

Experimental report

16/06/2022

Proposal: INTER-547

Council: 4/2021

Title: Dynamics in magnetocaloric materials

Research area:

This proposal is a new proposal

Main proposer: Nikolaos BINISKOS

Experimental team: Karin SCHMALZL
Nikolaos BINISKOS

Local contacts: Karin SCHMALZL

Samples: Mn₅Ge₃
Mn₂Sb

Instrument	Requested days	Allocated days	From	To
IN12	3	3	05/07/2021	08/07/2021

Abstract:

Scientific background:

The intermetallic ferromagnetic Mn_5Ge_3 compound has attracted great scientific interest in the recent years because it is considered as a promising candidate material for spintronic and magnetocaloric applications. Mn_5Ge_3 exhibits a 2nd order phase transition from the paramagnetic state towards the ferromagnetic phase at approximately 295K. It crystallizes in the hexagonal space group $P6_3/mcm$, with two distinct crystallographic positions for manganese atoms (Wyckoff positions (WP) $6g$ for Mn2 and $4d$ for Mn1). The magnetic structure of Mn_5Ge_3 was determined by polarized single-crystal neutron diffraction, which revealed a different size of the magnetic moments on the $4d$ ($1.96\mu_B$) and the $6g$ site ($3.23\mu_B$). In both sites the magnetic moments lie parallel to the c -axis of the hexagonal unit cell. The magnetic entropy change, ΔS_m , is of 7.2 J/kgK for a magnetic field change of 5T near room temperature. In addition, electrical resistivity and magnetization measurements in Mn_5Ge_3 indicated an anisotropic magnetoresistance and an anomalous Hall effect.

Aim of the proposal:

The aim of this beam time was to investigate the magnon dispersion of Mn_5Ge_3 at $T=10\text{K}$ with good resolution (i) along the high symmetry hexagonal directions Γ -M and Γ -K-M with energy scans at constant q and q -scans at constant energies and (ii) at the symmetry points M and K with energy scans.

Experimental setup:

IN12 was set up in W-configuration. We used a double focusing PG monochromator, a PG analyzer and a PG filter in the neutron scattered beam. The velocity selector was not available during this beam time. The data have been collected with a fixed $k_f=1.971\text{\AA}^{-1}$. The single crystal (with a mass of about 10g) was mounted with the $[100]$ – $[010]$ directions in the scattering plane. We used an orange cryostat as sample environment.

Results:

Inelastic neutron scattering measurements on IN12 were performed at $T=10\text{K}$. Before fitting, every spectrum was analyzed carefully looking for spurions, in particular Aluminum contamination and inelastic spurions appearing when the condition $k_i/k_f=2$ is fulfilled. The corresponding spurion regions were cut out during data evaluation. Gaussian functions were used to fit the observed peaks. A characteristic spectrum with the corresponding fits at a high symmetry K point is shown in Fig.1.

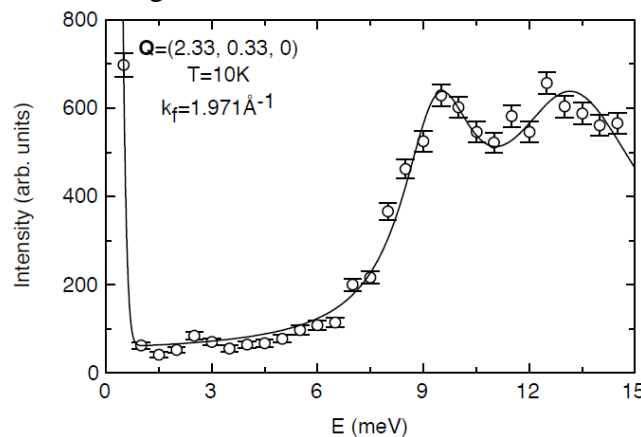


Fig.1: E-scan measured at $Q=(2.33, 0.33, 0)$ at $T=10\text{K}$. The solid line indicates fits with Gaussian functions.