Weak Localization in Few-layer Black Phosphorus

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Introduction

Recent reports of rediscovering black phosphorus (BP) have provided the missing pathway to a viable electronics technology in low dimensional materials. Bulk BP is a semiconducting material with a direct bandgap of 0.3 eV[1] and hole mobility in BP can be reached up to 10^4 cm^2/Vs.[2] The new wave of interests in BP has been focused on experimental transport in semiconductors,[3-6] potentially leading the way to understand the mechanical and electronic properties of BP. Similar to graphene, the bulk BP can be isolated by scotch tape method, where the single layer BP, known as "phosphorene" is recently demonstrated.[3] However, magnetotransport study of BP and phosphorene is still in its infancy. With this motivation, we have deeply studied the weak localization (WL) effect in few-layer BP, probed the values of phase coherence length within different temperatures.

Experimental Results

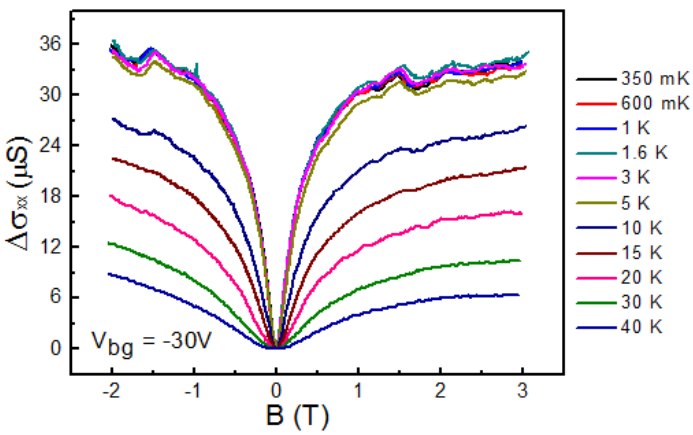

Fig 1: Magnetoconductivity varies with temperatures

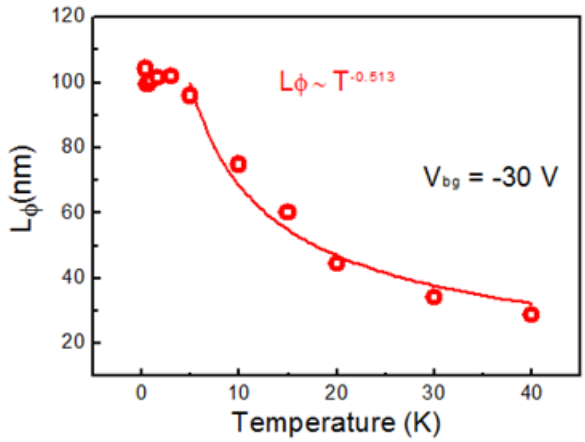

Fig 2: Phase coherence length varies with temperatures

Magnetotransport measurements of few-layer BP flake exfoliated onto insulating substrates were performed using SCM2 at NHMFL, Tallahassee, FL. Figure 1 shows a significant weak localization effect in few-layer BP. Also, a strong temperature dependent behavior of WL has been achieved in Figure 1 as well, where the negative correction dip to magnetoconductivity dies out as temperature passes 5 K. The phase coherence length has been extracted within the low *B*-field region from -500 mT to 500 mT by fitting Hikami-Larkin-Nagaoka model. A temperature dependent behavior of phase coherence length has been shown in Figure 2, indicating a power exponent of 0.5, with dephasing process due to hole-hole scattering.

Conclusions

For the first time, the WL has been revealed in 2D semiconducting material BP, where the effect has elucidated a strong temperature dependent behavior. The extracted phase coherence length in few-layer BP is around 100 nm at base temperature, pointing towards to future studies of a wide variety of phase coherent devices in the 2D material platform.

Acknowledgements

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References

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