2D Materials for MTJs: from band spin filtering to hybridization/spinterface

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Spin-based electronics has recently been highlighted as a main contender for new ultrafast and efficient embedded memories (MRAMs…) and post-CMOS approaches (spin logics, stochastic, neuromorphic and quantum computing). Beyond graphene properties for efficient spin transport, 2D materials have opened novel exciting opportunities in terms of functionalities and performances for spintronics devices. Here we will present experimental results on new outcomes arising from 2D materials integration in the prototypical spintronics device, the magnetic tunnel junctions (MTJ).
Indeed, large scale direct CVD growth (now even PLD growth) can enable the integration of graphene and other 2Ds into MTJs[1]. Here, the 2Ds can enable spin filtering while acting as a passivation layer and prevent the oxidation of a ferromagnetic spin source enabling the use of novel low-cost processes (such as ALD) for spintronics[1,2].
Importantly, we will discuss with recent experiments how 2D materials interfaces with ferromagnets can add new enhanced spin filtering properties through either band structure filtering or hybridization/proximity effect (a.k.a. spinterface). Starting with graphene [2,3] we will then present results concerning other 2D materials beyond graphene (H-BN, TMDCs…) for MTJs. For example, we will show how even an insulator material such as h-BN can become metallic and spin polarized through hybridization with Fe or Co leading to strong spin signals and inversion of the spin polarization (with ab-initio calculations in support) [3]. We will also show how K-Q band filtering can lead to layer dependent spin polarization reversal in TMDCs such as WS2 [4]. Overall we will show our most recent experiments making use of graphene and 2D semiconductors, highlighting fundamental interfacial spin polarization processes and unveiling the strong potential of 2D materials for spintronics.

References

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