ESRF

Experiment title: Palladium magnetism in Pd/Fe multilayers studied by XMCD at the Pd $L_{2,3}$ edges

Experiment number: HC 219

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Names and affiliations of applicants (*indicates experimentalists):

***Jan Vogel and *Alain Fontaine,** Laboratoire de magnétisme Louis Néel, CNRS, BP166, 38042 Grenoble.

***Vincent Cros and *Frédéric Petroff,** Unité mixte CNRS-Thomson CSF, Domain de Corbeville, 91404 Orsay.

***Jean-Paul Kappler,** IPCMS, 23 rue du Loess, 67037 Strasbourg.

***Gérard Krill,** Laboratoire pour l'Utilisation de Rayonnement Electromagmétique, Bat.209D, 91405 Orsay.

***Andrei Rogalev and *José Goulon,** ESRF, B. P.220, 38043 Grenoble.

Report:

On BL6, we have performed direct measurements of the Pd moments in Pal/Fe multilayer, using X-ray Magnetic Circular Dichroism (XMCD) at the $L_{2,3}$ absorption edges of Pd. The Pal/Fe multilayer which we studied were grown in an MBE chamber on MgO (001) substrates by the CNRS-Thomson group. The absorption spectra were taken alternating the helicity of the incoming X-rays after every spectrum. They were measured in fluorescence yield, using four Si detectors developed by C. Gauthier and J. Goulon at the ESRF. This detection technique has the advantage over total electron yield that it is bulk sensitive. For the thin ($\sim$ 1000 Å) samples on which we report here, deformation of the absorption spectra due to self-absorption effects was absent. Summing three or four spectra for each polarization lead to a total collection time for each sample of about 6 hours (10 seconds per point) and in a signal-to-noise ratio on the difference curve of better than 100.

In Fig. 1(a), we show the total absorption, the sum of spectra taken with the two polarizations of the light, and the difference between these two spectra, for the L_3 and L_2 edges of Pd in the Pal/Fe multilayer with 3.9 Å of Pd. The difference curve is corrected for the incomplete polarization of the X-rays and the projection of the magnetization direction on the light propagation direction. The correctness of the magnitude of the XMCD signals was checked by reversing the direction of magnetization.

The spectra were analyzed using the sum rules of Thole and Carra [1,2]. A non–negligeable orbital moment (0.04 μ_B) is found only for the smallest Pd interlayer thickness. This is in contrast with the strong

increase of the Co orbital moment in Pal/Co multilayer observed by Wu et al. [3]. Apparently, the Pd moments do not contribute directly to the in-plane anisotropy observed in our samples [4].

The average Pd moments calculated for different Pd interlayer thicknesses can be combined to get the average moment per Pd layer as a function of the distance to the interface. The result is reported in Figure 1(b), showing that the interface atoms are strongly polarized, but that atoms at a distance of more than 6 layers from the interface do not carry any magnetic moment (or, eventually, that their magnetic moments cancel). This result is in good agreement with calculations presented by Fullerton *et al.* [5].

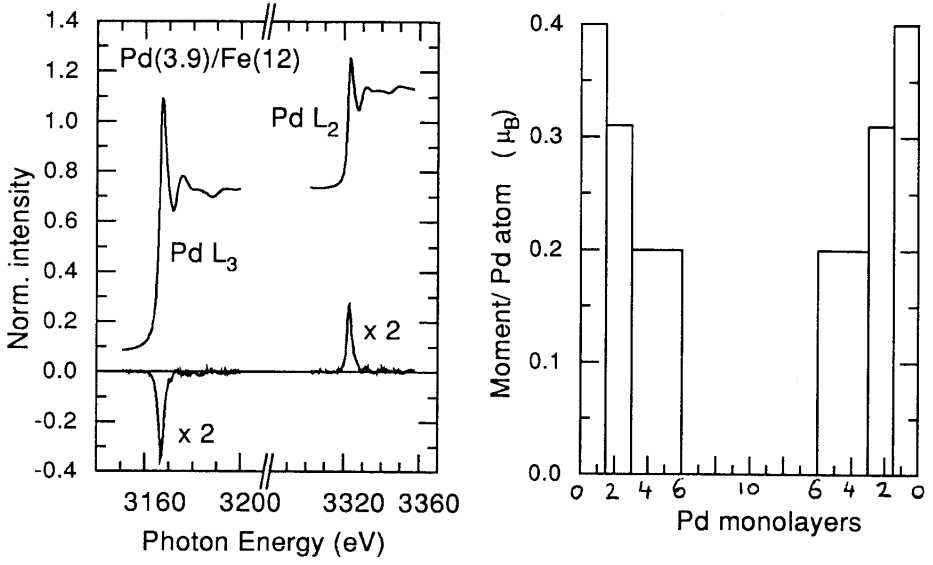

FIG. 1. (a) $L_{2,3}$ absorption edges of Pd in a Pd(3.89 Å)/Fe(12 Å) multilayer. Top: total absorption (sum of spectra taken with left and right circularly polarized light). Bottom: difference (or dichroism) curve. (b) Pd magnetic moments as a function of the dist ante to the Pal/Fe interface.

The high quality of the data, which could be obtained by the new concept of the BL6 beamline and the high brilliance of the ESRF storage ring, has allowed us to obtain additional information about the *atomic and electronic* structure of Pd from the spectra. The hybridization of the Pd 4d states with the Fe 3 d band leads to a small increase in the number of $4d$ electrons and to a narrowing of the Pd band $4d$ band.

The spectral features after the L_3 and L_2 white lines indicate that for thinnest interlayers the Pd atoms have a local structure which is different from fee, most likely a fct or bet structure imposed by the epitaxial growth on Fe.

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