Determination of the Fermi Surface of WTe_2

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Introduction

Transition metal dichalcogenides are emerging as a major research frontier due to their unique properties. In particular, WTe_2 has recently been observed to exhibit positive changes in the magnetoresistance of up to 2.5 million percent with no saturation[1]. Here, we present a systematic study of WTe_2 at various angles, temperatures, and fields in an effort to discover the origins of this large, non-saturating magnetoresistance. In addition, we investigate the electronic structure of tri-layer WTe_2.

Experimental

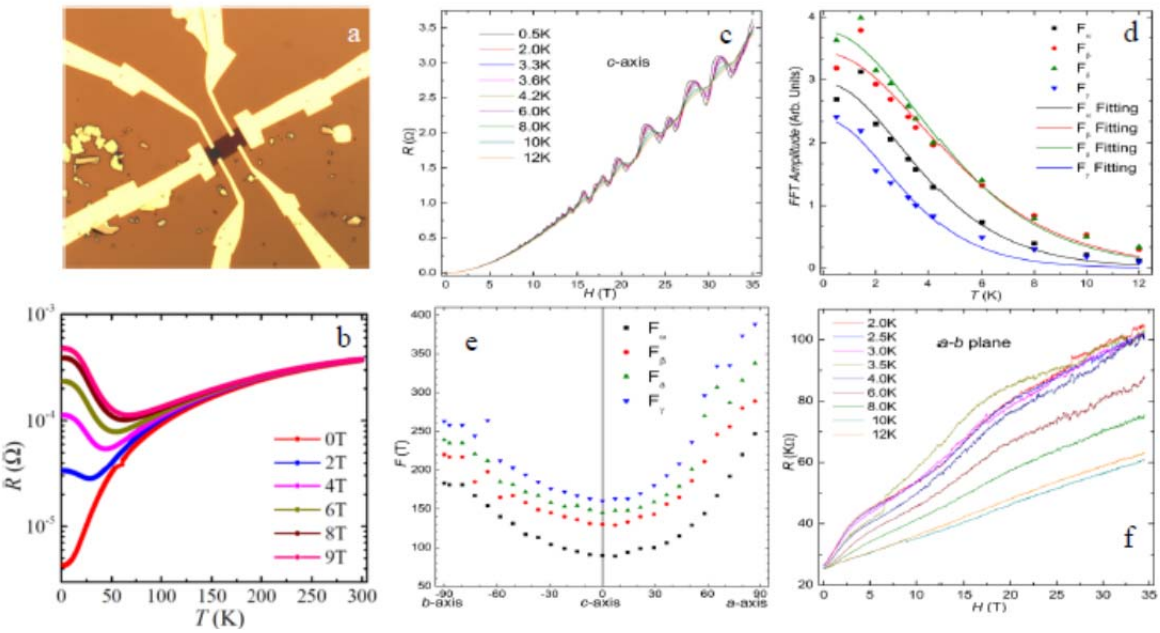

Fig 1 a. Schematic for the 3-layer device characterized in f **b.** Resistance *R* as a function temperature *T* and varying field for a typical crystal **c.** *R* as a function of magnetic field *H* applied along the *c*-axis for a WTe_2 single-crystal, at various temperatures. The electrical current was injected along the *a*-axis direction. **d.** The extracted peaks from the FFT taken from the Shubnikov de Haas (SdH) signal as a function of temperature for the *c*-axis, where the lines are fittings. The fittings, $A = BT/\sinh(CT)$ are used to extract the effective masses from $C = 14.69\mu/(\bar{H})$ **e.** The same peaks as in b, but plotted as a function of angle. **f.** Temperature-dependence of the resistance plotted as a function of *H* for a 3-atomic layer sample, contacted in 4-wire configuration. The electric current was injected in a random direction along the *a-b* plane. Notice i) that the resistivity still increases by a factor beyond 3 indicating that the mean free still large despite the interaction with the substrate, and ii) the emergence of a superimposed very low frequency oscillatory component.

Conclusions

The frequencies extracted as a function of angle show a minimum of the Fermi surface at the *c*-axis, increasing as one moves away from the *c*-axis and clearly maximizing along the *a*-axis. The effective masses show values which are heavier, as light as ~.47m_e along the c-axis and as heavy as 1.3 m_e along the a-axis. From this, one can conclude that the Fermi surface is highly anisotropic. Looking at fig.1.e., there seems to be some oscillations that are not exactly periodic in 1/*H*, possibly due to Zeeman splitting of small Fermi surfaces . Further investigation of the Fermi surface with varying number of layers is required.

Acknowledgements

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References

[1] N. A. Mazhar *et al.*, Nature **514**, 205-208(2014).