Quantum Effect on the π-d Hybrid Molecular Conductor

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Introduction

The Q1D π–*d* hybrid molecular conductors $(DIETSe)_2FeX_4$ [X=Br, Cl] show unprecedented magnetotransport phenomena such as spin-flop-induced electrical switching and nonvolatile memory for Cl salt [1] and large hysteresis in magnetoresistance for Br salt [2]. The substitution of Cl for Br reduced the spin density wave (SDW) instability of Q1D π–electrons while it enhanced the π–*d* interaction.

In order to investigate the effect of local moments on the field-induced spin density wave (FISDW) state and the quantum oscillation (QO), we have investigated the magnetotransport properties of the mixed crystals $(DIETSe)_2MBr_2Cl_2$ [M=Ga, Fe] using the 45 T hybrid magnet. The mixed crystals were used in this experiment because we could reduce the critical pressure to suppress the SDW phase and enhance the π–*d* interaction compared with Cl salt. We have investigated the field dependence as well as the temperature dependence of the QO amplitude.

Experimental

Magnetoresistance of the mixed crystals $(DIETSe)_2MBr_2Cl_2$ [M=Ga, Fe] was measured under pressure and high magnetic field up to 45T. Magnetic field was applied along the least conducting *b*-axis direction. Hydrostatic pressure of 0.3 GPa was applied using clamp-type small pressure cell. The pressure was calibrated by the resistance change of manganin wire.

Results and Discussion

We have succeeded to observe very clear QO in the magnetoresistance of $(DIETSe)_2GaBr_2Cl_2$ under the pressure of 0.3 GPa as shown in Fig.1. At low temperatures below about 10 K, the QO is superposed on the large magnetoresistance due to FISDW states. In the high temperature metallic state the QO is clearly observable up to 30 K which is the highest temperature of the present experiments. This result indicates that the effective mass of the carrier is very small. Actually, the mass is calculated to be 0.09 m_0 from the mass plot.

Compared with Ga salt, $(DIETSe)_2FeBr_2Cl_2$ shows less pronounced FISDW transitions and QO (data not shown), possibly due to the effect of local moments and/or some extrinsic reasons such as the quality of the crystal.

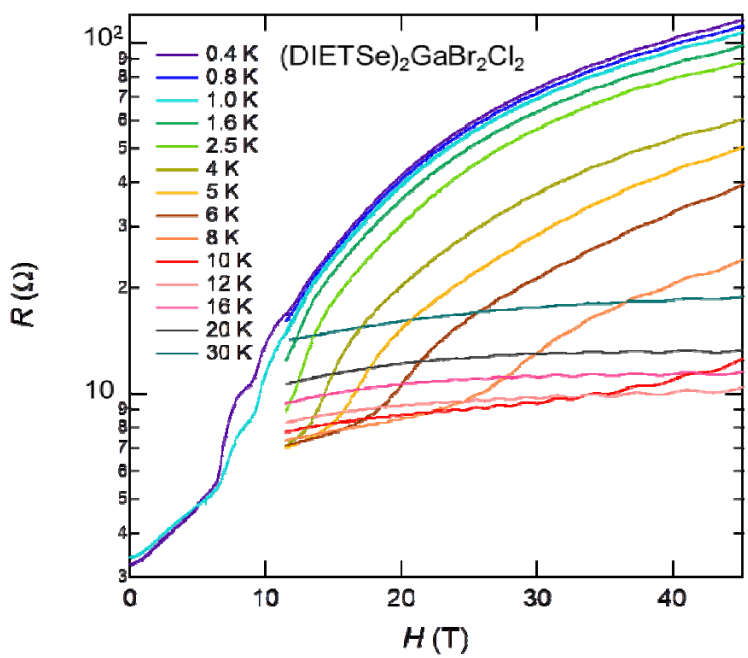

Fig. 1 Magnetoresistance of $(DIETSe)_2GaBr_2Cl_2$ up to 45 T under a hydrostatic pressure of 0.3 GPa.

Acknowledgements

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References

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[2] Maesato. M., *et al.*, J. Phys. Soc. Jpn., **82**, 043704 (2013).