Spin-Orbit and Magnetic Proximity Effects in Nanostructures with 2D Materials

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Two-dimensional (2D) materials can be interfaced with different classes of magnetic materials making them attractive for spintronics [1,2,3]. For instance, graphene is able to acquire exchange splitting via proximity with magnetic insulators [4,5] and can boost spin-orbit phenomena such as perpendicular magnetic anisotropy (PMA) and Dzyaloshinskii-Moriya interaction (DMI) playing a major role in spin-orbitronics [6-11]. Using first principles calculations, we provide insights into physical mechanisms of PMA and DMI enhancement in adjacent FM metal at Co/graphene and Co/h-BN interfaces [9-11] including possibilities of inducing skyrmion states in case of Co/h-BN [11] and controlling the DMI by graphene hydrogenation in Co/graphene [12]. Next, the influence of different magnetic insulators on the magnetic proximity effect induced in graphene is investigated using europium chalcogenides (EuO, EuS), yttrium iron garnet (YIG), cobalt ferrite (CFO)) as well as mutliferroic bismuth ferrite (BFO). Large exchange-splitting values in graphene varying from tens to hundreds of meV depending on substrate are found [4,5,13]. These results are then used for introduction of several proximity induced transport phenomena named proximity electro- (PER), magneto- (PMR), and multiferroic (PMER) resistance effects [13,14]. Finally, the possibility of inducing DMI and skyrmions in 2D magnets including Janus dichalcogenides is discussed [3,15,16]. Support from the EU Horizon 2020 Graphene Flagship project is acknowledged.

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