Carrier spin relaxation in electrostatically doped transition-metal dichalcogenides

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Ambipolar semiconducting members of transition-metal dichalcogenides (TMDs, Figure 1) are recently attracting great interests from many researchers as candidates not only for conventional electronics and optics but also for spintronics and valleytronics as next-generation information technologies [1]. The spin relaxation time and the valley relaxation time are ones of the most important physical parameters for designing practical spintronic and valleytronic devices. These parameters have been mainly investigated using optical technique, in which both polarities of carriers (electrons and holes) coexist. However, the actual devices are more likely to be a unipolar carrier device.
Detecting the quantum interference of weak-localization and weak-antilocalization by magneto-resistance measurement (Figure 2) has been proved to be an effective technique to evaluate the spin relaxation time of free carriers [2,3]. We applied this technique to various members of TMDs and comprehensively evaluated their spin relaxation times in both carrier polarities. These values are further compared with the spin relaxation time in other semiconductors, as well as the optically-detected valley relaxation time of excitons in TMDs.

References

[1] D. Xiao *et al.*, RPL, 108 (2012) 196802
[2] H. T. Yuan *et al.*, Nature Phys., 9 (2013) 563-569
[3] H. Schmidt *et al.*, PRL, 116 (2016) 046803

Figures

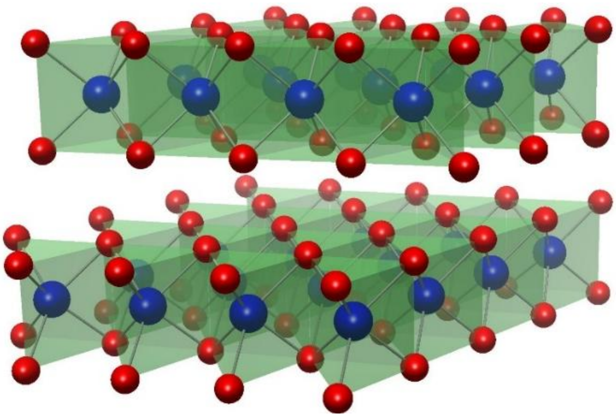

Figure 1: Crystal structure of TMDs. Blue and red spheres respectively represent transition-metal and chalcogen atoms.

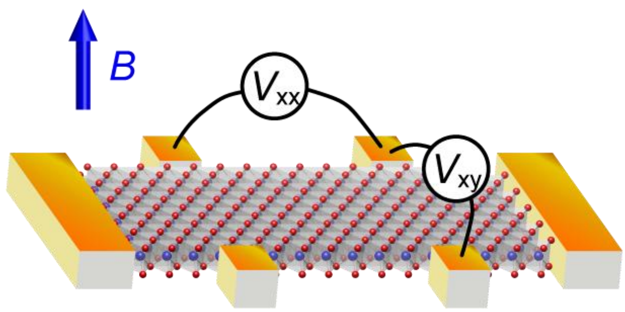

Figure 2: Measurement configuration of magneto-resistance of TMDs.