Spin transport in molybdenum disulfide multilayer channel

S. H. Liang[1], Y. Lu[1*], B. S. Tao[1], S. Mc-Murtry[1], G. Wang[2], X. Marie[2], P. Renucci[2], H. Jaffrès[3], F. Montaigne[1], D. Lacour[1], J.-M. George[3], S. Petit-Watelot[1], M. Hehn[1], A. Djeffal[1], S. Mangin[1]

[1]Institut Jean Lamour, UMR 7198, CNRS-Nancy Université, BP 239, 54506 Vandœuvre, France
[2]Université de Toulouse, INSA-CNRS-UPS, LPCNO, 135 avenue de Rangueil, 31077 Toulouse, France
[3]Unité Mixte de Physique CNRS/Thales and Université Paris-Sud 11, 1 avenue A. Fresnel, 91767 Palaiseau, France

yuan.lu@univ-lorraine.fr

Abstract :

Molybdenum disulfide has recently emerged as a promising two-dimensional semiconducting material for nano-electronic, opto-electronic and spintronic applications. However, demonstrating spin-transport through a semiconducting MoS_2 channel is challenging. A particular important issue for electrical spin injection is the conductivity mismatch between the ferromagnetic (FM) electrode and the MoS_2 channel, which generally results in a vanishing magnetoresistance (MR) due to spin-backflow process by the so-called impedance mismatch problem. In FM/MoS_2 contacts, a Schottky barrier height (Φ_b) 100-180meV is created at the interface with a large charge depletion region. However, it has been recently demonstrated that an effective reduction of Φb down to ~10meV at zero back-gate voltage can be achieved by inserting a 1-2nm layer of MgO [1], Al_2O_3 [2] or TiO_2 [3] as a thin tunnel barrier between the FM and MoS_2. A careful design of the interface structure to understand the role of the oxide barrier as well as the Schottky contact is mandatory to get efficient electrical spin injection and detection.

Here we demonstrate the electrical spin injection and detection in a multilayer MoS_2 semiconducting channel. A magnetoresistance (MR) around 1% has been observed at low temperature through a 450nm long, 6 monolayer thick channel with a Co/MgO spin injector and detector. From a systematic study of the bias voltage, temperature and back-gate voltage dependence of MR, it is found that the hopping via localized states in the contact depletion region plays a key role for the observation of the two-terminal MR. Moreover, the electron spin-relaxation is found to be greatly suppressed in the multilayer MoS_2 channel for in-plan spin injection. The underestimated long spin diffusion length (~235nm) and large spin lifetime (~46ns) open a new avenue for spintronic applications using multilayer transition metal dichalcogenides.

References:
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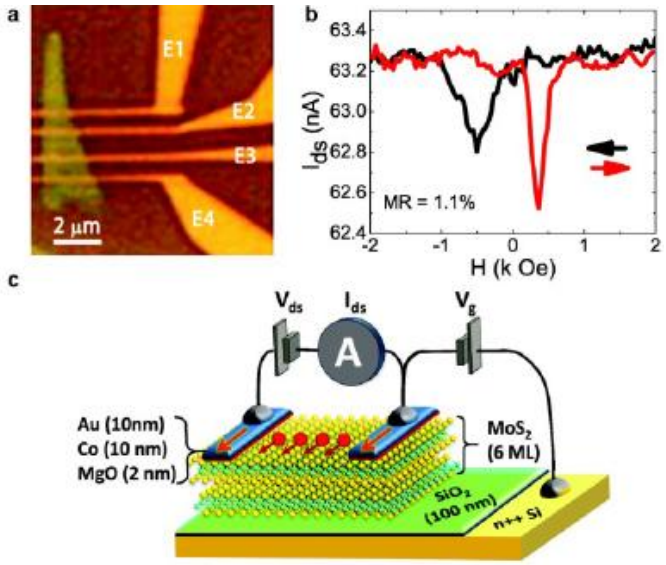

Figure 1. **a,** Optical image of the device with the multilayer MoS2 flake on 100nm SiO2/Si(n++) substrate. **b,** Magneto-resistance response of the multilayer MoS2 based lateral spin-valve device.. c, Schematics of the lateral spin-valve device.