Experimental report

10/09/2016

Proposal: 1-20-38 **Council:** 4/2015

Title: Optimization of the polarization analysis under high pressure

Research area: Physics

This proposal is a new proposal

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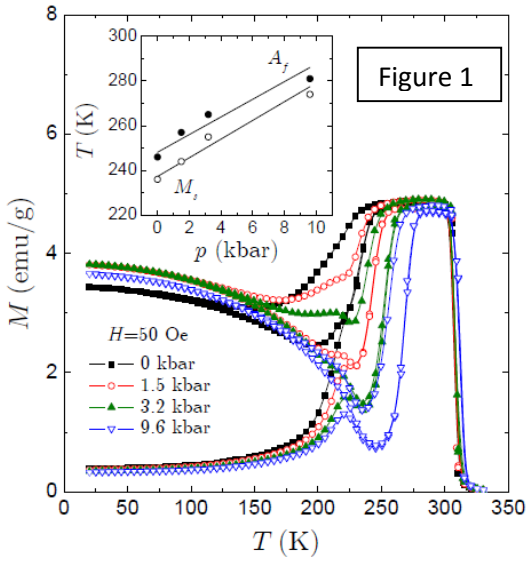
Samples: Ni50Mn34In16

Instrument	Requested days	Allocated days	From	To
D7	5	5	31/05/2016	05/06/2016

Abstract:

The xyz polarization analysis is suitable to study the possible presence of antiferromagnetic correlations on a sample. If these correlations appear under high pressure we need to use a proper pressure cell, which should be non-depolarizing, and at the same time it should have little or no diffuse scattering. A new type of pressure cell will be tested to use in experiments under high-pressure on D7. After calibrating the all instrument factors, the xyz polarization analysis carried out for powder Ni50Mn34In16 ferromagnetic Heusler alloy under pressure. In this sample, the magnetization drops in the vicinity of the martensitic transition, which is related to the development of antiferromagnetic correlations due to decreased Mn-Mn separation in the martensitic state. On applying pressure, the magnetization goes to zero and the sample gets a suitable state for polarization analysis.

$Ni_{50}Mn_{34}In_{16}$ is a compound which exhibits magnetic shape memory, magnetic superelasticity, magnetocaloric effect, magnetoresistance and barocaloric effect. Many functional properties derive from the coupling between the martensitic transition and the magnetic order. $Ni_{50}Mn_{34}In_{16}$ is ferromagnetic and undergoes a martensitic transformation as shown in Fig. 1. Data have been taken in zero-field-cooled (ZFC), field-cooled (FC), and field-heated (FH) sequence. On cooling, the cubic phase orders ferromagnetically at T_C^A=310 K which causes a sharp increase in the magnetization . At lower temperatures M_s, the sample transforms to the martensitic phase, and there is a sharp drop in the magnetization. The cause of the drop in M(T) is due to the strengthening of AF correlations below the martensitic transformation temperature as observed from the polarization analysis experiments. Upon further cooling the magnetization rises again, reflecting the increase in ferromagnetic order of the martensite at the Curie point of the martensitic phase T_C^M. When the hydrostatic pressure is applied to the sample, a significant effect is observed in the temperature region where the austenite and martensite phases coexist. All characteristic temperatures associated with the martensitic transition shift to higher values as the pressure is increased. The rate of shift in the transition temperatures in $Ni_{50}Mn_{34}In_{16}$ is 4 K/kbar. The aim of the present work is to perform the polarization analysis under high hydrostatic pressure using CuBe VX-1 PE press-type high pressure cell on D7 and to study the nature of the magnetic coupling in the temperature range $T_C^M \leq T \leq M_S$ in $Ni_{50}Mn_{34}In_{16}$.



We first checked the flipping ratio under ambient pressure in the temperature range 300 K <T<150 K. On decreasing temperature, the flipping ratio decreases from 18 to 12 as long-range ferromagnetism sets in. We have undertaken xyz-polarization analysis at the temperature 220 K under ambient pressure, 2 GPa and 4 GPa hydrostatic pressures. The results for the nuclear scattering contribution are shown in fig 2. In the background subtracted data, the amplitudes are wrong related to the background measurements which have more statistics than the sample

measurements. We observed a small Bragg peak at about 2.2 $Å^{-1}$. The Bragg peak, if it's real, it is pretty small. Any diffuse scattering will be substantially smaller than the Bragg peak, too. If it is not real, this means that the sample is out of the beam.

The magnetic scattering contribution to the cross section is shown in Fig. 3. The magnetic cross section is almost zero. We didn't see any magnetic scattering in this experiment.

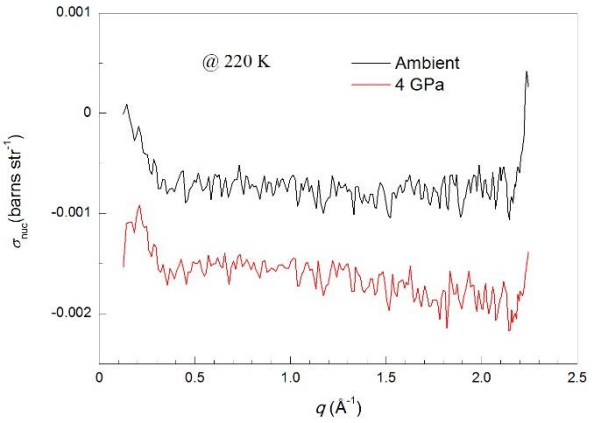


Figure 2.

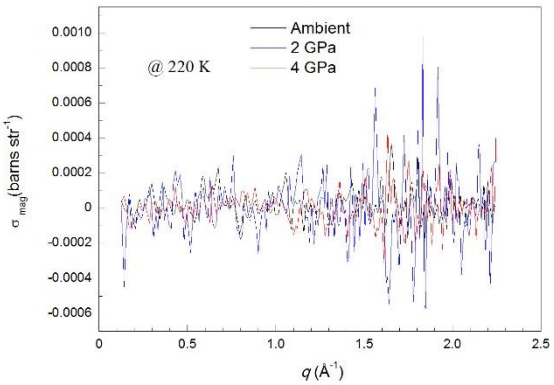


Figure 3.

We conclude that some improvements should be done in the experimental setup. These improvements are listed below.

- Firstly, the pressure cell with the cryostat is too tall. A modified spacer should be made to get the sample closer to the center of the beam.

- Be sure that we heat the capilary as well as the cell. Otherwise, the displex is too powerful for the heating from the temperature controller alone.
- Measurements for the quartz and vanadium were acceptable, although they might have been able to use more statistics. It might be worthwhile to measure a 3 mm height vanadium to reproduce the sample height or to use a gasket for quartz and vanadium measurements as the sample measurements.
- When measuring background, measure a thin-walled Al spacer that is the same height as the quartz/vanadium. A spacer is needed to lock the anvils in place. Thin-walled Al should be close to invisible, particularly at 4.8Å.
- We should consider using a crystalline gasket like CuBe rather than null-matrix TiZr.