

Small Angle Neutron Scattering Studies of Spontaneous Vortex Phase in ErNi₂B₂C

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Background and purpose

It is microscopically confirmed that ErNi₂B₂C exhibits the coexistence of weak ferromagnetism (WFM) and superconductivity below T_{WFM} ≈ 2.5 K [1]. For a type II ferromagnetic superconductors, it is predicted that an internal magnetic field Hint mediated by the ferromagnetic moments may lead a spontaneous vortex phase if Hint satisfies a condition: H_{c1} < Hint < H_{c2} [2].

ErNi₂B₂C is one of possible candidates for the spontaneous vortex phase because the estimated Hint satisfies the above condition of the spontaneous vortex phase. In this study, SANS experiment was performed in order to examine the possibility of spontaneous vortex phase in ErNi₂B₂C.

Experimental method and results

The SANS experiment was performed at the Paul Scherrer Institute in Switzerland. The single crystals of ErNi₂B₂C were prepared using floating zone method. The measurements were carried out at T = 3 K (spin density wave phase) and T = 0.1 K (weak ferromagnetic phase).

At 0.1 K after the zero field cooled (ZFC) procedure, the external magnetic field H_{ext} as large as 2000 Oe was applied, and then it was reduced down to 0 Oe. Figure 1 shows the FLL (flux line lattice) diffraction pattern measured at H_{ext}=0 Oe and T= 0.1 K after this procedure. The effective field H_{eff} was calculated from the diffraction patterns obtained at each fields.

Figure 2 shows the field dependence of internal field Hint (= H_{eff} - H_{ext}). Hint is not zero at H_{ext}=0 Oe and T=0.1 K although Hint is zero at H_{ext}=0 Oe and T=3 K, which may suggest the realization of spontaneous vortex lattice. The internal field Hint increases at both 3 K and 0.1 K as the external field

H_{ext} increases, showing that the magnetic moments at both SDW phase and WFM phase tend to align with the external magnetic field.

References

[1] H. Kawano, H. Takeya, H. Yoshizawa and K. Kadowaki, J. Phys. Chem. Solids. 60 (1999) 1053. [2] M. Tachiki et. al., Solid State Commun. 34 (1980) 19.

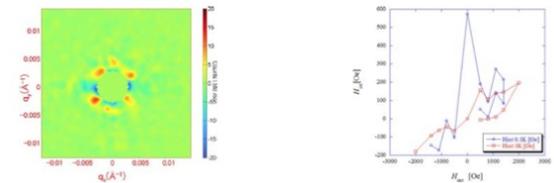


Fig. 1. left: FLL diffraction pattern at H_{ext}=0 Oe, T=0.1K right: Field dependence of Hint