ESRF	Experiment title: Dependence of the magnetism of $Fe_{1-x}Pd_x$ alloys on structural properties : chemical order/disorder, strain and concentration	**Experiment number:** HE219
Beamline: ID12A	**Date of experiment:** from: 03/09/97 to: 11/09/97	**Date of report:** 08/10/97
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Names and affiliations of applicants (* indicates experimentalists):

P. Kamp DRFMC/SP2M/IRS, CEA-Grenoble and H.Heine-Univ. Düsseldorf
M. Belakhovsky DRFMC/SP2M/IRS, CEA-Grenoble
C. Boeglin IPCMS/GSI, Strasbourg
A. Rogalev ESRF

Preliminary report:

Trying to improve our previous results from experiment HE13. we have measured the L_2 and L_3 edges of Palladium in several Fe_xPd_{1-x} epitaxial alloys, some of which presenting perpendicular magnetic anisotropy [1]. The first experiment showed that dichroism varied with the order parameter of the samples but that some uncertainty was introduced due to the use of Pd capping on the FePd alloy layers. Here a new series of 7 equiatomic samples had been elaborated by MBE, capped with aluminum at substrate temperatures such as to produce clearly different order parameters (cf table I. col. 1 and 2). In addition, FePd samples of different concentrations x, also with Al capping, had also been prepared as well as equiatomic CoPd samples.

The samples were inserted one at a time in an ESRF cryomagnet aligned to the X-ray beam such that the magnetic field was parallel to the beam. Being ferromagnetic well above room temperature, they could have been kept at room temperature (in practice at 150K). The samples were mounted on special sample holders. that oriented the sample normal either at 30 or 60 degrees to the X-ray beam. The magnetic field was 3T, enough to saturate every sample in both geometries. The fluorescence emission was detected using a Si diode inside the cryomagnet, located in the horizontal plane, perpendicularly to the X-ray beam from the sample location. The scans were performed on about 60 eV around each edge with 0.2 eV steps. The step heights at the L_2 and L_3 edges were normalized 1 : 2. The dichroic spectra were taken by switching the direction of the field, since we had some doubts about the reproducibility while changing the phase, later on we found out a reason for that was some instabilities in the electron beam (cf trouble section below).

Ihe data were corrected for the different polarisations at the L_2 and L_3 edges, around 21% and 12% respectively (Si_{111} rnonochromator). The spectra arc of excellent quality and reproducibility, and show a clear variation of the magnetic moments with the order parameter (cf table 1).

surface normal 30" *to beam*

deposition temperature (°C)	long range order S	effective spin Moment M_s/μ_B	orbital Moment M_l/μ_B
20	0.0	0.5 1	0,013
220	0,71	0.65	0,026
350	0,88	0.62	0,050
510	0.60	0.68	0,025
	surface normal 60" *to beam*		
deposition temperature ("C)	long range order S	effective spin Moment M, $/\mu_B$	orbital Moment M_l/μ_B
20	0,0	0.57	0,035
220	0.7 1	0.58	0,039
350	0.88	0.59	0,039
510	0.60	0.58	0,035

Table 1: Magnetic moments per atom in μ_B after correction for the degree of circular polarization

We observe large magnetic spin moments, as well as sizeable orbital moments, up to 8 % of the M_s for ordered samples. The results show clearly that at 60°, i.e. near the magic angle of 54.7' for which the spin dipole $T_\perp$ and anisotropic orbital moment $L_\perp$ do not contribute. the spin and orbit moments of differently ordered samples are almost the same. Whereas at 30" these quantities do contribute and the effect is clearly seen on table 1. This is a key result, that we already suspected from our previous experiment, and one of the very first clear demonstration such an effect. It effectively opens the way for the microscopic understanding of the magnetocrystalline anisotropy. From these results it is evident that ESRF-ID12A is the adapted tool to monitor such subtle differences, which lead to big changes in the macroscopic properties : from in plane easy axis of magnetization for the 20°C sample to out of plane easy axis for the high temperature samples. The next proposal (HE-335) should even go further using the transverse geometry as proposed in [2]

Trouble section : **In view of these really nice results. it was frustrating that only half of our very carefully and original samples have been measured, and this is in exact correspondence with the fact that only half the time has been available for** effective measurements. The remaining **unusable time is in turn half due to the beamline and half to the machine, the main causes being on the beamline side : failures of the cryomagnet power supply and of the computer system on the machine side : electron beam unstabilities (ascribed by the machine Head to temperature changes in SRTU). For comparison. we recall that in our previous experiment on ID12A wc were able to measure in 4 days, also in 2 geometries , 8 samples. the double of what we did this time..**

Références

1. Magnetic domains in epitaxial ordered FePd (001) thin films with perpendicular anisotropy, V. Gehanno et al., Phys. Rev. B 55 (1997) 12552
2. Magnetic circular X-ray dichroism in transverse geometry : a new tool to study the magnetocrystalline anisotropy. H.A. Dürr and G. Van der Laan, J. Appl. Phys. 81 (1997) 5355