Neutron diffraction studies on the magnetic field induced irreversible antiferromagnetic to ferromagnetic transition in Nd5Ge3

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The rare earth intermetallic compound Ne5Ge3 crystallizes in the Mn5Si3-type hexagonal structure with space group P63/mcm in which the Nd atom occupies two non-equivalent crystallographic sites. Nd5Ge3 has two antiferromagnetic states below TN = 50 K and Tt = 26 K; we have found the magnetic field induced irreversible antiferromagnetic to ferromagnetic transition in the low temperature phase [1]. Magnetization curve shows the square type hysteresis after the external magnetic field experience up to 70 kOe. Since this irreversible phase transition can take place by the martensitic structural phase transition which has been found in Gd5Ge4, neutron diffraction studies under external magnetic field is effective to reveal it. In this study, we have carried out the neutron diffraction studies on the field-induced irreversible magnetic transition in Nd5Ge3. Neutron diffraction measurements have been carried out by using the HQR (T1-1) spectrometer of JRR-3M with a wave length of 2.45820 A. External magnetic fields up to 50 kOe were generated by a superconducting magnet.

Fig.1(a) shows powder neutron diffraction profiles of Nd5Ge3 at 4.0 K under zero and 40 kOe magnetic fields. The low angle intensity around 3 to 5 degree indicates the (000)+ magnetic reflection. Under 40 kOe, magnetic reflections at the nuclear position indicating the field induced ferromagnetic state were observed. Magnetic reflections from (110), (020), (120) and (022) planes clearly remains after removing external magnetic field. Fig.1(b) indicates the magnetization curve at 2.0 K along the c-axis and the intensity of (120) magnetic reflection as a function of external magnetic field at 1.5 K. A jump is observed at about 23 kOe in the intensity - external field curve; the zero field intensity after removing external field does not coincide with the initial one. This indicates that the irreversible magnetic structure change occurs in Nd5Ge3 under magnetic field. Further, since the reflection peaks at the nuclear position does not change by external field, the irreversibility is not originated by the structural phase transition in Nd5Ge3.

References

[1] T. Tsutaoka, A. Tanaka, Y. Narumi et al., Physica B 405, (2010) 180.

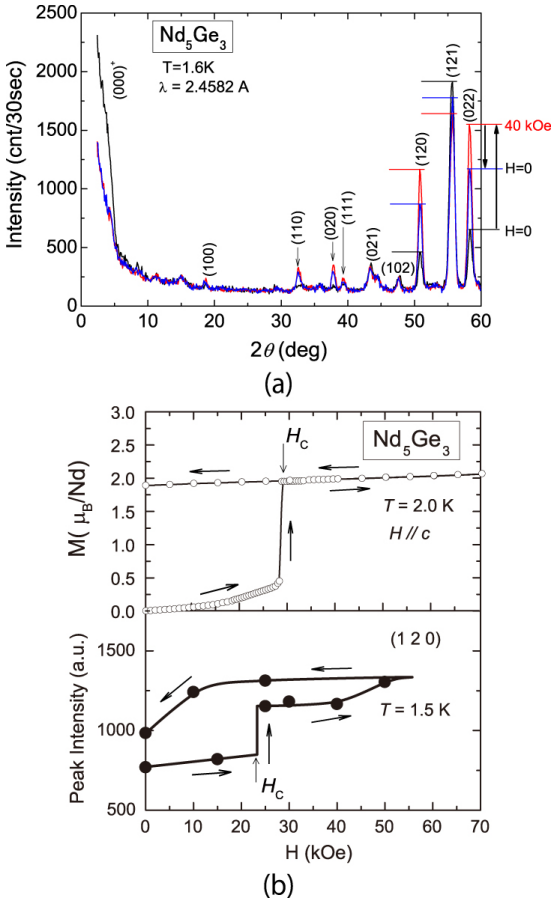

Fig. 1. Neutron diffraction profiles for Nd5Ge3 under several external magnetic fields (a), the magnetization curve along the c-axis and the intensity of (120) magnetic reflection as a function of external magnetic field (b).