EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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:** Determination of Eu electronic state in Eu-doped rare-earth intermetallics	**Experiment number**: HE-958
Beamline: BM29	**Date of experiment**: from: 20-09-2000 to: 22-09-2000	**Date of report**: 13-02-2001
Shifts: 6 6	**Local contact(s)**: Gloria Subias	*Received at ESRF:*

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Report:

The ternary compound $Nd_2Fe_{14}B$ has properties superior in many respects to those of $SmCo_5$, that coupled to the economic advantages over the earlier Sm-Co materials, have led to an intensive study of iron-rich ternary compounds based on rare earths. The range of temperature in which these new alloys are of technological significance is, however, strongly limited because ordering temperatures are low enough to render them unsuitable for some applications. In particular, $Nd_2Fe_{14}B$ exhibits a spin reorientation transition (SRT) at about T=150 K that destroys the uniaxial anisotropy.

In the past, several attempts to change the magnetocrystalline anisotropy of $Nd_2Fe_{14}B$ have been made as partial substitution of Nd by other magnetic rare-earth or by non-magnetic (Y,La,Lu) rare-earths species. However, the results are nor satisfactory: in the first case the whole magnetic diagram is changed while in the second one the SRT temperature decreases as increasing the dilution but the uniaxial anisotropy is also strongly depressed.

A promising result has been found starting from a new route of modifying the intrinsic magnetic anisotropy of $Nd_2Fe_{14}B$ by the partial substitution of Nd by Eu. The magnetic ordering temperature, Tc, has been found to increase while the total magnetization decreases upon substitution. Moreover, it was expected the depletion of the spin reorientation temperature as Eu content increases. However, the contrary behavior has been found. This results points out the peculiarity of Eu electronic state. Whereas Eu^{3+} has zero J as the non-magnetic rare-earths, L and S are large enough as to be susceptible to contribute to the uniaxial anisotropy as Nd.

However, the fist task to solve was to determine the exact electronic state of Eu in these new systems. To this end we have performed an x-ray absorption experiment at the Eu $L_{2,3}$-edges at the experimental station BM29. In addition we have recorded also the XAS spectra at the Fe K-edge and at the Nd L_3 absorption edges.

The determination of the electronic state of Eu has been made by direct comparison of the absorption of the Eu-doped $Nd_2Fe_{14}B$ samples to those of EuF_2 and EuF_3, i.e. Eu^{2+} and Eu^{3+} respectively. In the case of Eu^{2+} a typical double-peak edge is present while only one appears for Eu^{3+} with a chemical shift of about 8 eV. Our results indicate that the electronic state of Eu is trivalent in the systems under investigation (Fig. 1, left panel).

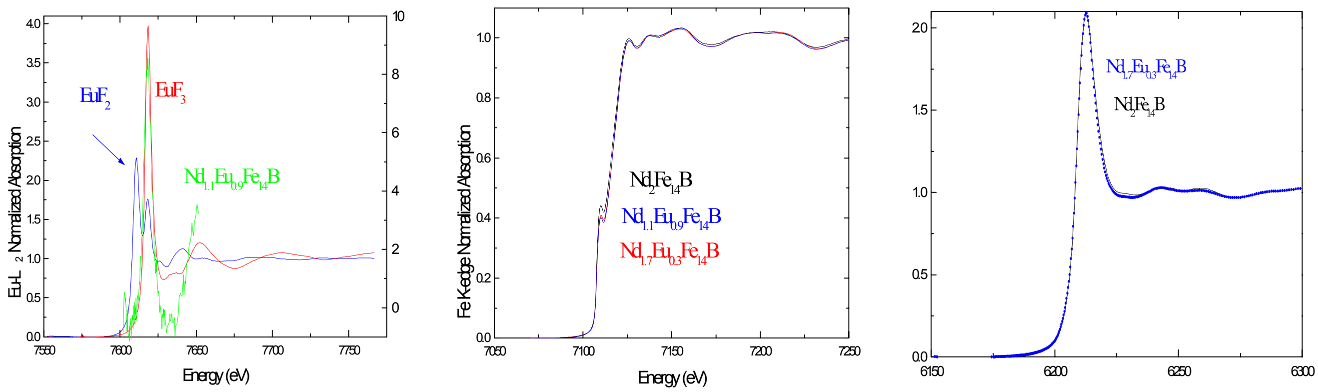

Figure 1. Eu L_2 (left panel), Fe K-edge (center) and Nd L_3 (right) absorption spectra in several Eu-doped $Nd_2Fe_{14}B$ samples.

In addition our results shown that while Eu substitution gives rise to the strong modification of the Fe K-edge no modification of the Nd L edge is detected. This indicates that Eu doping increases the magnetic ordering temperature of $Nd_2Fe_{14}B$ without to destroy the uniaxial anisotropy of the system. This result shows this new route of improving the technological performances of $Nd_2Fe_{14}B$ as a very promising one.