

Experimental report

22/07/2024

Proposal: CRG-2988

Council: 10/2022

Title: Study of the magnetic structures of the novel room temperature magnetocaloric compounds Dy₆ (Fe,Mn) Bi₂

Research area:

This proposal is a new proposal

Main proposer: Alberto OLEAGA

Experimental team: Javier CAMPO RUIZ
Aritz HERRERO HERNANDEZ

Local contacts: Ines PUENTE ORENCH

Samples: Dy₆ (Fe,Mn) Bi₂

Instrument	Requested days	Allocated days	From	To
D1B	3	1	24/05/2023	25/05/2023

Abstract:

Study of the magnetic structures of magnetocaloric compounds $\text{Dy}_6(\text{Fe}_{0.5}\text{Mn}_{0.5})\text{Bi}_2$

A. Oleaga¹, A. Herrero¹, G. Aurelio², J. Campo²

¹Departamento de Física Aplicada, Escuela de Ingeniería de Bilbao, Universidad del País Vasco UPV/EHU, Plaza Torres Quevedo 1, 48013 Bilbao, Spain

²Universidad de Zaragoza - CSIC, Inst. de Nanociencia y Materiales de Aragon- INMA, Spain

DIB instrument at ILL was used to resolve the crystal and magnetic structure of the polycrystalline $\text{Dy}_6\text{Mn}_{0.5}\text{Fe}_{0.5}\text{Bi}_2$ intermetallic compound. Eleven different regions of interest were measured in order to study the evolution of the magnetic phases, and to check the contribution to the magnetic moment of the rare earth and transition metals. Isotherms from 2 K to 300 K, using $\lambda = 2.45 \text{ \AA}$ in high intensity mode clearly show the magnetic evolution of the compound.

The aim of this measurements was to determine the magnetic structure $\text{Dy}_6(\text{Fe,Mn})\text{Bi}_2$ by using neutron diffraction, as a function of temperature, paying special attention to the low temperature phases which are expected to have a complex non-collinear arrangement of spins (incommensurate, canted AFM, etc.). The information will allow us to check if, indeed, the rare earth ions are the sole responsible of the magnetic properties of the materials, which is commonly accepted in literature, and to clarify the role of the transition metal ions. The full understanding of the magnetic structure will help to design magnetocaloric materials with improved properties.

The magnetic measurements of these compounds show that there are two phase transitions, a paramagnetic-ferromagnetic transition at around 240 K while there is a lower temperature spin rearrangement at around 100 K, towards a more complex magnetic structure [1].

In order to cover every region of interest eleven isotherms were obtained from 2 K to 300 K. A 6mm annular V sample holder, $\lambda = 2.52 \text{ \AA}$ and high intensity mode were used to overcome the small quantity of compound and the high absorption of Dy.

With the aforementioned measurements, we were able to identify our main phase ($\text{Dy}_6\text{Fe}_{0.5}\text{Mn}_{0.5}\text{Bi}_2$), and the peaks corresponding to V from the sample holder. The nuclear crystallographic structure was resolved in the paramagnetic phase (300 K) and later adjusted at lower temperatures. The cell data agrees with the Fe_2P -type structure (space group P-62m , No. 189, hP9), as expected from previous X-Ray studies [1]. A. Oleaga, A. Herrero, A. Salazar, A.V. Garshev, V.O. Yapaskurt, A.V. Morozkin. JAC 843, 155937 (2020).

Figure 1 shows the evolution of the lattice parameter $a=b$ for the main phase. Figure 2 shows the fitting for 270K diffractogram using two phases P-62m and a phase corresponding to the Vanadium of the sample holder. The magnetic structure is not resolved and more work is needed to get some results. In Figure 3 the evolution of the peaks with the temperature is shown.

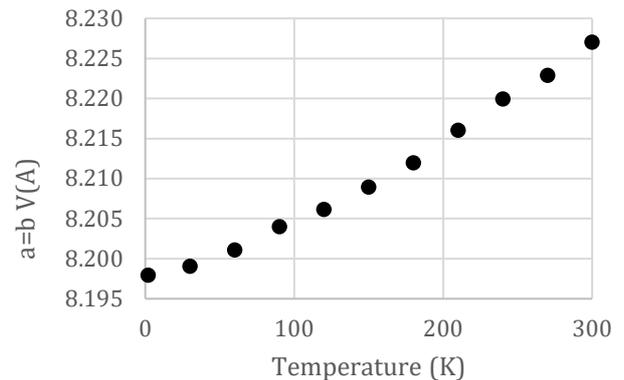


Figure 1: Experimentally determined cell parameters for $\text{Dy}_6\text{Fe}_{0.5}\text{Mn}_{0.5}\text{Bi}_2$ compound's main phase P-62m.

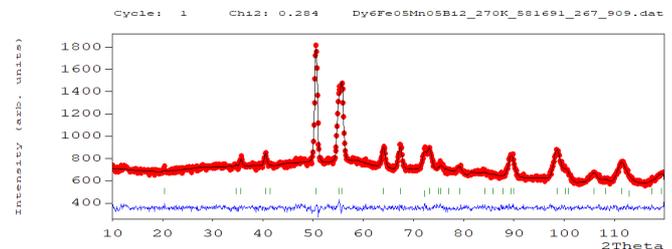


Figure 2: Fitting at 270 K

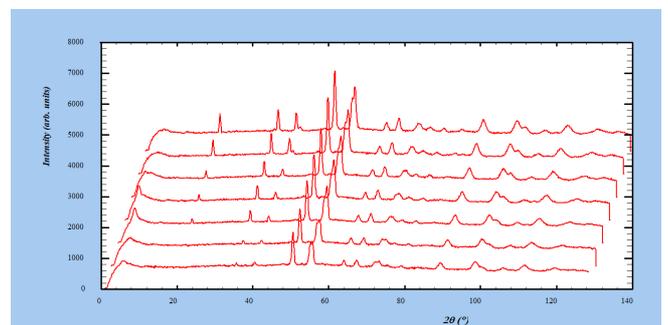


Figure 3: Diffractograms at 270 K, 240 K, 150 K, 120 K, 90 K, 30 K and 2 K.

- [1] A. Oleaga, A. Herrero, A. Salazar, A.V. Garshev, V.O. Yapaskurt, A.V. Morozkin. JAC 843, 155937 (2020).