Strongly anisotropic spin relaxation in graphene–transition metal dichalcogenide heterostructures at room temperature

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In graphene spin information can be transported over long distances and, in principle, can be manipulated by using magnetic correlations or large spin-orbit coupling (SOC) induced by proximity effects [1]. Such SOC has been predicted when interfacing graphene with semiconducting transition metal dichalcogenides. Signatures of such an enhancement have been reported, but the nature of the spin relaxation in these systems remains unknown.

We recently demonstrated anisotropic spin dynamics in bilayer heterostructures comprising graphene and different transition metal dichalcogenides such as tungsten and molybdenum disulphide at room temperature. Using our pioneering technique [2], we demonstrate that the spin lifetime varies over one order of magnitude depending on the spin orientation, being largest when the spins point out of the graphene plane [3]. Similar results have been reported for graphene molybdenum diselenide heterostructures at low temperatures [4]. This indicates that the strong spin–valley coupling in the transition metal dichalcogenide is imprinted in the bilayer and felt by the propagating spins. Our findings provide a rich platform to explore coupled spin–valley phenomena and offer novel spin manipulation strategies based on spin relaxation anisotropy in two dimensional materials.

Figures

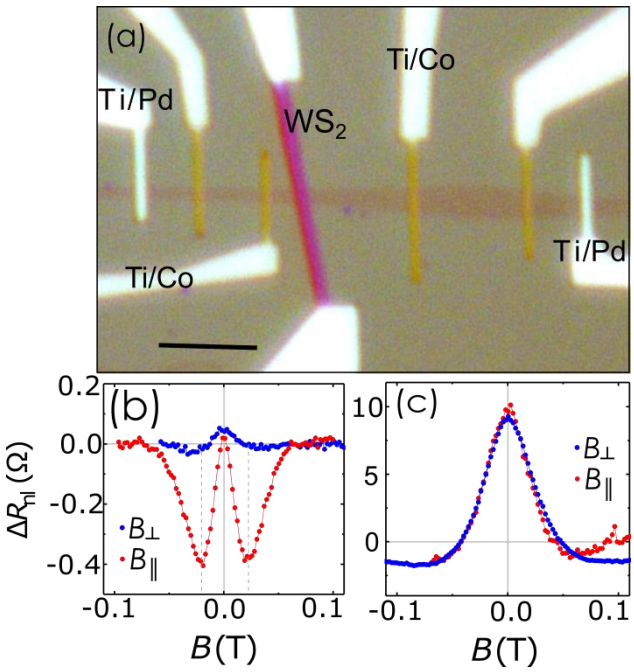

Figure 1: (a) Optical image of a typical non-local device used for the measurements. It consists of one graphene–WS_2 device and two reference graphene devices enclosing it. The bar represents 5 μm. **(b)**, **(c)** Spin precession response for magnetic field perpendicular $B_\perp$ (blue) and parallel $B_\parallel$ (red) to the graphene plane for the graphene–WS_2 device **(b)** and a reference device **(c)**. The nearly perfect overlap of the two curves in **(c)** is a consequence of the isotropic spin relaxation in graphene while the disparity of the curves in **(b)** demonstrates the highly anisotropic nature of the spin transport in graphene–WS_2.

References

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