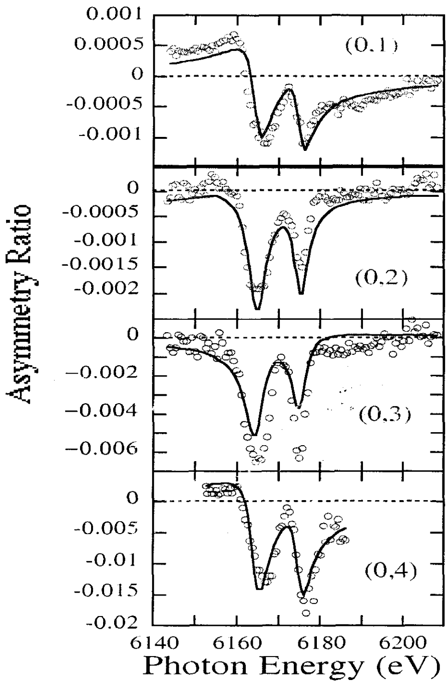
Names and affiliations of applicants (* indicates experimentalists):

J.M. Tonnerre, L. Sève, F. Bartolome, D. Raoux
Laboratoire de Cristallogruphir, CNRS, B.P. 166, F-38042 Grenoble cedex 09, France
M. Arend, W. Felsch
I. Physikalisches, Universität Göttingen, Bunsenstr. 9. 37073 Göttingen, Germany
A. Rogalev, C. Gauthier, J. Goulon
ESRF, B.P. 220, F-38043 Grenoble Cedex, France

Report:

In highly correlated Ce/Fe multilayers, Cerium adopts an a-like electronic structure within 20 Å from the Fe interface. XMCD experiments at the L and M edges, have confirmed that the hybridization of the Ce 5d and 4f states with the 3d states at the Fe interface induce at room temperature a magnetic order with weak magnetic moments on both the 5d and 4f states of Ce. XMCD results reveal a fundamental difference between the 4f polarisation which is restricted at the Fe interface, and the 5d one which extends over 20 A, though it decreases with Ce thickness.

In order to get more insight on the complex behaviour of the induced 5d states polarization, we have performed a resonant magnetic scattering experiment at the Ce L_2 edge on a Ce $_{10}$ Å / Fe 30 Å multilayer. Ce being amorphous, it does not provide diffraction peaks at large angles. We thus had to investigate the low angle Bragg peaks of the multilayer. For such an experiment, a circular polarization of the X-ray beam is required to enhance the magnetic contribution to the scattered intensities. Measurements have been performed on the ID12a Beamline with the benefit of a high circular polarization rate (τ_C =0.84 after monochromator), with a magnetic field applied parallel (I+) or antiparallel (I-) to the diffraction plane. Fig. 1 displays the asymmetry ratio $(I_+-I_-)/(I_++I_-)$ measured at the Ce L_2 edge on top of the first 4 Bragg peaks. Their amplitudes vary from 10^{-3} for the first order, up to 1.8 10^{-2} for the fourth order. Each scan is the sum of 3 or 4 scans of one hour. The overall shape of the energy dependence of the asymmetry ratio compares well with the L_2 XMCD spectra in which there are two lobes associated with the $4f^0$ and $4f^1$ configuration in the final state. The increase of the amplitudes with the Bragg order directly evidences a non constant magnetic profile across the Ce layer.



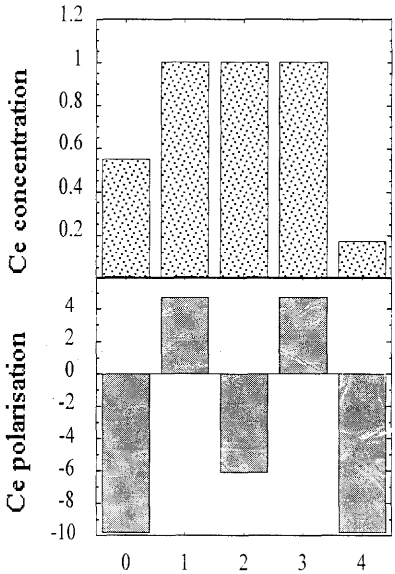


Fig 1 : Energy dependence over the Ce L2 edge of the asymmetry ratio measured on top of the 1st and 2nd order (Fig 1.a) and 3rd and 4th order (Fig 1.b) Bragg peak for a Ce 10Å / Fe30Å multilayer. The lines display the best refinement results.

Fig 2 : Polarization and composition profiles across the Ce sublayer, resulting from the fitting procedure. Polarization amplitude is given in units of the average XMCD amplitude.

To analyze the data, we use a kinematical approach, the Ce layer being described by a discrete stacking of atomic plane, each carrying a polarization amplitude. The shape of the magnetic resonance is taken from the XMCD measurements. Both interface planes are refined for concentration in Ce. The distribution tentatively derived from the dependence of the XMCD spectra on the Ce thickness, with the polarization decreasing with the distance from the Fe interface, does not allow to fit the data, the sign of the 3rd order asymmetry ratio being even reversed with respect to the experimental data. A different refinement procedure exploiting our XRMS data yields an unexpected oscillating polarization distribution shown in Fig. 2, together with the Ce concentration at the interfaces. We point out that the average moment deduced from the fitting is in agreement with its XMCD evaluation within 20% depending on the actual values of the structural parameters used in the calculation. The same approach, used to determine the 5d induced magnetic profile for the La layers in a La(40Å)/Fe(30Å), show that the 5d magnetization decreases drastically from the interfaces with Fe towards the center in agreement with the strong reduction of the XMCD amplitude which is observed when inserting a 5Å thick Ce layers between La and Fe.

This first attempt to determine the induced spin polarization in a magnetic multilayer demonstrate the usefulness of the XRMS method in complement with the XMCD one.