Preliminary Magnetotransport Study on Franckeite; a Naturally Occurring Van der Waals Heterostructure

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Introduction

We will measure, for the first time, high-field transport in *franckeite*, a naturally occurring van der Waals heterostructure consisting of alternating layers of galena (PbS) and tin disulfide (SnS_2) with substitutional Fe and Sb [1]. Found in Bolivia, franckeite has been the subject of analytical and structural study, with basic electrical characterization and density functional theory (DFT) performed [2,3]. However, numerous questions about this rare van der Waals heterostructure remain.

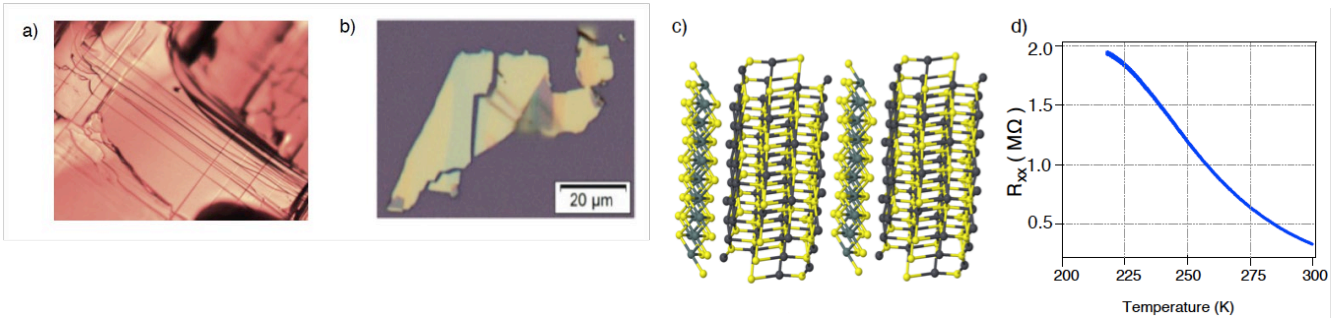

Figure 1: Optical micrographs of **a)** a bulk franckeite crystal, and **b)** a mechanically exfoliated franckeite crystal with a mean thickness of 30 nm. **c)** Crystal structure representation of alternating tin disulfide and galena layers in franckeite. **d)** The in-plane resistance versus temperature, showing intrinsic semiconducting behaviour.

Experimental

Bulk franckeite samples in both Hall bar and van der Pauw geometries were measured in a helium-3 refrigerator with an 18 T superconducting magnet at SCM2.

Results and Discussion

Longitudinal magnetoresistance has been measured in the hall bar devices. Tilting the angle of the sample relative to the direction of the field yielded a decrease in the signal, confirming the dependence of resistance in the sample on the amplitude of the field perpendicular to the surface. Furthermore, the resistance of the franckeite was observed to depend significantly on the temperature, eluding further to the insulating nature of the bulk material.

Conclusions

Although preliminary work at high magnetic fields and different orientations of the bulk franckeite devices in these fields have provided useful insight into the nature of the naturally occurring van der Waals heterostructure, more work is required in order to fully characterize the observed magnetotransport data, and efforts are on-going to improve the conductivity of franckeite flakes through electron doping by cesium intercalation.

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References

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