Angle Dependence of the Critical Field in Weyl Superconductor $MoTe_2$

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Introduction

Magneto-transport is a powerful tool to identify relativistic carrier dynamics. The unusual transport properties such as giant magnetoresistance, negative mangnetoresistance and nonlinear Hall effect are observed in many Dirac and Weyl semimetals of Na_3Bi, Cd_3As_2, TaAs, NbP, WTe_2 via doping, magnetic field, pressure and non-centrosymmetric crystal structure. $MoTe_2$, one of group 6 TMDs exhibit not only various crystal structures including hexagonal (2H), rhombohedra (3R), monoclinic (1T') and orthorhombic (T_d) structure, but diverse electronic phases including semiconducting, semimetallic, superconducting and topological phases. Among them, 1T'- and T_d-$MoTe_2$ have been reported as semimetallic phases where 1T' phase undergoes the structural phase transition to T_d phase below 250 K [1, 2].

Experimental

We synthesized semimetallic $MoTe_2$ single crystals, which exhibit a low temperature phase of Td. $MoTe_2$ crystals, were prepared for the magneto-transport measurements and 4 probe measurements were conducted at 20 mK with the field sweep rate of 0.3 T/min, in SCM-1. The current flows along a- and b-axis where a-axis is a parallel direction of Mo-Mo chain and b-axis is a perpendicular direction of M-Mo chains. The angles between magnetic field and current were changeable during measurements, giving different in-plane and out of plane B-field to layered materials.

Results and Discussion

In magnetic field dependent magnetoresistance curves of MoTe2 show two distinct critical fields (Hc1 and Hc2). In the MR curves at the temperature of 1.8 K, the preliminary data shows the Hc2 is clearly depending on the angle. H_{c2} values deduced from angle dependent MR curves at 1.8 K are varied and the projected H_c values to the sample normal ($H_c \cos\theta$) show constant values of 0.5 T This indicates Hc_2 is related to the Lorentzian force of the current. However, the angle dependent MR curves at 20 mK show that the transition from superconducting state to normal metal state exhibit two critical fields, Hc_1 and Hc_2. The resistance is rapidly increased up to Hc_1 and then, the resistance is gradually increased up to Hc_2. Different from Hc_2 which we described above, HC_1 doesn't show strong angle-dependency in the critical field.

Conclusions

We observed the angle dependent critical field in layered transition metal dichalcogenide, $MoTe_2$. The magnetoresistance in the normal metal state is strongly depending on the effective magnetic field applied on the sample. In addition, the critical fields of superconducting state doesn't show strong angle dependency.

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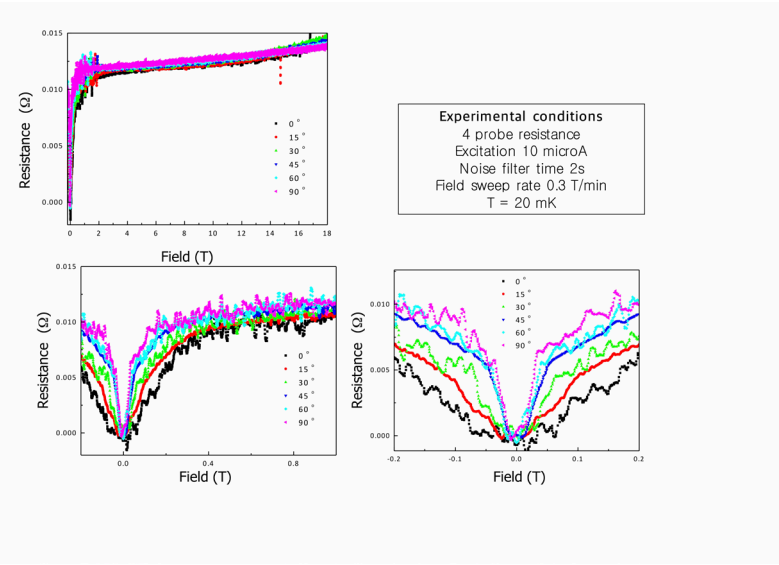

Fig.1 The angle dependent MR curves in $MoTe_2$