EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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:** The Interfacial Domain Wall in Exchange-Bias Layer Systems	**Experiment number**: HE-1927
Beamline: ID22	**Date of experiment**: from: july 20th 05 to: july 26th 05	**Date of report**:
Shifts: 15	**Local contact(s)**: R Rüffer	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Stéphane Mangin, Laboratoire de Physique des Matériaux (Nancy)

Jean Juraszek, Groupe de Physique des Materiaux (Rouen)

Thomas Hauet, Laboratoire de Physique des Matériaux (Nancy)

François Montaigne, Laboratoire de Physique des Matériaux (Nancy)

Thomas Diederich, Hasylab at DESY (Hamburg)

Ralf Roehlsberger, Hasylab at DESY(Hamburg)

Report:

HE1927 experiment was devoted to the study of the evolution of magnetic configurations at the interface of an anti-ferromagnetically exchange coupled bilayer which exibits both positive and negative exchange bias depending on the cooling field [1]. The isotopic sensitivity of the Nuclear Resonant Scattering to ^{57}Fe has been used to probe only the interfacial magnetization of the hard TbFe layer. The experiment has been conducted in July 2005 at ID22 using a Glass/$Tb_{12}Fe_{88}$ (15 nm)/**$Tb_{12}{}^{57}Fe_{88}$ (10 nm)**/$Gd_{40}Fe_{60}$ (50 nm)/Al (5 nm) sample.

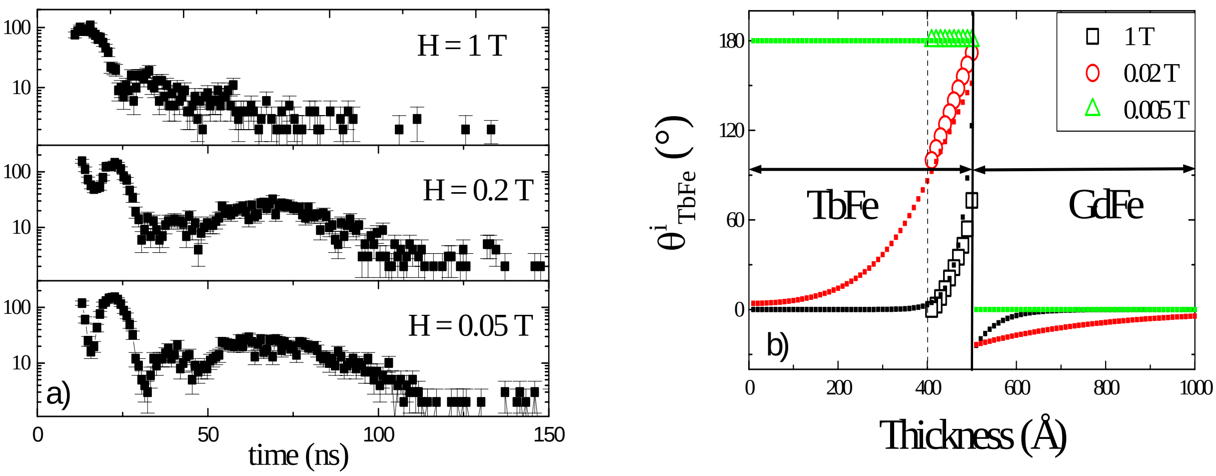

Figure 1. a) NRS intensity versus time obtained at room temperature on Glass/$Tb_{12}Fe_{88}$ (15 nm)/$Tb_{12}{}^{57}Fe_{88}$ (10 nm)/$Gd_{40}Fe_{60}$ (50 nm)/Al (5 nm) for different applied fields (H= 1 T, 0.2 T and 0.05 T). b) Magnetic profiles used to simulate the 295 K NRS spectra (symbol) and micromagnetic simulations (dashed line)

First, NRS was measured at room temperature for different applied magnetic fields. Those data are presented on figure1a and could be very well fitted. The two major parameters for simulating such NRS curves are the hyperfine field distribution inside the $Tb^{57}Fe$ and the orientation of the $Tb^{57}Fe$ layer's magnetization. The hyperfine field distribution chosen for the preliminary fits are close to the results found in literature but we will soon have the exact ones thanks to conventional Mössbauer measurements (CEMS). In figure 1b, we compare the magnetic configurations used in our actual best fits and the one obtained from a micromagnetic simulation. This micromagnetic calculation is performed supposing a spin chain and taking into account the exchange interaction between neighbour spins, the magnetocrystaline anisotropy and the effect of the applied field. The very good agreement between the two magnetic configurations confirm the presence of an interface DW mainly in the TbFe layer.
The next step was to correlate the magnetic configuration inside the TbFe and the exchange bias phenomena (Exchange bias field, Coercive field, Training effect) observed at low temperature (T=5K). We then cooled down the sample from 300K to 5K under different fields cooling field (H_{cf}) and, for each H_{cf}, measurements were done along the GdFe reversing minor loops between 200 Oe and -200 Oe, several loops were performed. The NRS measurements clearly showed "reversible" and "irreversible" changes in the TbFe during the GdFe magnetization reverses. The so call "irreversible" changes are evidence by the difference observed on two consecutive NRS spectra recorded at 200 Oe (one obtained just after the sample cooling and one after the first hysteresis loop 200 Oe -> -200 Oe -> 200 Oe). Such variation are at the origin of the training effects (evolution of the hysteresis loop depending on the number of cycle). After two to three hysteresis loops this effect is no more visible. However variation in the TbFe configuration while the field is swept from 200 Oe to -200 Oe is still detectable which characterised the so call "reversible" changes. This effect is at the origin of the coercivity observed in the sample. Those results show that our first hypothesis [1] of a perfectly frozen TbFe after the temperature cooling is not totally valid and that changes at the TbFe interface cause training effect and evolution in the coercivity. Effort are devoted to the spectra fitting and to the study of the results obtained at different temperatures. Those last results should give information on the role of thermal activation.

[1] S. Mangin, F. Montaigne and A. Schuhl, *Phys. Rev. B* 68, 140404(R) (2003)