Stannous Selenide Magnetotransport and Valence Band Structure

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Introduction

Stannous selenide (SnSe) is a layered semiconductor that is a polar analogue of the elemental layered semiconductor black phosphorus [1], which has been studied in its exfoliated form [2]. This group IV monochalcogenide has an orthorhombic crystal structure consisting of highly puckered, honeycomb layers with a d = 0.58 nm spacing [3]. SnSe is known for it's remarkable thermoelectric properties [4].

Experimental

A field effect transistor (FET) with a channel formed from an exfoliated single SnSe crystal (**Fig.1a**) was measured in a 35 T resistive magnet system. A bulk SnSe Hall bar (**Fig.1c** inset) was also measured in a helium-3 refrigerator with an 18 T superconducting magnet.

Results and Discussion

The longitudinal resistance of the exfoliated SnSe FET (**Fig.1b**) shows a strong dependence on both magnetic field and carrier density, revealing a multiple valley valence band structure. A Kohler plot of normalized magnetoresistance $(R_{xx} - R_0)/R_0$ versus B/R_0 of bulk SnSe at different temperatures (**Fig.1c)** rules out single carrier type conduction in SnSe.

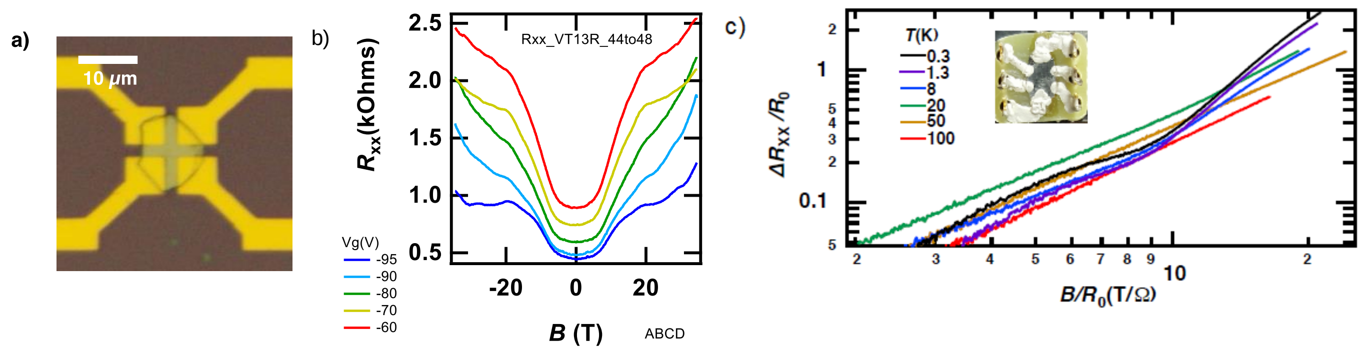

Figure 1 a) Optical micrograph of an exfoliated SnSe crystal contacted with metal electrodes defined by electron beam lithography. **b)** Measured longitudinal resistance versus gate voltage of an exfoliated SnSe FET. **c)** Kohler plot of bulk SnSe (inset). The data does not fall on a single universal curve, explicitly showing a violation of Kohler's rule.

Conclusions

Despite its close relation to black phosphorus and its potential for thermoelectric applications, relatively little is known about the electronic structure and transport properties of SnSe. Quantitative analysis of our magnetoresistance data identifies multiple valence band valleys that contribute to high Seebeck coefficient at high carrier density, and hole mobilities reaching over 2000 cm^2/Vs at low temperature in bulk SnSe. Work is on-going to improve FET characteristics.

Acknowledgements

A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-1157490 and the State of Florida. Further support was provided by the Natural Sciences and Engineering Research Council of Canada, the Canada Research Chairs program, the Canadian Institute of Advanced Research, the Institute d'Énergie Trottier and HydroQuébec.

References

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