High Field Angle Dependence of the Magnetoresistance in the Layered Organic Superconductor

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Introduction

The interlayer coherency is an important problem in the wide community of layered conductors. The organic superconductor κ_{4H}-(DMEDO-TSeF)$_2$[Au(CN)$_4$](THF), where DMEDO-TSeF is dimethyl(ethylenedioxy)tetraselenafulvalene, has thick anion (insulating) layers [1]. As a result, this compound has a possibility of incoherent interlayer transport properties. The angle dependence of the magnetoresistance (ADMR) is one of the methods to clarify the coherent/incoherent problem [2].

Experimental

Single crystals were prepared by electrocrystallization in RIKEN [1]. The samples were mounted on a one-axis rotator in the He3 refrigerator in a 35 T resistive magnet (Cell 8). The measurements were carried out by the four probe method with ac current along the $a^*$-axis, i.e., interlayer resistance $R_{zz}$. All measurements were carried out at NHMFL, Tallahassee.

Results and Discussion

Fig.1 shows the ADMR at 1.2 K under various magnetic fields. At 12.5 T, the background shape of ADMR is opposite as compared with a usual quasi-two-dimensional (coherent) system, because $R(\theta = 0^\circ)$ is larger than $R(\theta = 90^\circ)$ as shown in Fig.1. Between 15 and 20 T, the ADMRs show normal background shapes. Above 20 T, a dip structure around $\theta = 90^\circ$ develops. The peak structure at around $\theta = 90^\circ$ is due to the existence of closed orbits on the Fermi surface when the field lies close to the plane of the layers in a coherent system [3]. The peak width is proportional to the interlayer transfer integral and is independent of the magnetic field strength [3]. Although our present compound shows a peak structure around $\theta = 90^\circ$, the peak width clearly decreases as the magnetic field increases. At 35 T, the peak width is narrow and the height is extremely small. This indicates that the peak structure of the present compound is not originated in the closed orbits on the Fermi surface. The present results are novel phenomena and the present compound is potentially an incoherent system.

Conclusions

The background shape of the ADMR of the present compound depends on the magnetic field. The peak structure around $\theta = 90^\circ$ also depends on the magnetic field. This indicates that the origin of the peak structure is not a Fermi surface topology.

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References