Ce 5d and 4f Induced Magnetic Profiles in Multilayers Probed by XRMS

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This study is devoted to the investigation of induced magnetism in ultrathin Ce layers in [Ce/Fe] multilayer structures. It has been undertaken in the framework of the studies on magnetic properties of low dimensionality artificial structures.

It has been shown by XAS and XMCD that the Ce adopts an α-like electronic structure and that 5*d* and 4*f* states carry a net weak magnetic moment due to the hybridisation of these states with the Fe 3*d* states at the interface. However, a fundamental difference between the Ce 4*f* polarisation and the 5*d* one has been revealed on samples with La layers of increasing thickness inserted at the interfaces. While the mean Ce 4*f* polarisation is restricted at the immediate interface, the mean 5*d* magnetic polarisation decreases rapidly from the interface up to a distance of about 10-12Å, while beyond that thickness, it decreases slowly.

In order to get more insights on the intriguing behaviour of the Ce magnetisation, X-ray Resonant Magnetic Scattering (XRMS) has been used at the Ce L_2 edge in order to investigate the distribution of the induced 5*d* magnetic moments across the Ce layer in [Ce/Fe], [Ce/La/Ce/Fe] and [La/Ce/La/Fe] multilayers. The energy dependence of the asymmetry ratio, $R=(I^+-I^-)/(I^++I^-)$ obtained for two opposite directions of an applied saturating magnetic field, has been measured on top of several chemical modulation Bragg peaks. The simultaneous refinement of these curves enables us to describe the *5d* magnetic profile throughout the Ce layer. Such a procedure relies on the description of the average chemical profile inside multilayer period, which has been derived from x-ray resonant reflectivity measurements. The striking feature of the 5*d* magnetisation profile is its oscillating behaviour with a period of two monolayers decreasing from the Fe interface towards the centre. The same approach has been used at the Ce $M_{4,5}$ edges, in the soft x-ray range (≈ 900 eV), on [Ce/Fe] multilayers. Up to six sharp Bragg peaks have been observed indicating that, despite the strong absorption of the RE atoms at the *M* edges, magneto-optical measurements in scattering condition are possible. The refinement of the *R*(E) will allow to probe the 4*f* magnetic profile and a direct comparison of the 4*f* and 5*d* magnetisation. Furthermore, hydrided multilayers have been studied in order to investigate the effect of a strain relaxation, accompanied by a relocalisation of the 4*f* states, on the magnetic profile. Strong differences in shape and amplitude have been observed for sample with the similar structure (Fig. 1). Full analysis is underway and will be presented.

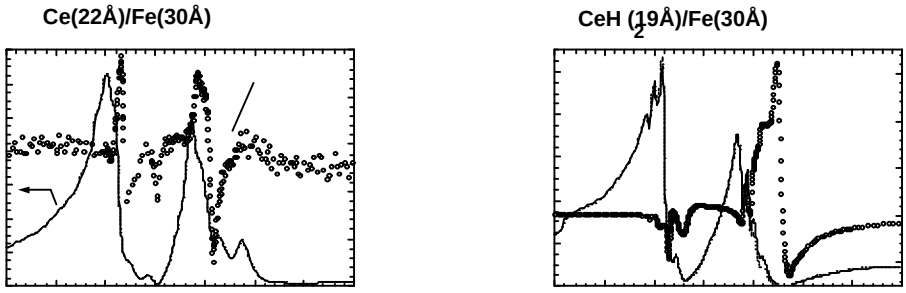

Fig 1 : Full and dash lines represent the intensity measured, for two opposite directions of an applied magnetic field, at the top of the 3rd bragg peak. Open circles show the asymmetry ratio.