Experimental Report

Proposal: **7-01-377** **Council:** 10/2012

Title: Phonon Dynamics and Volume Magneto-Striction in Magneto-Caloric Intermetallics Re2Fe17 (R=Y, Pr, Nd, Er and Tb)

This proposal is a new proposal

Researh Area: Physics

Main proposer: **BLANCO RODRIGUEZ Jesus Angel**

Experimental Team: GORRIA Pedro
BLANCO RODRIGUEZ Jesus Angel
ZBIRI Mohamed

Local Contact: ZBIRI Mohamed

Samples: R2Fe17 (R=Y, Pr, Nd, Er and Tb)

Instrument	Req. Days	All. Days	From	To
IN4	5	5	01/06/2013	06/06/2013

Abstract:

In intermetallic alloys Re2Fe17 containing light lanthanides, it has been clearly established a close link between the MCE effect, the magneto-volume anomalies and the temperature dependence of the Fe magnetic moment, through combining magnetization measurements and neutron diffraction experiments. In order to get information in R2Fe17 powdered samples on the magnetoelastic coupling it will be necessary to investigate the phonon excitations in the paramagnetic phase averaged within the Brillouin zone. The temperature dependence of these excitations as well as the effect of the Rare Earth (contraction and exchange field strength) will provide deeper insights into the underlying magneto-structural mechanisms characterizing these intermetallics.

EXPERIMENTAL REPORT: IN4-7-01-377

Phonon dynamics and volume magnetostriction in magnetocaloric intermetallics R_2Fe_{17} (R=Y, Pr and Nd)

The aim of the present experiment was to investigate the close link between the magnetocaloric effect, the magneto-volume anomalies (in particular the Invar character of these materials) and the temperature dependence of the Fe magnetic moment in intermetallic alloys R_2Fe_{17} [1-5]. In order to get a deeper insight on the interactions governing these properties in this system, it was necessary to determine the phonon excitations in the paramagnetic phase averaged within the Brillouin zone. The temperature dependence of these excitations as well as the effect of the Rare Earth (contraction and exchange field strength) could provide information about the underlying magneto-structural mechanisms characterizing these materials.

In this experiment, the five days of neutron beam time allocated on IN4 have been used to study the binary R_2Fe_{17} intermetallics with light rare earth metals (R = Y, Pr and Nd). Inelastic neutron scattering measurements (INS) were performed using two neutron wavelengths (1.2 and 2.4 Å) and collecting data at selected temperatures above and below their respective Curie temperatures, T_C (all of R_2Fe_{17} investigated have T_C around room temperature, then the spectra were recorded at 500 K, 350 K, 200 K, and 50 K). The INS spectra recorded at 500 K with λ = 1.2 Å for Y_2Fe_{17} and Nd_2Fe_{17} are shown in the figure below. The data of the Y-based compound were used as a measure of the pure phonon scattering; the fact that the energy spectra of the two compounds at large momentum transfer (where the magnetic signal is expected to be negligible) are the same above 20 meV is a proof that the phononic scattering is well accounted for. However, the slight differences found at energies below 20 meV could be due to Crystal Field excitations. The study of the spectra collected at both paramagnetic and magnetically ordered regimes are now still under progress. In particular, the estimation of the density of states is of paramount importance to understand the role of the phonon-magnon coupling for explaining the Invar character of these materials.

It was worth noting that starting over the weekend was a serious drawback because the temperature control of the NOMAD was not appropriately initialized after changing the cryostat used in the previous experiment. For this reason we spent a lot of time during Saturday 01/06 and Sunday 02/06 trying to rich the selected measurement temperatures between 500 K and 50 K for each spectra. Finally, on Monday 03/06 morning, the technical staff was able to fix the problem (the control parameters of the cold valve and the corresponding heating power where out-of-range for the interval temperature used during the experiment).

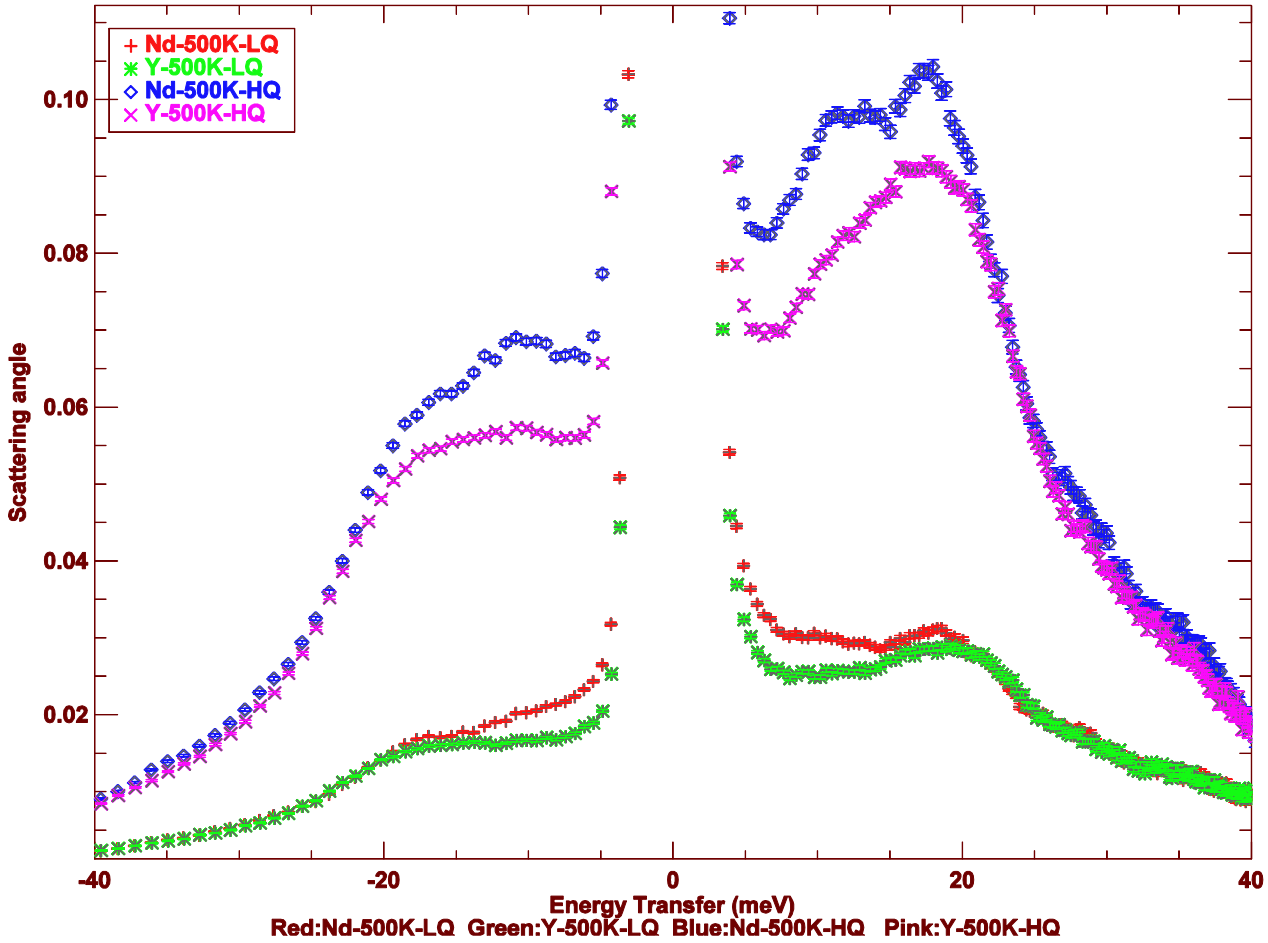

Figure 1. INS spectra for Y_2Fe_{17} and Nd_2Fe_{17} collected at 500 K for high- and low-momentum transfer Q with 1.2 Å.

References

[1] D. Givord, R. Lemaire, IEEE Transactions on magnetics, MAG-10, 2 (1974) 109.

[2] K. Mandal, A. Yan, P. Kerschl, A. Handstein, O. Gutfleisch, K.-H. Müller, J. Phys. D: Appl. Phys. 37 (2004) 2628.

[3] P. Gorria, J.L. Sánchez Llamazares, P. Álvarez, M.J. Pérez, J. Sánchez-Marcos, J.A. Blanco, J. Phys. D: Appl. Phys., 41 (2008) 192003.

[4] P. Álvarez, J.L. Sánchez Llamazares, M.J. Pérez, B. Hernando, J.D. Santos, J. Sánchez-Marcos, J.A. Blanco, P. Gorria, J. Non-Cryst. Solids, 354 (2008) 5172.

[5] P. Gorria, P. Álvarez, J. Sánchez-Marcos, J.L. Sánchez Llamazares, M.J. Pérez, J.A. Blanco, Acta Mater., 57 (2009) 1724.