ESRF	**Experiment title:** **XMCD study of the Dynamics of the Spin Reorientation Transitions in $R_2Fe_{14}B$ systems**	**Experiment number:** HC-543
Beamline: ID12A	Date of experiment 2-Apr-96 to: 9-Apr-96	**Date of report:** 24-Feb-97
Shifts: 21	Local contact(s): **Andrei** Rogalev and Jose Goulon	*Received at ESRF:* 4 MAR.1997

Names and affiliations of applicants (* indicates experimentalists):

Chaboy Nalda, Jesùs
* Bartolomé Usieto, Fernando
* Garcia Vinuesa, Luis Miguel

Instituto de Ciencia de Materiales de Aragón, ICMA-CSIC,Universidad de Zaragoza (SPAIN)

* G. Cibin
* A. Marcelli
Laboratori Nazionali di Frascati, 00044 Frascati, Italy

Report:

The X-Ray Circular Magnetic Dichroism (XMCD) technique appears to be a unique probe to study the magnetism of complex alloys allowing direct measurement of the spin-dependent absorption cross section on a given atomic specie in a material with net magnetization [I]. However. despite of the growing interest motivated by the results obtained in the last few years by XMCD, to date there is no published report about the feasibility to study magnetic phase transitions, other than the fcrro(i)magnetic ordering transition, with such technique at the Fe K-edge.

The $R_2Fe_{14}B$ tetragonal compounds (R=Nd, Ho, Er. Tm and Yb) are known to undergo changes in the oricntation of the easy axis magnetisation diition (EMD). As the temperature is lowered, the magnetic structure with the EMD parallel to the c-axis, gives way to different structures: in $Er_2Fe_{14}B$, $Tm_2Fe_{14}B$ and $Yb_2Fe_{14}B$ the EMD becomes abruptly parallel to the a-axis, whereas in $Nd_2Fe_{14}B$ and $Ho_2Fe_{14}B$ the EMD tilts from the c-axis towards the [110] direction by an angle θ_t which varies continuously with temperature [2]. Such transformation is called Spin Reorientation Transition (SRT) and for each compound it occurs at a specific transition temperature TS. Although the behavior of the bulk magnetisation has been well determined in these compounds, the evolution of the magnetic moments on the microscopic scale is fess understood, specially in the case of $Nd_2Fe_{14}B$ where in the low-temperature phase the R and Fe moments can be considerably non-collinear. Although the $R_2Fe_{14}B$ compounds have been thoroughly studied by many experimental techniques [3-5], no general agreement on the mutual orientation of the R and Fe moments has been reached so far.

The XMCD signal, related to the projection of the magnetic moment on the direction of the x-ray beam, has been measured as a function of temperature at the Fe K-edge and at the Nd $L_{2,3}$-edges in the case of $Nd_2Fe_{14}B$ (continuous tilt of the magnetisation from the c-axis). The XMCD spectra obtained at both the Fe K-edge and at the Nd $L_{2,3}$-edge in the $Nd_2Fe_{14}B$ compound as a function of temperature are shown in Fig. 1

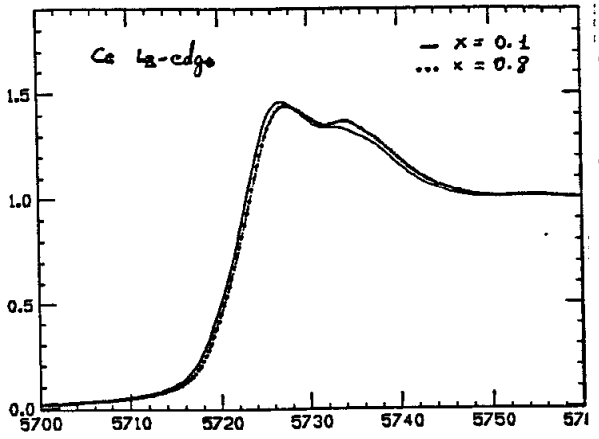

Fig. 1

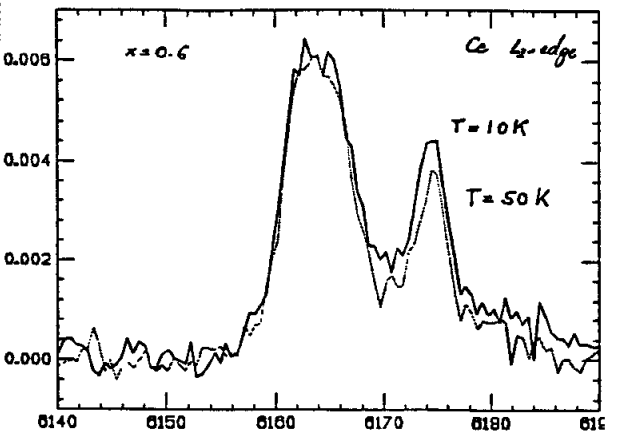

Fig 2

In addition to the Ce $L_{2,3}$ edges, we have carried out the measurement of the cerium L_1 -edge and Fe K-edge XAS spectra With these experiments we have tried to determine the existence of modification of the local and partial density of states around the Fermi energy induced by the Fe substitution.

The analysis of the Fe K-edge and cerium L_1 -edge XANES spectra shows the existence of strong electronic effects induced upon Fe substitution in the near edge region, addressing the modification of the magnetic properties of the series to the weakening of the hybridization between the R 5d- and the Fe 3d-states.

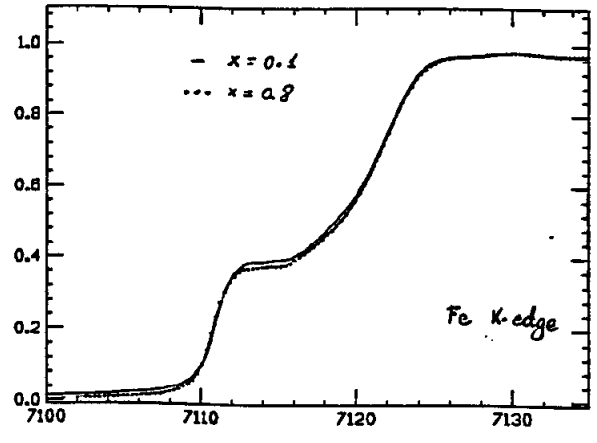

Fig. 3

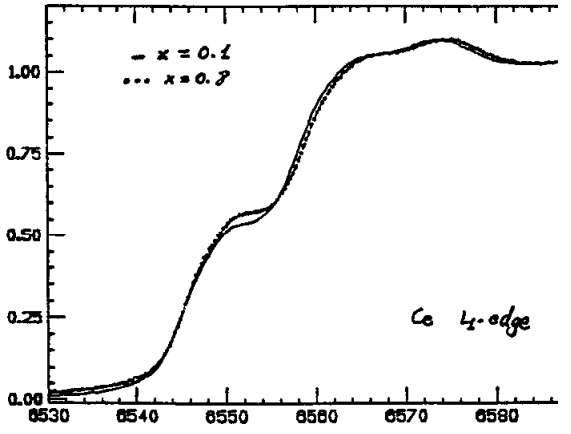

Fig. 4

The results of the present investigation are in agreement with electronic-structure calculations, showing direct details of the reduction of the fd hybridization induced by cobalt substitution. The electronic and structural modifications are not enough to determine the localization of the Ce 4f states and the subsequent turn up of a 4f magnetic moment at the Ce sites, as also clearly demonstrated by x-ray magnetic circular dichroism experiments performed at the same absorption edges. The combined interpretation of unpolarized (XAS) and polarized (XCMD) absorption data support also the hypothesis that the anomalous strong cell expansion of the Ce-based compounds is linked to the sensitivity of Ce to the hybridization between the 4f and 5d states, directly related to the reduction of the Ce(5d)-Fe(3d) overlapping.