

Experimental report

15/10/2024

Proposal: 5-31-2962

Council: 4/2023

Title: Structural and magnetic properties of $\text{YNi}_{3-x}\text{Fe}_x$ compounds ($x = 0.25$ and 0.8)

Research area: Materials

This proposal is a new proposal

Main proposer: Valerie PAUL-BONCOUR

Experimental team: Hugo BENET
Valerie PAUL-BONCOUR

Local contacts: Maria Teresa FERNANDEZ DIAZ

Samples: $\text{YNi}_{2.75}\text{Fe}_{0.25}$
 $\text{YNi}_{2.2}\text{Fe}_{0.8}$

Instrument	Requested days	Allocated days	From	To
D1B	2	0		
D2B	2	2	10/12/2023	12/12/2023

Abstract:

Intermetallic compounds based on rare earth and transition metals display a lot of interesting magnetic properties leading to many applications (permanent magnet, magnetic recording, magnetostriction, magnetic cooling). In this study, we aim to investigate the change of structural and magnetic properties induced by the substitution of nickel by iron in $\text{YNi}_{3-x}\text{Fe}_x$. The progressive substitution of nickel by iron in YNi_3 increases the lattice parameter while keeping the same R-3m hexagonal structure. In the case of small substitutions ($x < 0.6$), a phenomenon of magnetic reentrance has been observed below 50 K which might be due to the presence either of spin glasses or AFM-FM transition. The Curie temperature increases versus Fe content, but a change of slope is observed for $x = 0.82$. The neutron diffraction experiments on two samples ($x = 0.25$ and 0.8) from 2 to 200 K will help us to solve the nuclear (Fe localisation) and magnetic structure of these compounds and understand the magnetic phase diagram. 2 days of measurements on D1B spectrometer with an orange cryostat are required to perform these experiments.

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Intrument : D2B

Requested days : 2 **Allocated days :** 2

In this study, we wanted to investigate the change of structural and magnetic properties induced by the substitution of nickel by iron in $\text{YNi}_{3-x}\text{Fe}_x$. This solid solution crystallizes in a PuNi_3 structure type (space group $R\bar{3}M$), and Fe for Ni substitution increases lead to a linear increase of a parameter but a break in the slope is observed for c parameter. In this structure, Ni occupy 3 different Wyckoff sites (3b, 6c and 18h), thus neutron diffraction was necessary to determine in which sites Ni is substituted by iron and in which proportion. These compounds also show interesting magnetic properties with a phenomenon of magnetic reentrance below 50 K for $x < 0.6$. The Curie temperatures increase versus Fe content, but a change of slope was observed near $x = 0.82$. The neutron diffraction experiments were also performed to solve the magnetic structures.

Two samples ($\text{YNi}_{2.7}\text{Fe}_{0.3}$ and $\text{YNi}_{2.25}\text{Fe}_{0.75}$) have been measured by powder neutron diffraction on D2B beamline at different temperatures between 5 and 300 K, $\lambda = 1.59 \text{ \AA}$ (Figs 1 and 2). Mössbauer spectrometry measurements show that only 2 sites are occupied by Fe. Although the scattering lengths of iron and nickel are really close ($b_{\text{coh}}(\text{Ni}) = 10.3$ and $b_{\text{coh}}(\text{Fe}) = 9.5$), it is possible to have a better fit when iron only occupy 2 Wyckoff sites, however, the exact occupancy rate of Fe and Ni is yet to be determined due to limited contrast between, Fe and Ni.

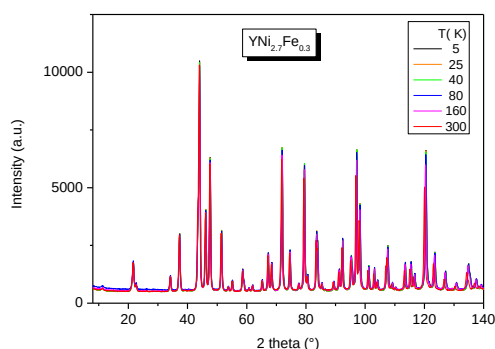


Figure 1: $\text{YNi}_{2.7}\text{Fe}_{0.3}$ data files at different temperatures

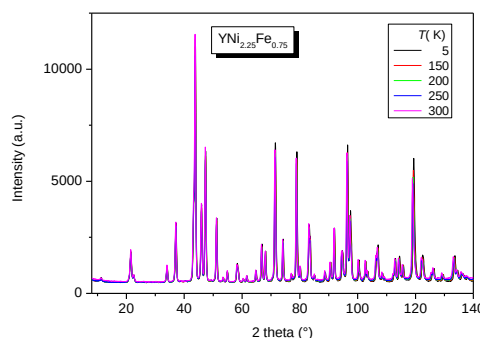


Figure 2: $\text{YNi}_{2.25}\text{Fe}_{0.75}$ data files at different temperatures