Tailoring spin and electronic structure of MoS_2 monolayer via interaction with substrate

Vladimir Voroshnin

Helmholtz-Zentrum Berlin für Materialien und Energie,
Synchrotron BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany
vladimir.vorishnin@helmholtz-berlin.de

MoS_2 monolayer is a prominent direct band semiconductor. The band gap is 1.8eV and located at K and K' points in the Brillouin zone. Using circularly polarized light, one can separately excite electrons in K- and K+ valleys (the regions of K and K' points). Electrons in K- and K+ valleys feature opposite out-of-plane spin and cannot easily change the valley. This property is called spin-valley locking. One can excite electrons with a particular spin using circularly polarized light.

In the presented work, we manipulate the electronic and spin structure of MoS_2 via interaction with a substrate, to potentially gain control over MoS_2 optical properties. We demonstrate the Rashba effect in the MoS_2 in-plane spin structure in the MoS_2/Au(111) system. At the same time, due to symmetry reasons, the Rashba effect does not influence the regions of K and K' points, which are interesting from the point of view of optical implementation.

In order to manipulate the MoS_2 spin structure in the K and K' points regions, we use the magnetic proximity effect between the MoS_2 monolayer and the cobalt thin film in the MoS_2/graphene/Co(0001) system. We place graphene between MoS_2 and Co(0001) to prevent possible excitons, potentially able to mediate spin flipping effects in the MoS_2 monolayer, from dissipating to the metallic substrate. We demonstrate that the magnetic proximity effect causes the Zeeman splitting in MoS_2 valence band states in the region of Γ point and a spin tilt toward in-plane direction of the conduction band states in the regions of K and K' valleys.