High-Field Magneto-Transport Study of a Metallic Delafossite Oxide

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Introduction

Large magneto-resistance is one of the attractive physical properties in both scientific and application fields. Giant magneto-resistance in magnetic multilayered thin films and colossal magneto-resistance in manganite oxides are essentially realized in a coupling between the localized spin configuration and charge transport. On the contrary, we focus on a simple metallic oxide $PdCoO_2$ with a layered-hexagonal delafossite structure. Although no sign of magnetic anomalies were observed on this material, the inter-layer magneto-resistance reaches 35,000 % at 2 K, and 50 % even at room temperature (300 K) up to 14 T when the field (*H*) is applied along *H* // [1-10] [1]. $PdCoO_2$ has a quasi-two dimensional half-filled electronic structure, indicating single large Fermi surface. Besides, the observed large magneto-resistance can be explained in terms conventional Boltzmann transport theory, combined with the Fermi-surface topology [2]. We focus on both application and scientific aspects: (1) how the magneto-resistance evolves and (2) whether novel phenomena are detected under the higher fields. For the former case, we explore the potential of the nonmagnetic oxide as a functional material that are applicable over the wide temperature and field ranges.

Experimental

High quality single-crystals of $PdCoO_2$ were grown by Dr. H. Takatsu at Tokyo Metropolitan University. Magneto-resistance was measured at NHMFL using a resistive magnet (Cell 12) and a superconducting magnet (SCM 2). For both systems, temperature was controlled between 1.4 and 300 K using 4He VTI system. Also, the probes we used had single-axis rotator, we were able to carefully rotate the sample under the magnetic field in order to align the samples as exact as possible. The magneto-resistance was measured by a standard four-probe method.

Results and Discussion

Figure 1 shows the transverse magneto-resistance of $PdCoO_2$ under various temperature, where we measured inter-layer resistance under *H* // [1-10] and the current (*I*) flowing along [001]. We note that, in particular, we aligned the angle along *H* // [1-10] at low temperature within 0.03 degrees, because the magneto-resistive behavior is very sensitive to the angle. At low temperature, the magneto-resistance reached 350,000% up to 35 T. Interestingly, the magneto-resistance increased (almost linearly at high fields) without saturation. The magneto-resistance suppresses with increasing temperature, it still reaches ~ 100 % even at room temperature. Using these results, we found that conventional Kohler plot was successful. This indicates that the single scattering process is responsible for the transport properties on this material.

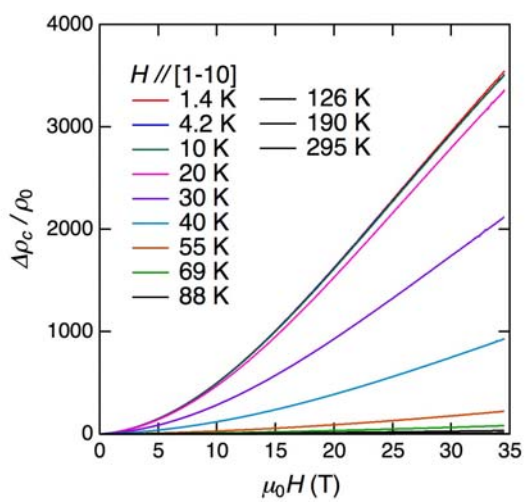

Fig.1 Inter-layer transverse magnetoresistance of $PdCoO_2$ under various temperatures. Non-saturating magneto-resistance is seen.

Conclusions

We have measured non-saturating magnetoresistance reaching 350,000% up to 35 T when measuring the transverse configuration (*H* // [1-10], *I* // [001]) on $PdCoO_2$ with single Fermi surface.

Acknowledgements

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References

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