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Spin filtering effect of ferromagnetic metal-organic interfaces

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The study of the spin properties of organic semiconductors (OSC) is recently receiving great attention. Being characterized by moderate spin-relaxation lengths, one of the most promising routes to employ OSC for spintronics applications is probably to exploit the high spin injection achievable across ferromagnetic metal-organic interfaces [1,2]. Combined with the extreme flexibility and tunability of OSC, it is expected that such hybrid interfaces will constitute a fundamental building block for advanced spintronics devices, where spin-injection is controlled by fine-tuning of the interface physical ad chemical properties. An example has been recently presented in [3], where doping of the OSC copper phthalocyanine (CuPc) has been successfully used to tune the spin functionality of a cobalt-CuPc interface. In particular, the presence of a spin-polarized hybrid interface state, acting as a spin-filter at the interface, has been used to enhance the efficiency of spin injection to values above 100%. In order to exploit such great potential of hybrid organic-inorganic interfaces, fundamental knowledge about their spin-dependent properties is essential. Besides the cobalt-CuPc interface, we have studied the iron-CuPc, cobalt- tris[8-hydroxyquinoline]aluminium (Alq3) and iron-Alq3 interfaces. We applied several complementary experimental techniques, namely spin polarized scanning tunnelling microscopy and spectroscopy together with spin polarized ultraviolet photoemission spectroscopy and spin- and time-resolved two-photon photoemission. We found evidence for spin-polarized interface states and show that they act as a spin-filter for electrons crossing the interface between the ferromagnetic metal and the OSC. Correspondingly, we observed a pronounced spin-dependency of the lifetime of electrons injected in the above mentioned hybrid spin-polarized interface states.

[1] M. Cinchetti et al., Nature Materials 8, 115-119 (2009);
[2] H. Ding et al., Phys. Rev. B 78, 075311 (2008);
[3] M. Cinchetti et al., Phys. Rev. Lett. 104, 217602 (2010).