NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2023-2024

Current-driven manipulation of the magnetisation of magnetic insulator thin films

General Scope :
Ferromagnetic thin-films are the main component of hard disks for data storage, magnetic random access memories, magnetic sensor technology based on giant- and tunnel magnetoresistance and also prototypes of logic and memory devices using domain walls. The main characteristics of these devices is their ability to control the magnetic state of the thin films either by magnetic fields or, more interestingly, by electric current pulses.
More recent is the interest of the scientific community for the manipulation of the magnetisation of insulating magnetic oxide films, and in particular of garnet thin films. These materials are of particular interest due to their low damping, and their large magnon diffusion length, which make them promising candidates for spin-wave communication and ultralow-power-dissipation applications
One of the most efficient mechanisms to switch magnetization in thin films, and move domain walls, is the so called spin orbit torque (SOT) associated to the generation of spin currents by spin Hall effect (SHE) in an adjacent heavy metal film (e.g. in Pt/Co or W/CoFeB stacks): the spin currents are transmitted to the ferromagnetic film, which exerts a torque on the magnetisation.
Charge currents cannot flow in magnetic insulators (MI), but it has been recently demonstrated that the spin currents generated by the SHE in platinum layers can be transmitted across the Pt/MI interface and lead to magnetisation switching. The internship will study the possibility to induce spin orbit torques in garnet iron films grown by magnetron sputtering and patterned with different lithography techniques.

Research topic and facilities available :
This is an experimental internship. The student will prepare garnet thin films of different thicknesses with magnetron sputtering techniques, will characterize their structural and magnetic properties and will study the dynamics of domain walls driven by a magnetic field. He/she will then pattern the Pt layer with UV lithography in the Institut Néel cleanroom, either by lift-off and etching techniques. Transport measurements will be carried out to quantify the SHE. By monitoring the magnetisation switching efficiency under the application of current pulses, the spin orbit torque strength in the different samples will be studied and compared, for different treatments of the garnet film surface.
Available instruments at Institut Néel : magnetron sputtering for magnetic thin film deposition, clean room for optical and electronic lithography, structure and magnetic characterization techniques, magneto-optical microscopes (MOKE) for magnetic imaging, etc. A Brillouin Light Scattering spectrometer may be used for complementary measurements.

Possible collaboration and networking :
Interactions with colleagues of SPINTEC are likely

Possible extension as a PhD :
Yes

Required skills:
Some notions of magnetism or nanomagnetism are required; having followed magnetism courses in M1 would be a plus. A pronounced taste for experimental physics.

Starting date : March/April 2024

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