Organic spintronics

S. Boukari
Université de Strasbourg, CNRS, Institut de Physique et Chimie des Matériaux de Strasbourg, UMR 7504, F-67000 Strasbourg
samy.boukari@ipcms.unistra.fr

To ensure the long-term progress of information technology, radically new concepts, materials and processing methods are required to circumvent the limitations of traditional electronics. Spin electronics, or spintronics, adds a new spin degree of freedom to conventional charge-based electronics. By injecting, transporting, controlling and detecting spin-polarized currents, new spin-based devices can be obtained, including spin valves (magnetoresistive devices), spin-FETs (field-effect transistors with spin-polarized source and drain), spin-LEDs (spin-polarized light-emitting diodes), and quantum bits for quantum computation and communication.

Separately, organic electronics offers the advantages of low-cost materials and processing, the tuning of electronic properties by simple chemical routes to build multifunctional devices, and self-organization. In a more long-term perspective, organic electronics at the nano- or molecular scale will exploit intriguing electric properties of nanoscopic objects down to single molecules in electric circuits.

For instance, the spin-polarized hybridization resulting from the adsorption of molecules on ferromagnetic metals, which is called an organic spinterface [SAN11], can lead to a high spin polarization (~100%) even at room temperature [DJE16], and in turn promotes giant magnetoresistance, high tunneling magnetoresistance (up to 10000 % !) or tunneling anisotropic magnetoresitance [BAR15, BAR16]. The recently reported ability to electrically modulate the magnetism of the organic spinterface [STU17], which drives its spintronic properties, represents an important first building block within a conceptual proposal to develop active molecular spinterfaces [CIN17].

Recently, as another consequence of interface properties, it appeared that an organic layer can induce an effective exchange field on ferromagnetic layers, either i) due to the presence of spin chains in the molecular layer [BAR15, GRU15] -- a mechanism similar to exchange bias in inorganic materials -- or ii) due to spin frustration induced at the interface [RAM13]. The latter case is a new effect, not yet not fully understood, specific to organic materials and unknown with inorganic materials, in that it occurs with nominally non-magnetic molecules.

[BAR15] Barraud *et al*. Phys. Rev. Lett. **114** (2015) 206603.
[BAR16] Barraud *et al*. Dalton Trans **45** (2016) 16694.
[CIN17] Cinchetti *et al*. *Nat. Mater.* **16** (2017) 507.
[DJE16] Djeghloul *et al*. *J. Phys. Chem. Lett.* **2016**, 7, 2310.
[GRU15] Gruber *et al*. Nature Mater. **14** (2015) 981.
[RAM13] Raman *et al*. Nature **493** (2013) 509.
[SAN11] Sanvito, *Chem. Soc. Rev.* **40** (2011) 3336.