Subphthalocyanine based spin valve:
From diode-like behavior to bias-voltage dependence of magnetoresistance

Safaa Elidrissi Moubtassim,[1] Eugenio Coronado[1]

[1] *Instituto de Ciencia Molecular (ICMOL) Universidad de Valencia, Spain*
e-mail: Elidrissi.safaa@uv.es

The spin valve can easily be considered the most studied and the most cited spintronic device. The spin-polarized current is being injected from ferromagnetic electrodes into an interlayer material. These electrodes should present distinct coercive fields so their magnetization changes differently while applying an external field which leads to hysteretic switching in the device resistance between two states: the parallel and the antiparallel one. Such spin transport requires either high carrier mobility or long spin-relaxation times which can be limiting in the case of organic materials.

Two decades of prolific number of reported "organic spin valves" contrasts with the mere understanding of the spin-dependent processes in organic semiconductors and the lack of phenomenological approach to untangle mechanisms. In sum, organic materials are claimed to show weak spin-orbit coupling and strong spin-hyperfine interaction, they can offer, as active interlayers, an extensive amount of possibilities to tailor the device properties, much more than inorganic semiconductors, besides, the spinterface is key! Yet, the community is still struggling to explain the origin of the observed magnetoresistance.

Here we present the first example of Subphthalocyanines (subPcs) based spin valve. SubPcs are contracted homologues of the Phthalocyanines, one of the most investigated porphyrin. They are only known as boron derivatives and are formed with three isoindole subunits. This unique configuration gives rise to a nonplanar bowl-shaped structure contrasting with the planar aromaticity of the above-mentioned phthalocyanines. They are interesting because their optoelectronic features can be tuned by changing their axial ligand (B-A) and by functionalizing the peripheral positions (R) (figure 1). The integration of subPcs as active molecular layer was first motivated in order to investigate how their electrical permanent dipole would affect the spin injection from the ferromagnetic electrode and at the same time the hysteretic resistance switching (figure 2 and 3).

References

Boehme C. and Lupton J. M., Nature Nanotechnol., 8, 612–15, **2013**
Cinchetti M., Dediu V. A. & Hueso L. E., Nature Materials, 16, 507–515, **2017**

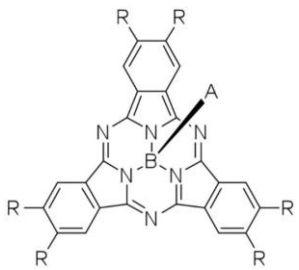

Figure 1 Chemical structure of subphthalocynines

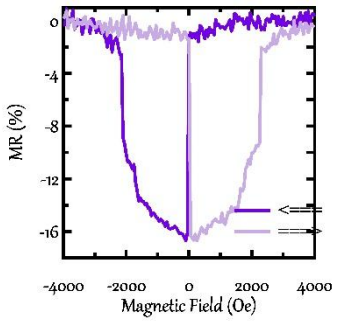

Figure 2 Magnetoresistance signal at 20 K

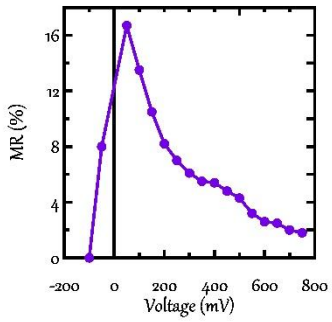

Figure 3 Bias voltage dependence of the magnetoresistance