Nanomagnetism: Emergent phenomena at interfaces for spintronics

Interfaces of ultrathin magnetic films have recently unraveled new phenomena for spintronics. This has been crucial to the emergence of *spinorbitronics* [1], induced by adjacent large spin-orbit coupling (SOC) layers as well as the advent of *molecular spintronics* [2], where the electron spin is manipulated by molecules.

Recently, a large variety of new phenomena with an improved efficiency as compared to conventional spintronics has been found at interfaces of non-magnetic materials with spin-orbit coupling (MSOC) and ferromagnets (F) [1]. Spin/charge conversion was first observed in heavy metals due to a spin-dependent scattering, called *spin Hall effect*. Other means of conversion called *Edelstein effect* find their origin in the spin-momentum locking found at interfaces with Rashba SOC or at edges of 3D topological insulators. In MSOC/F heterostructures, the charge-current-induced spin-accumulation at MSOC diffuses into the ferromagnet and induces a spin-orbit torque. This acts on the magnetization and may induce magnetization switching, domain wall motion, or sustained oscillations, even in insulating ferromagnets, pure spin-currents being able to flow into insulators through spin-waves. Additionally, MSOC/F interfaces may induce *Dzyaloshinskii-Moriya interaction*, which arises from the combination of SOC with inversion symmetry breaking at the interface. It promotes non-collinear, chiral spin textures, such as chiral domain walls, spin-spirals or skyrmions.

Molecular spintronics [2] is an advanced research field combining the flexibility of molecular electronics and molecular magnetism, with the advantages of spintronics. Its main goal is the manipulation of the electron spin by a wise combination of *ad hoc* molecules and inorganic substrates. Besides the rich magnetic behavior resulting from the interaction between a magnetic molecule and a metal surface, or vice versa, additional functions such as switchability by external parameters (light, voltage) can be integrated. In the recent years the concept of *spinterface* [3] has emerged showing that magneto-transport properties of molecular based nano devices is essentially governed by the interface between the molecules and the substrate. In particular the “matching” (or “unmatching”) of orbitals between the two materials plays a crucial role. This concept initially introduced in the context of molecular spintronics is also extremely relevant in spinorbitronics.

Both domains offer a wide range of routes towards spin-based devices with potential applications in information storage and processing. However, due to the very large number of possible material combinations, there is an important need for fundamental understanding, guiding concepts and tools to scale up and systematize the search of a new generation of multifunctional spintronic devices that can respond simultaneously to various physical stimuli (magnetic or electrical field, current, light…). In this symposium, we wish to gather scientists from various communities to share and discuss these emerging fields, which will help defining (or refining) general concepts that could be used to devise strategies for the design of new materials or devices.

[1] A. Soumyanarayanan et al. Nature 539, 509 (2016)
[2] L. Bogani and W. Wernsdorfer, Nat. Mater. 7, 179 (2008)
[3] S. Sanvito, Nat. Phys. 6, 562 (2010)

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