Observation of Strong Spin Orbit Coupling in $TaSe_2$

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Introduction

Semiconducting transition metal dichalcogenide (TMD) family of materials with two-dimensional layer structure has been put under the spotlight for their reasonable mobility and moderate bandgap.[1,2] With graphene's zero bandgap limitation for transistor application[3], much of nanoelectronics community's interest in TMD has been focused on semiconducting phase, in a demonstration of field-effect transistors with high on/off ratio values.[4,5] However, metallic TMDs, on the other hand, have received much less attention. With this motivation, for the first time, we study the metallic 2H-$TaSe_2$, and determine the spin-orbit scattering length of $TaSe_2$ by characterizing the weak anti-localization phenomena. Our work in engineering the magnetotransport measurements of $TaSe_2$ has provided the missing pathway to a viable electronics platform where the future possible application of spintronics devices may now be realized in 2D metallic $TaSe_2$ material.[6]

Experimental Results

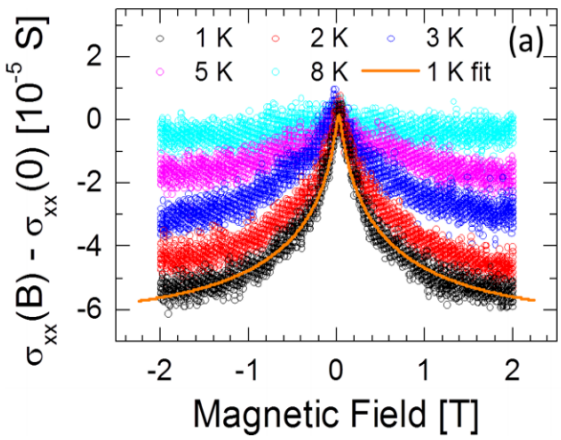

Fig 1: Differential magnetoconductance of $TaSe_2$

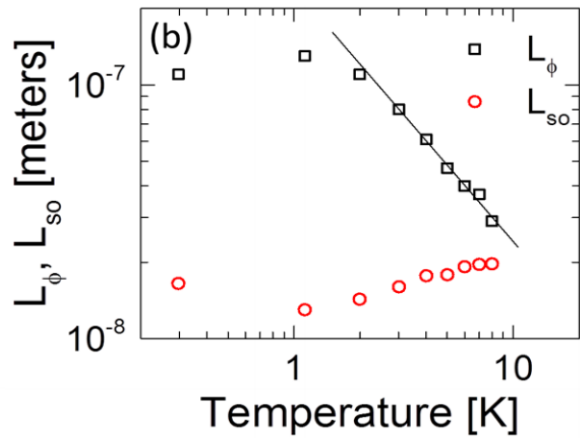

Fig 2: L_Φ and L_{SO} of $TaSe_2$

Magnetotransport measurements of few-layer $TaSe_2$ flakes exfoliated onto insulating substrates were performed using SCM2 at NHMFL, Tallahassee, FL. Figure 1 shows weak anti-localization in a $TaSe_2$ flake and indicates strong spin orbit coupling in $TaSe_2$. As shown in Figure 2, phase coherence length L_Φ decreases as T^{-1}, which is consistent with dephasing due to electron-electron scattering.[6] In addition, we observe that the spin-orbit scattering length is independent of temperature, where L_{SO} = 17 nm for 2H-$TaSe_2$ at 1 K, indicating the potential of $TaSe_2$ for future application in 2D spintronics devices.

Conclusions

In contrast to the semiconducting TMD material MoS_2, a strong spin-orbit coupling is realized in metallic phase 2H-$TaSe_2$, in a demonstration of weak anti-localization effect. Furthermore, the spin-orbit scattering length and phase coherence length have been calculated in our research. A magnitude of 17 nm spin-orbit scattering length is achieved at low temperature, indicative of a good opportunity for $TaSe_2$ in future spintronics devices.

Acknowledgements

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