Experimental report

15/02/2017

Proposal: 1-10-36 **Council:** 10/2016

Title: Optimization of pressure-cell for polarization analysis on D7

Research area: Physics

This proposal is a continuation of 1-20-38

Main proposer: Seda AKSOY ESINOGLU

Experimental team: Seda AKSOY ESINOGLU

Local contacts: Andrew WILDES

Samples: Ni50Mn34In16

Instrument	Requested days	Allocated days	From	To
D7	7	6	09/02/2017	15/02/2017

Abstract:

The XYZ polarization analysis is suitable to study the possible presence of short range 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 CuBe VX-1 type pressure cell with cryostat will be used to perform polarization analysis 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.

Report of 1-10-36

$Ni_{50}Mn_{34}In_{16}$ 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 figure 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 (up to 40 kbar) 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 sample position and background of the pressure cell under ambient pressure. Unfortunately, the scattering coming from the pressure cell was too high even the Bragg peaks of a dummy sample YIG (Yttrium Iron Oxide) couldn't observed (YIG has a well-known nuclear scattering pattern at a wavelength of 4.8 A). Under this circumstances, we decided to measure $Ni_{50}Mn_{34}In_{16}$ in ambient pressure without using high pressure cell. The xyz-polarization analysis was undertaken at the temperature between 220 K and 280 K in martensite state with a step of 10 K, and at 315 K in austenite state. The flipping ratio is given in figure 1 at selected temperature region together with the magnetization data. The nuclear and the average magnetic scattering contributions are shown in figure 2 for 270 K under ambient pressure and 15 kbar. Hydrostatic pressure is applied with a clamp type pressure cell.

Some satellites Bragg peaks appeared when pressure is applied. The xyz-polarization analysis is performed under 15 kbar pressure. The comparison of the total scattering data under ambient pressure and under pressure show that it is very difficult to get an information related to the short-range magnetic correlations. To get more statistical data, we have to measure longer than 12 hours for each temperature. The magnetic scattering contribution to the cross section under 15 kbar is almost zero without background subtraction. At ambient pressure We observed short-range AF correlations which is very similar to the $Ni_{50}Mn_{37}Sn_{13}$ and $Ni_{50}Mn_{40}Sb_{10}$.

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

- For high pressure cell should be well covered with cadmium jacket to pretend any possible nuclear scattering.

- For clamped-type pressure cell, the background should be measured long enough. The position of the cell during the background measurement should be stay the same after the sample loaded. Any change can create some miscalculation problem for background subtraction.

Figure 1

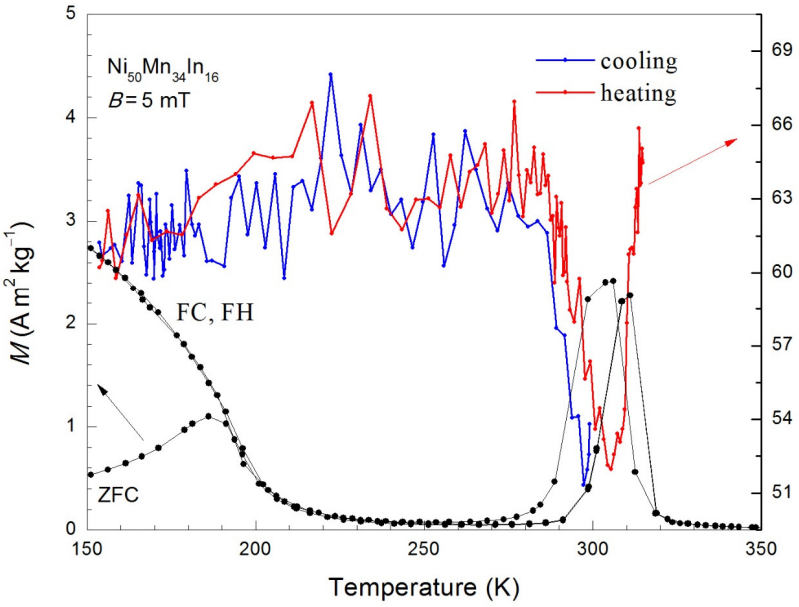
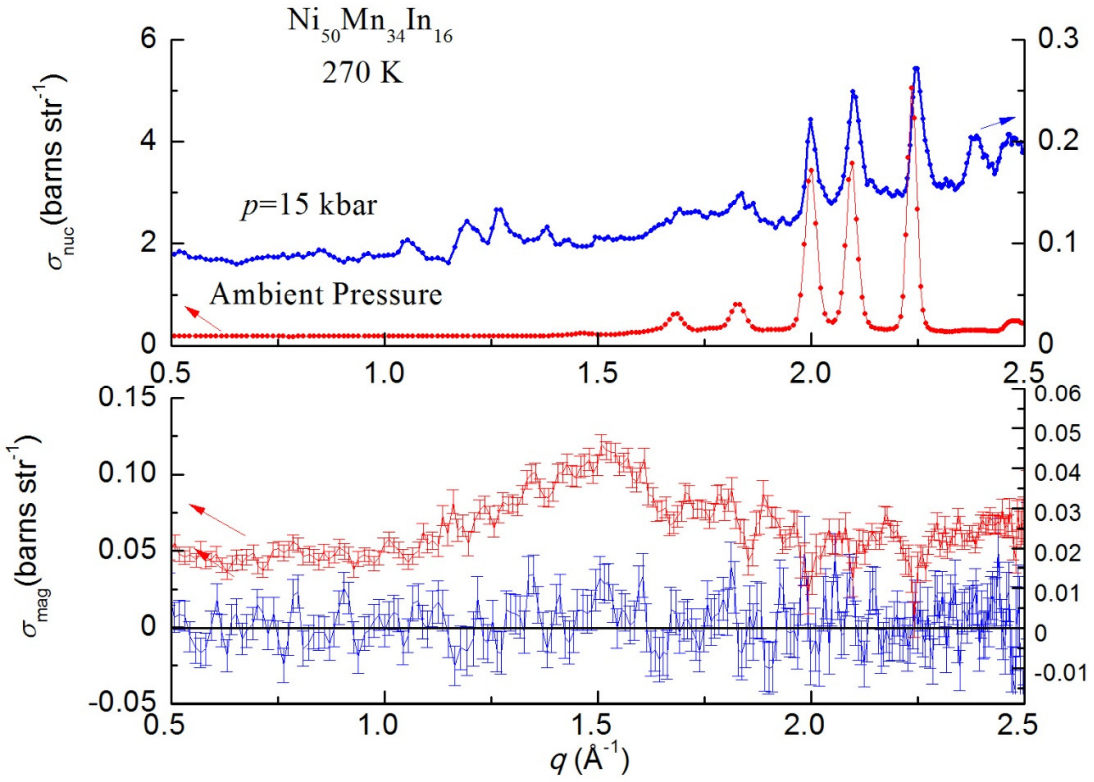


Figure 2


Ni50Mn34In16
270 K
p=15 kbar
Ambient Pressure
σnuc (barns str-1)
σmag (barns str-1)
q (Å-1)