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Interface as key unit in molecular spintronic devices

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Information and communication technology (ICT) is calling for solutions enabling lower power consumption, further miniaturization and multi-functionality requiring the development of new device concepts and new materials. A fertile approach to meet such demands is the introduction of the spin degree of freedom into electronics devices, an approach commonly known as spintronics. This already lead to a revolution in the information storage (GMR read heads) in the last decades. Nowadays, the challenge is to bring spintronics also into devices dedicated to logics, communications and storage within the same material technology [1].

Organic semiconductors emerged as an extraordinary spintronic material about ten years ago, when a few papers appeared with straightforward and encouraging claims on spintronics phenomena [2]. From then on Organic Spintronics has evolved into a prolific discipline populated by a large number of experimentalists and theoreticians.

Research in molecular spintronics began with the aim of using molecules as spin transport media, thanks to their intrinsically weak spin relaxation mechanisms. Initial experiments focused on reaching spin transport in molecular films and on replicating previous device concepts taken from inorganic spintronics, such as spin valves and magnetic tunnel junctions. However, it soon became apparent that molecules were playing another role beyond that of mere spin transport materials. For example, in experiments with vertical spin valves, many groups were reporting consistently negative magnetoresistance. These results were striking, as they contradicted the well-established spin polarization sign of the ferromagnetic electrodes and the present knowledge at that time regarding spin transport. A few years later, a coherent picture arose invoking the role of molecular layers in tuning the spin polarization of ferromagnetic materials at the interface, and 'spinterface' was officially born.

Along this line I will especially concentrate on interfaces, representing the most important and the most hidden part of any spintronic device. Revealing their secrets is scientifically hard and experimentally costly, requiring sophisticated spectroscopic methods and massive calculations. For an interface consisting of a hard metallic electrode touching a soft organic layer, the situation obviously becomes even more complicated. I will overview the main achievements of the community in the investigation of very complex and very rich interface properties [3] and will describe the possibilities to develop and fabricate multifunctional devices which operation is fully dominated by the interface.

References

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