A7 : Skymionic Bubbles : Fabrication, Characterisation

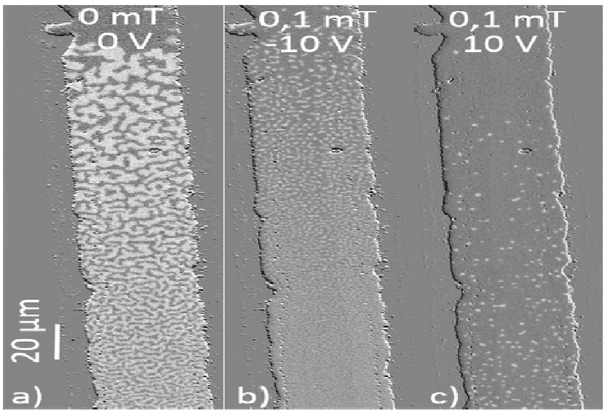
Laurent Ranno, Institut Néel CNRS/UGA

Nanomagnetism deals with the study of magnetic objects, which, using available fabrication techniques (thin film deposition and lithography), can be designed at the nanoscale. Characteristic lengths may then become similar to the object size and the surface/volume ratio increases a lot. New magnetic behaviours are evidenced. Such objects are relevant to the field of spin electronics (spintronics) where denser, i.e. smaller, devices are always of interest and deep understanding of their magnetism is necessary.

Spin-dependent transport is a very general property of magnetic conducting materials. In a homogeneous material, resistivity depends on the configuration of magnetisation relative to the electrical field (or current lines). This is the anisotropic magnetoresistance (AMR). The amplitude of this effect may reach a few % in some 3d metal alloys at 300K. Much larger magnetoresistance effects in small fields (up to 50% at 300K in milliTesla field) were later discovered in magnetic heterostructures such as magnetic metallic mutilayers with metallic spacer layers (giant magnetoresistance effect : GMR) or insulating spacer layers (tunnel magnetoresistance : TMR).

GMR can be described as the impact of the magnetic configuration on the spin polarised current. The opposite impact has recently been showed to be experimentally observable. A spin polarised current can influence the magnetic configuration leading to current-induced magnetisation reversal and current-induced domain wall displacement.

Fig. : Magnetic domain imaging using a Polar Kerr microscope at 300K. A transparent gate electrode above the sample allows to electrically control its magnetic properties and the domain structure. The multilayer structure is Si/SiO2/Ta/Pt/Co/AlOx.



An interesting new type of magnetic domains is now investigated. Bubble domains, i.e. cylindrical domains in out-of-plane magnetised films were already well known at the micron-scale. Such domains can now be induced in ultrathin films, where an extra ingredient emerges due to a large interface contribution. A chiral interface-induced exchange interaction leads to surprising new properties : the bubbles are homo-chiral, their internal structure is not the usual Bloch spin configuration but the Néel one.

This practical will take place in Institut Néel (CNRS campus). The idea is to study some of the steps involved in the fabrication of such magnetic multilayer with interesting spintronics properties and evidencing bubble domains. The multilayer will be deposited using the sputtering technique. Lift-off of some patterns will be carried out and followed by room temperature characterisation of their magnetic properties (M(H) loops using magnetometer and Kerr imaging) and transport properties (MR loops). Magnetic Domain configuration will be visualised and magnetic reversal studied using XYZ magnetic fields in a polar Kerr microscope and bubble behaviour will be evidenced. Interaction spin-current bubble will be studied.