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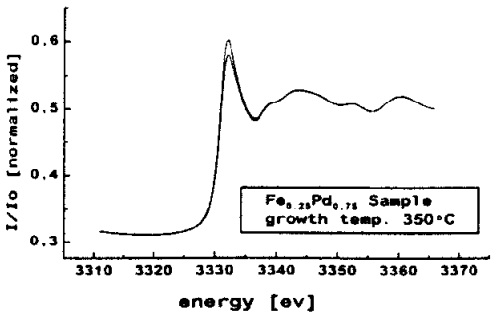
Report:

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 [I]. Since this property depends on the chemical order , we wanted here to see whether the XMCD was sensitive to it.

The alloys have been prepared by MBE: the Fe and Pd atoms have been codeposited at various substrate temperatures: 420°C 350°C 300°C and 20°C for x=50, 350°C and 20°C for x=25, and 20°C for the x=75. 6 bulks samples (x=5 to 50%) could not be measured because of lack of time.

In addition to general considerations showing that the fluorescence yield in case of Pd $L_{2,3}$ is adequate to measure XMCD [2], the FePd films are thin enough for assuming with good accuracy the proportionality of the fluorescence yield to the absorption coefficient. The samples were inserted one at a time in an ESRF cryomagnet aligned to the X-ray beam such as 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). Each sample was vertical and rotated by 30 and 60degrees to the X-ray beam. The magnetic field was 4 T, enough to saturate every sample 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 edge were normalized l : 2, this was confirmed by a long scan including both edges within I %.

The dichroic spectra were taken by changing the polarization of the light as well as the direction of the field, both methods giving the same results. The spectra were corrected for the different polarizations at the L_2 and L_3 edge. around 21% and 12% respectively. A typical scan sequence of H-field inversion (+--+) is given in fig. I a, showing the reproducibility of the spectra. Fig I b shows the dichroic peaks for the L_2 edge.



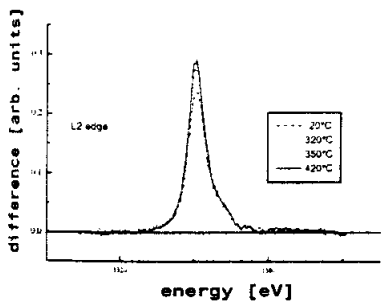


Fig. la : normalized spectra with +--+H

Fig. lb : dichroic signals for L_2 edges on x=0.5 samples

By comparing the 3 concentrations x=25, 50, 75 in the γ disordered phase , the dichroic signal increases as expected, in agreement with the corresponding XMCD calculations for disordered alloys [3].

We would like to emphasize one major aspect : we have found for each of the two cases studied, x=50 and x=25, a significant variation of the XMCD signal as a function of growth temperature. This means that the XMCD is sensitive to the variations of the local chemical order. This is to our knowledge the first time that such relation has been clearly demonstrated. This result is apparent on fig.lb and in table 1.

T_{depot} °C	M_L/μ_B	M_S/μ_B (+7/2 T_z)	L_3/L_2
20	0,000	0,48	2,17
320	0.050	0,57	2,19
350	0,061	0,58	2,11
420	0,013	0,54	2,07

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 orbital moments up to IO % of the M_s for ordered samples. When growing the sample at temperatures too near to the order-disorder transition. the short range order decreases, which has the effect of decreasing spin and orbital moments.

From these results it is evident that ESRF is a fine tool to monitor such subtle differences. which lead to big changes in the macroscopic properties, in plane easy axis of magnetization for the 20°C sample and out of plane easy axis for the high temperature samples.

References

1. V. Gehanno et al., Magnetic domains in epitaxial ordered FePd (001) thin films with perpendicular anisotropy, to be published in Phys. Rev. B

2. J. Vogel et al., Structure and magnetism of Pd in Pd/Fe multilayers studied by XMCD at the Pd $L_{2,3}$ edges. Phys. Rev. B 55 (1997) 3663

3. H. Ebert. private communication