POSSIBILITY OF FFLO STATE IN ORGANIC SUPERCONDUCTOR λ-$(BETS)_2FECL_4$

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Introduction

The two dimensional organic material λ-$(BETS)_2FeCl_4$, where BETS is bis(ethylenedithio)tetraselenafulvalene, is a good example of low dimensional magnetic conductors where rich ground state properties appear. When the magnetic field is applied parallel to the conducting layers (*ac* plane), a superconducting (S) phase is induced above 17 T below 1 K [1,2]. Although the overall feature of the field induced S phase is well understood by Fischer theory [3], based on the Jaccarino-Peter (J-P) effect [4], an inhomogeneous superconducting state with a spatially modulated order parameter, the so-called a FFLO state [5], is theoretically expected to be stabilized [2,6,7]. All the necessary conditions for the FFLO state are well fulfilled for λ-$(BETS)_2FeCl_4$. In order to investigate the possibility of the FFLO state in the field induced S phase, we have performed the resistance measurements under high magnetic fields up to 45 T.

Experimental

Single crystals of λ-$(BETS)_2FeCl_4$ were synthesized electrochemically. The resistance measurements were performed by a conventional *ac* technique with the electric current along the *b** axis in the hybrid magnet at NHMFL.

Results and Discussion

Figure 1 shows the interlayer resistance (I//b*) in fields parallel to the *c* axis. At 0.5 K, the resistance linearly increases with field, and then shows an anomalous feature (successive dip structure) in the superconducting transition. Similar anomalies are also slightly observable at high fields above 37 T. The dips are smeared out with increasing temperature, but the dip positions, denoted by arrows, do not change. The dips become more evident at higher currents. At 1.6 K, we observe no anomalous features. When the field is tilted from the *c* axis by a few degrees, the dips disappear. The resistance as a function of the field angle θ, which is the angle between the *c* axis and field is plotted in the inset of Fig.1. A sharp peak is evident for H//*c*. The sharp peak is well understand in terms of a lock-in transition and the dynamics of the Josephson vortices (JV) penetrating the insulating layers. The dip structure in the resistive transition shows that the JV are strongly pinned at some different fields, which suggests the commensurability effect of the JV lattice and the oscillating order parameter in the FFLO state [8].

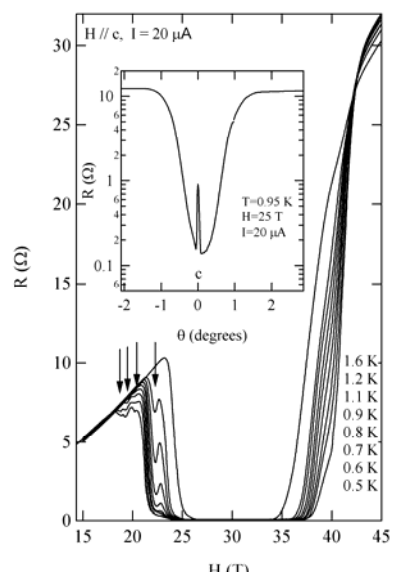

Fig. 1. Interlayer resistance (I//*b**) in fields parallel to the *c* axis.

Acknowledgements

This work was supported by a Grant-in-Aid for Scientific Research from MEXT (No. 15073225) and NSF-DMR-0203532.

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