Spinterface: hybridization and interface effects in magnetic tunnel junctions from molecules to 2D materials

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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). Here we will present experimental results on new outcomes arising from molecules and 2D materials integration as hybrid quantum materials in the prototypical spintronics device, the magnetic tunnel junctions (MTJ). We will show that beyond graphene's potential for highly efficient spin information transport [1], originally overlooked opportunities arising from hybridization or proximity effect could lead to develop radically new spintronics functionalities, unavailable with conventional inorganic materials.

We will discuss, with recent experiments, how 2D materials or molecular interfaces with ferromagnets can add new enhanced spin filtering properties through either band structure filtering or hybridization/proximity effect, a.k.a. spinterface [2]. Starting with molecules and graphene [2,3] we will then present results concerning other 2D materials (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 [4]. We will also show how K-Q band filtering can lead to layer dependent spin polarization reversal in TMDCs such as WS2 [5]. Overall we will show our most recent experiments, highlighting fundamental interfacial spin polarization processes and unveiling the strong potential of hybrid quantum interfaces (now even large scale[6]) for spintronics.

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