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X-ray circular dichroism in adsorbed films of homochiral organic molecules on ferromagnetic substrates

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We have used synchrotron based techniques (XAS, XPEEM, spin polarized UPS) to study the influence of the chirality on the magnetism, when a thin film of chiral molecules is adsorbed on a ferromagnetic layer. We have grown monolayer-thick films of 1,2-diphenyl-1,2-ethanediol (DPED), adsorbed in ultra-high vacuum on Fe and Co thin films. This molecule has two chiral centers and presents two enantiomers, which are designated according to their conformation and optical activity as (R,R)-(+)-DPED and (S,S)-(–)-DPED. We observe clearly dichroic features (natural circular dichroism) by measuring the absorption by the molecular film of circularly polarized X-rays (XAS) of opposite helicity, at the carbon K edge. This dichroic asymmetry depends on the chirality showing opposite sign for the two enantiomers.

In experiments of spin-polarized photoemission spectroscopy we observe that the photoelectons emitted through adsorbed layers of pure enantiomers display a clear spin polarization at room temperature, independent of their binding energy. The spins point along different directions in space: in-plane for (R,R)-(+)-DPED and out-of-plane for (S,S)-(–)-DPED, which makes the DPED molecule a prototype system to study enantioselective spin filtering [1].

Further photoemission microscopy (PEEM) experiments making use of the magnetic circular dichroism effect have also allowed us to image the magnetic state of the sample substrate –an epitaxial Fe film deposited on W(110)–and detect the modifications induced by the adsorption of different enantiomers of DPED. These findings lend additional support to the existence of some link between the molecular chirality and the electronic spin. They create opportunities for applications not only in organic-based molecular spintronics but also in other fields such as asymmetric chemical synthesis.

References

[1] M. Á. Niño *et al.*, Adv. Mater. **26**, (2014) 7474.

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