EUROPEAN SYNCHROTRON RADIATION FACILITY

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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:** **Magnetic configuration in exchange coupled $DyFe_2/YFe_2$ superlattices**	**Experiment number**: HE-1995
Beamline: ID12	**Date of experiment**: from: 15/02/06 to: 21/02/06	**Date of report**: 01/09/06
Shifts: 18	**Local contact(s)**: Andreï ROGALEV	*Received at ESRF:*
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Report:

[$DyFe_2/YFe_2$] superlattices are single crystalline model systems for the study of magnetic springs, exchange bias effects and interface exchange coupling phenomena. $DyFe_2$ is a hard ferrimagnet while YFe_2 is a soft one. The ferromagnetic coupling between iron magnetic moments in both compounds results in an antiparallel coupling between the net magnetization of $DyFe_2$ and YFe_2.

Previous XMCD experiments (at the Dy and Y L_3 edges) have been performed with the external magnetic field applied *parallel* to the incident photon beam, to measure separately the $DyFe_2$ and YFe_2 magnetic contributions along the field direction. They have shown an interesting magnetization reversal process, where the magnetization reverses first in the hard $DyFe_2$ layers. Moreover, for superlattices with thin $DyFe_2$ layers (in the 3nm range), the magnetic configurations that are stabilized under field still remain unclear:

(i) At 200K and under a strong applied field of ±7T, the XMCD signal measured at the Dy L_3 edge is almost zero, which reveals no net $DyFe_2$ magnetization along the field.

(ii) At 12K, the XMCD signal measured at the Dy L_3 edge does not depend on the external field, which reveals a frozen $DyFe_2$ magnetic configuration in the –7T/+7T field range. This XMCD signal strongly depends on the cooling field, which reveals the influence of the cooling process on the frozen magnetic configuration. As observed at 200K, the signal is also close to zero for a ±7T cooling field (report HE 1449).

The aim of the present experiment was to bring further insight into these magnetic configurations with no net $DyFe_2$ magnetization along the field, and to the various configurations frozen at low temperature. The main idea was to investigate the **transverse** component of the magnetization, i.e. the component perpendicular to the applied field. XMCD measurements were performed at the Dy L_3 edge with a new experimental set up recently installed on the ID12 beamline that permits a 0° and 90° orientation of the external field with respect to the direction of incoming X-rays.

A typical normalized XMCD spectrum obtained in this transverse geometry is shown in figure 1, together with the corresponding normalized absorption spectra (The XMCD signal is the average of four measurements with 1 second counting time per energy value). The XMCD signal is the signature of a component of the magnetization, perpendicular to the applied magnetic field.

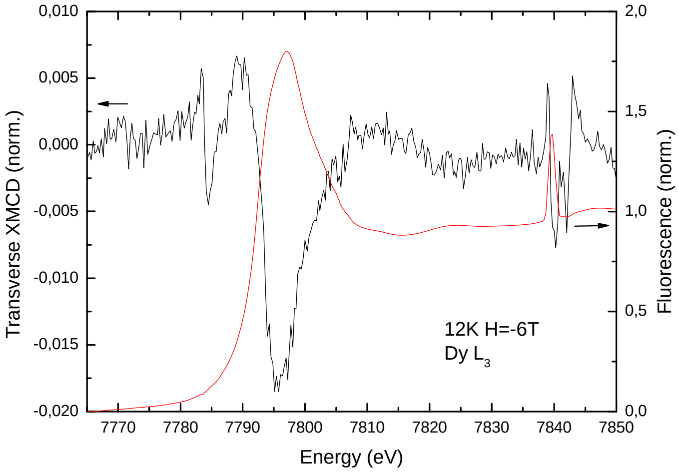

Figure 1: Normalized transverse XMCD signal and normalized fluorescence for the DyFe$_2$(3nm)/YFe$_2$(13nm) superlattice measured across the Dy L_3 edge at 12K under a –6T field.

Hysteresis loops for the *transverse component* of magnetization have been measured for the superlattice DyFe$_2$(3nm)/YFe$_2$(13nm). The hysteresis loops measured at 200K, both in the transverse and longitudinal (previous exp) configurations, are presented in figure 2. The transverse component depends on the field and especially, it reaches its maximum value for large values of the magnetic field (+6T and –6T), when the longitudinal component is close to zero. The magnetization thus exhibits a net component perpendicular to the magnetic field.

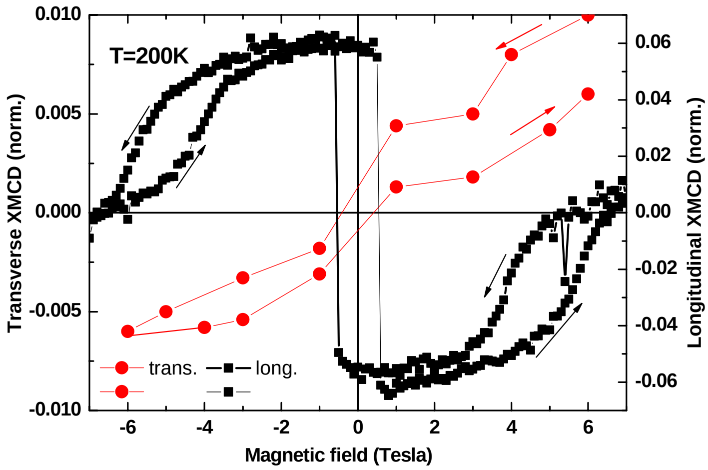

Figure 2: Hysteresis loops measured for the DyFe$_2$(3nm)/YFe$_2$(13nm) superlattice at 200K both in the longitudinal and in the transverse configuration

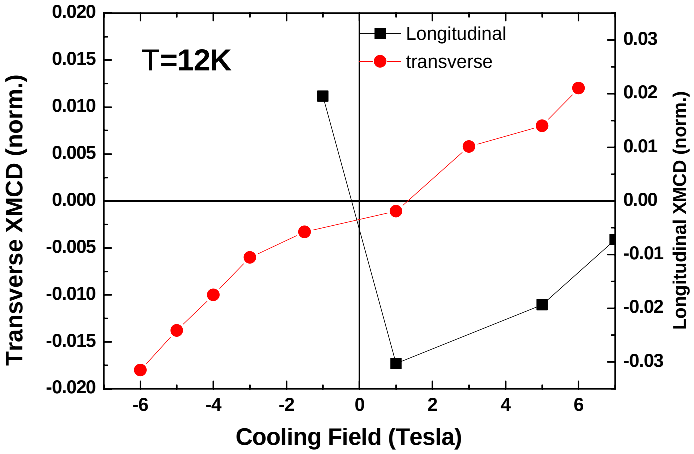

Figure 3: Transverse and longitudinal XMCD signals as a fonction of the cooling field, measured at 12K for a DyFe$_2$(3nm)/YFe$_2$(13nm) superlattice.

The influence of the “cooling” field” has been also investigated at 12K. The transverse component is shown together with the longitudinal one (previous exp) in figure 3. The transverse component appears to decrease continuously with the cooling field and, as expected, its value is maximum when the longitudinal component is minimum.

These experiments have shown that it is possible to measure and investigate the field dependence of the transverse component.

The experimental conditions have now to be improved, to increase the signal to background ratio and the counting rate, so that a complete study may be undertaken.