Flux Line Lattice Symmetry in MgB_2-type Superconductor CaAlSi probed by Small Angle Nuetron Scattering

S. Kuroiwa[1], Y. Sugiyama[1], T. Muranaka[1], H. Kawano-Furukawa[2] and J. Akimitsu[1]
[1]*Department of Physics and Mathematics, Aoyama-Gakuin Univ., Kanagawa 229-8558*
[2] *Department of Physics, Ochanomizu Univ., Tokyo, 112-8610*

Since the flux line lattice (FLL) configuration can be dominated by the Fermi surface property and underlying crystal symmetry, investigations of FLL state play an important role to understand the superconducting mechanism. In this work, we have focused on the superconductivity in a MgB_2-type superconductor CaAlSi (CAS).

According to the recent report [1], the CAS possesses two types of multi-stacked crystal structures, in which a clear five-layered (5*H*-CAS) or six-layered (6*H*-CAS) superlattice along the *c*-axis was observed. On the other hand, we first fabricated a no superstructured CAS (1*H*-CAS) with AlB_2-like structure [2]. In order to clarify the relationship between the crystal symmetry, structure of superconducting order parameter and vortex lattice symmetry in three phases of CAS, we have performed the first small angle nuetron scattering (SANS) experiments.

The SANS experiment was conducted by using SANS-U spectrometer installed in JRR-3 at Japan Atomic Energy Agency (JAEA), and single crystal of respecetive phase with the dimension $7 \times 7 \times 2$ mm^3 was used. The mean wavelength of incident neutron beam monochromatized by a mechanical velocity selector was set to $\lambda_n \sim 6.7$ Å with resolution $\Delta\lambda_n/\lambda_n = 10$ %.

Figure 1 shows the representative SANS diffraction patterns in 6*H*-CAS (not shown the data of 1*H*- and 5*H*-CAS) at 2 K applied fields parallel to the crystalline (a) *c*- and (b) *a*-axes. We found that the hexagonal FLL structure under $H \| c$ over the entire temperature/field range was observed in the respective phases in CAS, but that they exhibit a no sign of reorientation with increasing temperature/field as in multi-gaped superconductor MgB_2 [3]. Meanwhile, only 6H-CAS shows a distortion with Bragg peaks lying on an ellipse under $H \| a$ due to the magnetic penetration depth anisotropy.

Consequently, we obtained an usual FLL phase diagram in 6*H*-CAS expected for the uniaxial conventional superconductor described by London theory. The further SANS experiments are also needed to determine the comprehensive FLL phase diagram in 5*H*- and 1*H*-CAS.

References

[1] H. Sagayama, et al.: J. Phys. Soc. Jpn. **75** (2006) 043713.
[2] S. Kuroiwa, et al.: Phys. Rev. B **74** (2006) 014517.
[3] R. Cubitt, et al.: Phys. Rev. Lett. **91** (2003) 047002.

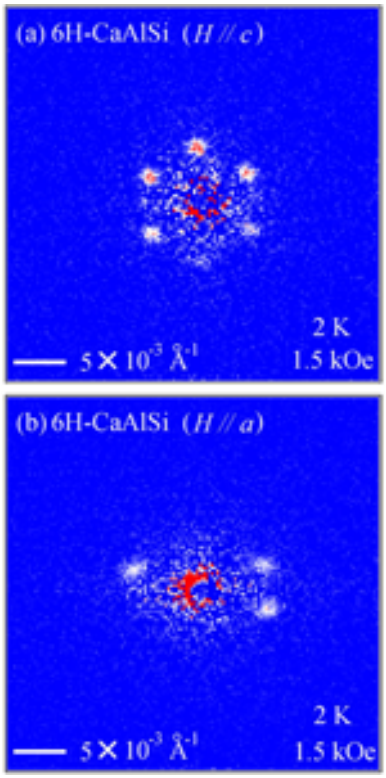

Fig. 1. SANS diffraction patterns from the FLL state in 6*H*-CaAlSi at 2 K applied fields of 1.5 kOe parallel to the crystalline (a) *c*- and (c) *a*-axes.