FISDW and Quantum Oscillation in π–d Hybrid Molecular Conductors

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Introduction

The quasi-one-dimensional (Q1D) π–d hybrid molecular conductors $(DIETSe)_2FeX_4$ [X = Br, Cl] show unprecedented magnetotransport phenomena, attributed to the correlation between spin-density-wave (SDW) instability of Q1D itinerant π-electrons and antiferromagnetic (AF) ordering of localized d-electron spins. The Cl salt shows spin-flop-induced electrical switching and nonvolatile memory [1] while the Br salt shows large hysteresis in magnetoresistance (MR) [2]. Dimensionality and π–d interaction can be increased by applying physical pressure. After suppressing the SDW phase by pressure, kink structures reminiscent of field-induced SDW (FISDW) transitions are discovered at high magnetic field in MR of the Cl salt, which is the first example of AF π–d molecular conductor exhibiting FISDW transitions [3]. The chemical modification with mixed anion can also alter the dimensionality and π–d interaction.

In order to study systematically the correlation between AF ordering of d-spins and SDW instability of itinerant π-electrons, we have studied magnetotransport properties of anion-mixed crystals $(DIETSe)_2FeBr_{4x}Cl_{4(1-x)}$ [x = 0.5, 0.75]. We have also measured Hall resistance of $(DIETSe)_2FeCl_4$ to investigate FISDW states.

Experimental

Magnetoresistance of $(DIETSe)_2FeBr_{4x}Cl_{4(1-x)}$ [x = 0.5, 0.75] and Hall resistance of $(DIETSe)_2FeCl_4$ were measured under high magnetic field up to 35 T using the resistive magnet in Cell12. Magnetic field was applied along the least conducting *b*-axis. Hydrostatic pressure was applied to the crystals using clamp-type pressure cell so that SDW transition is suppressed. Pressure was estimated by the resistance change of manganin wire.

Results and Discussion

We have succeeded in observing FISDW transitions and quantum oscillation (QO) in $(DIETSe)_2FeBr_{4x}Cl_{4(1-x)}$ [x = 0.5, 0.75]. Figure 1 displays the results of $FeBr_2Cl_2$ salt. Clear QO appears in both FISDW and metallic phases and even at 20 K. This indicates the crystals are of high quality and have very light effective mass. The areas of Fermi surface contributed to QO in $FeBr_2Cl_2$ and $FeBr_3Cl$ salts are estimated to be 380 and 350 T, respectively, which are consistent with the results of resent DFT band structure calculations. It should be noted that the anomalous MR below 8 T is attributed to spin-flop and AF transitions of d spins.

We have also found the rapidly increase of Hall resistance above ca. 15 T in the $FeCl_4$ salt, confirming the FISDW transition at the highest critical field.

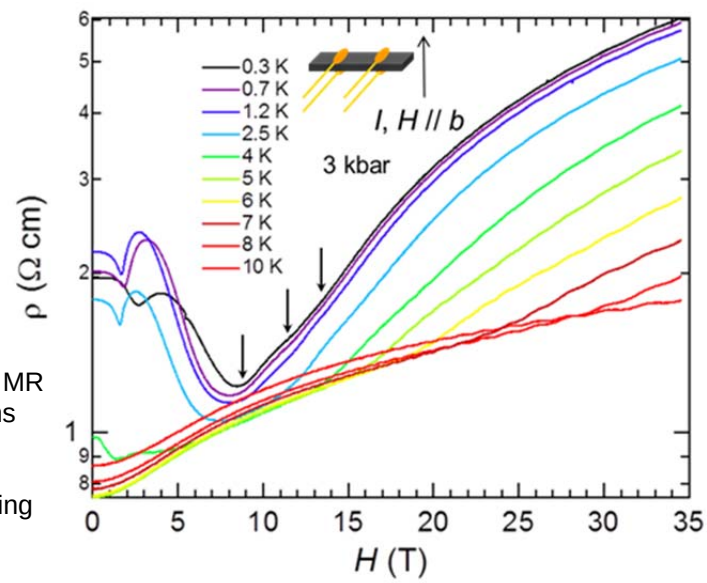

Fig.1 Magnetoresistance of $(DIETSe)_2FeBr_2Cl_2$ up to 35 T

Acknowledgements

This work was supported by KAKENHI (25400367) and JSPS Fellowship (25-1778) from JSPS. Work at the NHMFL was supported by National Science Foundation Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy.

References

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