Experimental report

15/06/2018

Proposal:	**TEST-2855**	**Council:**	4/2018
Title:	Investigating the lattice dynamicsof MnFe4Si3		
Research area:			

This proposal is a new proposal

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Samples: MnFe4Si3

Instrument	Requested days	Allocated days	From	To
IN8	5	5	18/04/2018	26/04/2018

Abstract:

Background:

The search for more efficient use of energy has been leading to a growing interest for the research field of magnetocaloric materials[1]. The magnetocaloric effect (MCE) refers to a change of temperature/entropy of a magnetic material exposed to a change of magnetic field. The MCE requires the exchange of magnetic entropy, lattice entropy and/or electronic entropy during an adiabatic (de-)magnetization process. A large MCE at room temperature and low magnetic field for a material with abundant and environmentally friendly elements opens the way for magnetic cooling devices. The ferromagnetic compound $MnFe_4Si_3$ (S.G.: $P\bar{6}$) is a promising candidate material for such devices as it has a magnetic phase transition of about 300 K and shows a moderate MCE of 2.9 J/(kg·K) at a reasonable magnetic field change from 0T to 2T[2-4]. To add to the understanding of the fundamental driving forces of the MCE on the selected magnetocaloric compound $MnFe_4Si_3$ a study of spin and lattice dynamics and their interactions is indispensable.

Aim of the experiment:

The aim of this experiment was to investigate the lattice and spin dynamics along the [100] and [001] directions of the hexagonal cell at 1.5K.

Experimental setup:

The IN8 spectrometer was set up in W configuration. We used a Si(111) monochromator (double focusing mode), a monitor, slits before and after the sample, a PG filter after the sample and a PG(200) analyser. Data have been collected with a fixed k_f=2.662Å^{-1}. The single crystal (with a mass of about 6g) was mounted with the [100] – [001] directions in the scattering plane inside an orange cryostat.

Results:

For obtaining the low lying phonon dispersion along the (h00) and (00l) direction at T=1.5K mainly E-scans in transverse and longitudinal geometry were carried out around the magnetic Bragg peaks (0 0 2), (0 0 3), (2 0 0), (3 0 0) and (4 0 0). Before fitting, every spectrum was analyzed carefully looking for spurions, in particular Al contamination, and the corresponding regions were cut out. Specific scans were repeated above T_C, e.g. at T=313 K, in order to establish the magnetic nature of the excitations. In Fig.1(a) such typical E-scans are presented.
Fig.1(b) shows in the form of color map the acoustic magnon branch (E<13meV) and optic phonons (17<E<21meV) along the (h00) hexagonal reciprocal high symmetry direction of the hexagonal system. Further analysis is required to update the previously measured phonon and magnon dispersion curves along the (h00) and (00l) directions [5-8].

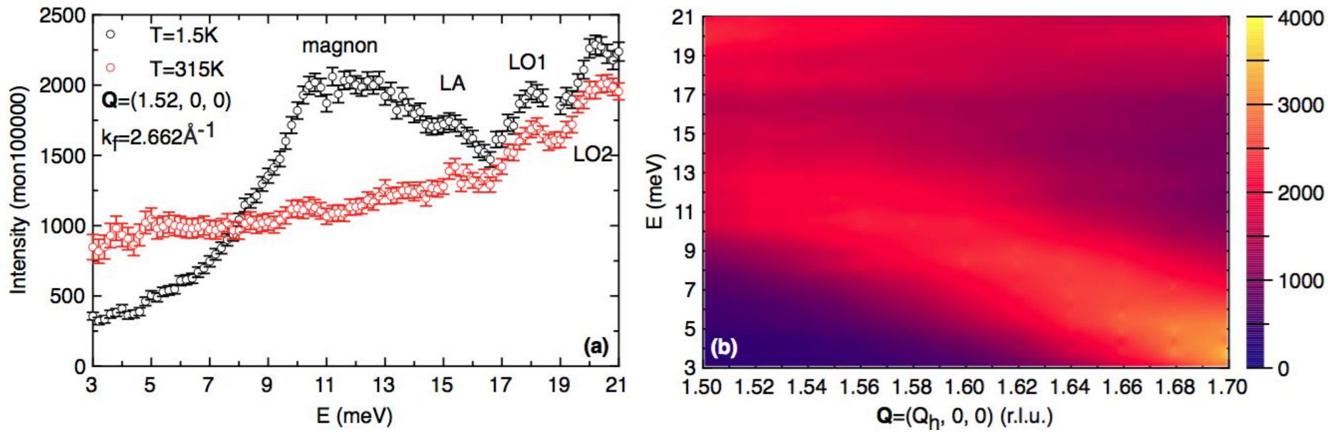

Fig. 1: (a) Energy spectra at Q=(1.52, 0, 0) measured at IN8 spectrometer with unpolarized setup at 313K (red circles) and 1.5K (black circles). The measured intensity for the spectrum collected at T=315K is corrected by the Bose factor. (b) Colour map constructed from E scans around (2 0 0). Data were collected at T=1.5K.

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[3] A. Candini et al., J. Appl. Phys., 95 (2004), 6819−6821
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[5] EXP-296 Experimental Report
[6] CRG-2263 Experimental Report
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[8] CRG-2292 Experimental Report