Unravelling the potential of hybrid organic-inorganic interfaces for spintronics

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Organic semiconductors (OSC) have considerably attracted the interest of the scientific community due to the possibility of implementing very-low-cost and versatile electronic devices based on organic thin-film materials. Examples are organic light-emitting diodes, organic thin-film transistors and organic photovoltaic cells. Recently, different pioneering experiments suggested that OSC represent as well a major opportunity for application in the growing field of spintronics, which is built upon active manipulation and control of the electronic spin degree of freedom. OSC are composed of light elements, leading to low spin-orbit coupling and hyperfine interaction of the electronic states participating in the electrical conductance process.
The study of the spin properties of OSC is currently 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) [4] 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-hydroxyquinolinato)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 characterized by a pronounced spin-dependent lifetime and show that they act as a spin-filter for electrons crossing the interface between the ferromagnetic metal and the OSC.

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[3] M. Cinchetti et al., Phys. Rev. Lett. 104, 217602 (2010);
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