Electron-Spin-Resonance in a proximity-coupled MoS_2/Graphene van-der-Waals heterostructure

Chithra H. Sharma
Pai Zhao, Lars Tiemann, Marta Prada and Robert H. Blick
Center for Hybrid Nanostructures (CHyN), Universität Hamburg
Chithra.Sharma@physik.uni-hamburg.de

Abstract

The extended family of van der Waals (vdW) materials offers a comprehensive resource to tailor hybrid systems of semiconducting, metallic, superconducting, and insulating layers that exhibit novel properties. [1,2] MoS_2 and Graphene are two among the most widely studied vdW-systems. MoS_2 is a semiconductor transition metal dichalcogenide (TMDC) with high spin-orbit coupling (SOC) where carrier density and thus conductivity can be tuned easily by application of gate voltages. The mobility and conductivity of MoS_2 is limited predominantly due to the Schottky contact that it forms with most metals. On the other hand, graphene is a semimetal with Dirac electrons (holes) and high conductivity and carrier mobilities. The lack of a sufficiently large band gap and the relatively small intrinsic SOC of the order of 20-40 μeV [3], however, prohibits certain device applications. Proximity induced SOC is predicted in graphene on MoS_2 and has been signaled in the observation of weak-anti-localization [4] and spin Hall effects [5]. Modification in SOC will also be reflected in the deviation of g-factor from the free electron value of 2.0023.

Here, we report low-temperature measurements on a MoS_2/Graphene heterostructure shown in Figure 1 (a). The device is laterally separated into a pure layer of graphene (left) and an MoS_2/Graphene stack (right) that allows us to study and compare the interaction-induced changes in the graphene layer using magneto-transport. Resistively-detected electron-spin-resonance measurements (Figure 1 (b)) reveal that the g-factor in the hybrid system is ~1.91 further deviating from the previously measured g-factor of 1.952 ±0.002 for pure graphene. [3,6] Understanding the nature of the interlayer coupling will facilitate observation of topological phases and designing spin-transfer devices.

References

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Figures

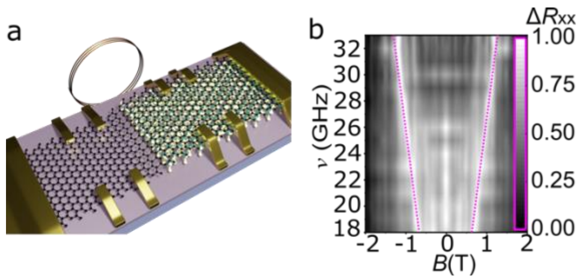

Figure 1: Schematic of the device (left). ESR measurement showing the resonance at different frequencies shown with red line as a guide to the eye (right). Measurements done at 1.5 K