NOVEL SPIN EFFECTS AT METAL-ORGANIC INTERFACES

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Our objective is a better understanding of the electronic and the magnetic interactions at the interface between an organic semiconductor and a ferromagnetic metal. In fact, the study of the spin properties of metal-organic (MO) interfaces has recently received considerable attention because of the prospect of developing a new generation of spin devices useful for information technology [1]. One anticipates the development of new hybrid, versatile, flexible, low-cost and multifunctional molecular devices based upon organic and non-volatile magnetic materials. The advantage is that molecular materials are built upon cheap, light elements (C,N,H…) that are widely available, and their properties can be tuned by organic synthetic methodologies.

However, in order to be able to exploit in full the promising features of ferromagnetic MO interfaces, a more complete understanding of the interfacial properties, in particular the spin transport through the organic layer, needs the knowledge of (1) the molecule-induced electronic band structure at the interface and (2) how incident spin-polarized electrons are influenced when interacting with the molecular layer. This is exactly the goal of the present project which will concentrate on two novel aspects of ferromagnetic MO interfaces which we discovered very recently:

(1) The existence of highly spin-polarized molecule-induced interface states close to the Fermi energy at room temperature in ferromagnetic MO interfaces [2].

(2) A completely unexpected and up to now unexplained effect: The spin dependence of the electron reflectivity at ferromagnetic MO interfaces breaks down [3].

By exploiting different experimental as well as theoretical methods (in collaboration with theoreticians at the IPCMS) we will study these aspects with the goal to find out which parameters are actually governing the interaction of spin-polarized electrons at ferromagnetic MO interfaces. While the study of spin-polarized interface states at these interfaces is motivated by the search for an ideal spin-polarized current source which will constitute a fundamental building block for advanced spintronic devices, the study of the breakdown effect is necessary in order to elucidate the physics behind this completely novel property of carbon-based materials.

The study of the spin-polarized interface states will mostly be performed at the synchrotron SOLEIL (Paris), while the measurements of the spin-dependent electron reflectivity will be performed at the IPCMS [4]. Both parts of the project will get essential input from collaborations which we want to start with two groups: one from the University of Muenster in Germany, which is the leading group in the world concerning spin-resolved inverse photoemission spectroscopy. This collaboration will allow us to get a more complete picture of the molecule-induced spin-polarized band structure of ferromagnetic MO interfaces. A second collaboration will be started with a group in France which has great expertise in spin-polarized low-energy electron microscopy. This will enable us to study the spatial evolution of the breakdown effect with organics as well as with graphene. These measurements are believed to become essential for the understanding of this novel spin effect.

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[2] F. Djeghloul *et al.*, Sci. Rep. **3**, 1272 (2013).
[3] F. Djeghloul *et al.*, submitted to Phys. Rev. B.
[4] P. Dey, W. Weber, J. Phys. Cond. Mat. **23**, 473201 (2011).