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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Effect of the milling-induced lattice expansion in the magnetic properties of FeAl	**Experiment number**: HE-1512
Beamline: ID-24	**Date of experiment**: from: 18-06-03 to: 24-06-03	**Date of report**: 18-08-03
Shifts: 18	**Local contact(s)**: Olivier Mathon	*Received at ESRF:*

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Report:

The X-ray Magnetic Circular Dichroism (XMCD) of Fe-40Al at.% ball milled powders, was studied at the Fe K-edge, as a function of pressure, from 0 to 12 GPa.

The as-milled powders had been previously structurally and magnetically characterized by means of X-ray diffraction (XRD) and vibrating sample magnetometry (VSM) at ambient pressure. From a structural point of view, the as-milled powders had been found to be atomically disordered and to exhibit a 0.8 % lattice expansion, with respect to unmilled powders. From a magnetic point of view, although unmilled Fe-40Al at.% powders are paramagnetic, the milled powders show a strong magnetization (M_S = 75 emu/g). This magnetim was attributed to both the milling induced structural disorder and cell expansion [1]. The goal of this experiment was thus to separate the two contributions (disorder and lattice expansion) to the magnetism of Fe-Al alloys.

High-pressure XMCD experiments were performed using a high-pressure diamond anvil cell, CuBe DAC, provided by Dr. F. Baudelet from Laboratoire de Physique des Milieux Condense Paris 6. Since XMCD spectra were taken for the first time on powdered samples (usually this type of experiment is performed on foils with a constant thickness instead of powders), several hours were required in order to mount the complete experimental setup and to obtain a very small and stable focused beam on the sample. For each pressure, in order to normalize the XMCD signal, the absorption spectra were recorded simultaneously to the XMCD spectra. Further, in order to improve the signal-to-noise ratio a large number of spectra, taken using both polarities of the incident beam, were averaged. The XMCD were then taken at different applied presures. Typical absorption and XMCD curves are shown in Figure 1. As can be seen in the figure, in spite of the, a priori, difficulty of the experiment, the results were very successful. Actually, our results show, for the first time, that XMCD spectra can be recorded at the Fe K-edge on magnetic powders subjected to high pressures.

As can been seen in Fig. 2, as the pressure is increased the area of the XMCD spectra decreases. This

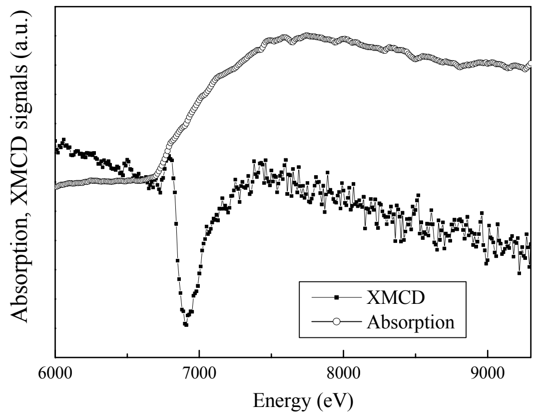

Figure 1: Absorption and XMCD spectra, recorded at room temperature, at the Fe K-edge, of Fe40Al at.% as-milled powders, subjected at a pressure p = 6 GPa.

area reduction is more clearly seen in Fig. 3, where the overall area enclosed by the XMCD peaks is plotted as a function of the applied pressure for two different runs. As can be seen in the figure, a reduction of the XMCD intensity is observed, progressively, for pressures between 2 and 6 GPa and the integrated signal tends to level off for larger pressures. This implies a reduction of the magnetic moment of the sample as the pressure is increased. Since the quasi-hydrostatic strong pressure probably causes a reduction of the cell parameter of the sample, this implies that the milling induced lattice expansion indeed contributes to the magnetism of these alloys. Actually, it can be infered from the results that the lattice expansion contributes 35% to the magnetic moment of Fe-40Al at. %. Assuming that the main effect of the pressure was only to reduce the lattice parameter, disorder should be the main contribution to the magnetism in ball milled Fe-Al alloys as proposed theoretically [2].

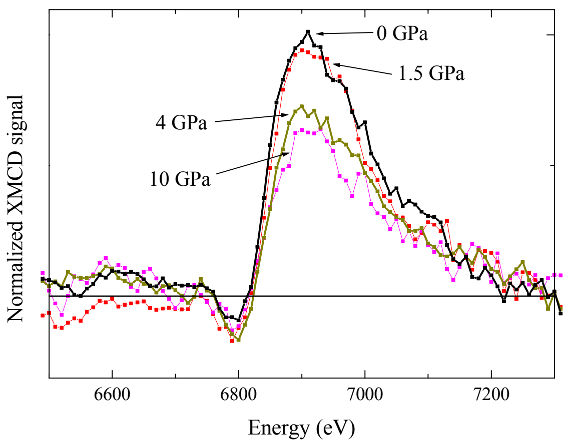

Figure 2: Normalized XMCD signals, recorded at room of temperature at the Fe K-edge, of Fe40Al at.%as-milled powders, subjected at different pressures from 0 to 10 GPa.

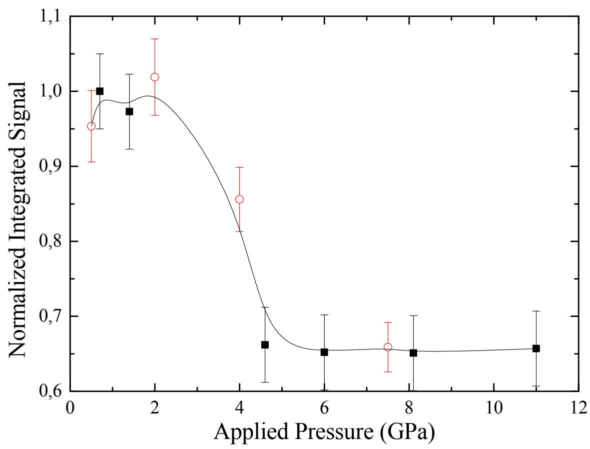

Figure 3: Dependence of the normalized integrated XMCD signal Fe40Al at. % as-milled powders on the applied pressure.

Nevertheless, despite the novelty of our results, further studies are necessary to fully understand the effects. First, it is necessary to study the structural changes occurring under pressure on this alloy, to make sure that the main effect of the pressure is inded to to reduce the lattice parameter and, for example, to disregard any pressure-induced phase transformation. Moreover, the study of other ball milled Fe_xA_{l-x} should confirm the role to the lattice expansion in the magnetism of Fe-Al alloys, especially taking into account that it has been theoretically prerdicted that the role of the lattice parameter becomes more important for larger Fe contents [2].

[1] X. Amils et al. IEEE Trans. Magn. **34** (1998) 1129; X. Amils, et al., Phys. Rev. B **63** (2001) 52402.
[2] E. Apiñaniz et al., J. Magn. Magn. Mater. (2003) in press.