Thermal and Electrical Properties of Weyl Semimetals

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Introduction

2 dimensional TMD materials have drawn attention due to a variety of interesting electronic properties depending on chemical compositions, crystal structures, dopants, physical pressure and stress. $MoTe_2$ is known to have a phase of Weyl semimetal and/or a superconducting phase, after undergoing structural phase transition from monoclinic phase (T'-$MoTe_2$) to orthorhombic phase (Td-$MoTe_2$). Td-MoTe2 was reported to show extremely large magnetoresistance on samples with large RRR or superconductivity with small RRR, presumably due to electron-electron interaction changed with other scattering factors, which is still a controversy.

Experimental

We measured electrical transport properties of CVT (chemical vapor transport) grown Td-$MoTe_2$ in dilution refrigerator (SCM1), and thermal and thermoelectric properties in 3He system (SCM2) in order to observe Weyl Fermion behaviors and abnormal superconductivity.

Results and Discussion

In electrical transport measurements, superconducting transition of Td-$MoTe_2$ were observed from 0.3K to 1K, with upper critical field of less than 0.5T. Td-$MoTe_2$ thin film also showed angular dependence of superconducting transition in fields. Thermal and thermoelectric transport properties showed polar structural transition around 250K and phonon-contributed resonance peak below 30K, as reported. The ratio of thermal conductivity and electrical conductivity showed some deviation from Wiedemann-Franz law with showing field dependence.

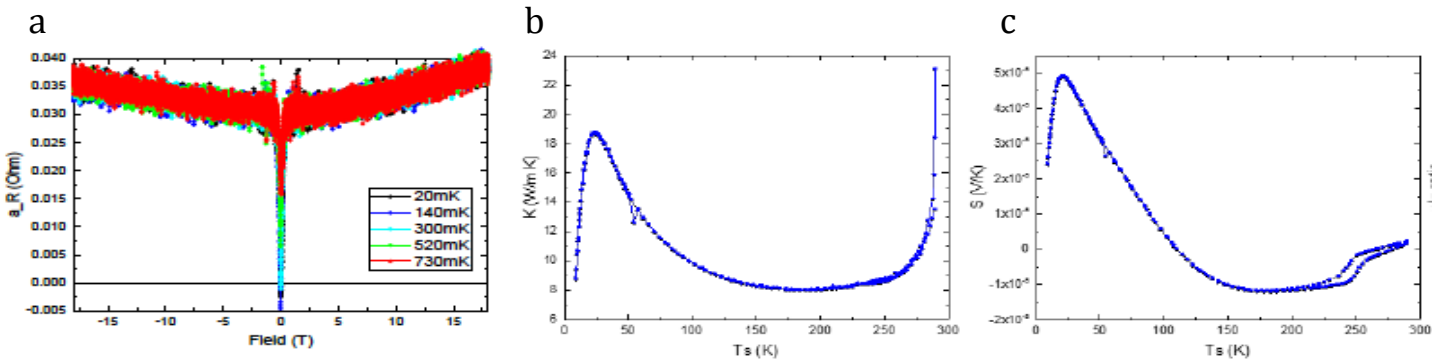

Fig.1 (a) Field induced superconducting transition under out-of-plane fields, (b) thermal conductivity, (c) Seebeck coefficient of Td-MoTe2.

Conclusions

We observed superconducting transition of Td-$MoTe_2$ in electrical transport measurements, phonon contributed resonance in thermal transport and polar structural transition. Field dependent Wiedemann-Franz law could be evidence of Weyl Fermion that requires more studies at low temperatures and high magnetic fields.

Acknowledgements

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References

[1] Gooth, J. et al., Nature **547**, 324 (2017).
[2] Liu, Z. K. et al., Nature Materials **15**, 27 (2015).
[3] Stockert, U. et al., J. Phys. **29**, 325701 (2017).
[4] Kim, K., Phys. Rev. B **90**, 121108(R) (2014).