PhD position – TEM magnetic imaging of ferromagnetic nanotubes for 3D spintronics

Keywords: 3D spintronics, magnetic nanotube, magnetic domain wall, curvature, electron holography, magnetic imaging, core-shell

Topic

Three-dimensional spintronics is a fast emerging topic [1]. On the fundamental side this opens pathways for novel spin configurations and magnetization dynamics, owing to the possibility of three-dimensional spin textures in nanowires and nanotubes [2], periodic boundary conditions and curvature-induced effects. On the applied side this would allow to extend existing spintronic technologies to three-dimensional architectures, liable to compete as an ultra-high density storage medium.

The objective of the PhD is to explore the physics of basic 3D spintronic building blocks. We will consider chemically-synthesized single-shell and core-shell magnetic nanotubes, and mostly address their magnetization textures and dynamics. While the systems will be provided through internal and external collaborations based on our recent pioneering achievements of well-defined domain walls and flux-closure domains [3], a key tool for the PhD will be transmission electron microscopy (TEM). The technique will be used for the chemical and structural analysis by electron diffraction, and high-spatial-resolution and sensitivity magnetic imaging by electron holography. The candidate will be in charge of sample preparation for electron microscopy, the imaging, and image processing needed to analyze the data. Complementary magnetic imaging techniques will also be used, such as magnetic force microscopy in the lab, and photo-emission electron microscopy and transmission x-ray microscopy at synchrotrons. Along the PhD the topic will progressively shift from a nanomagnetics focus, to spintronics objectives. We will consider operando experiments, to control the magnetization state of nanotubes under spin-polarized current in the microscope, and in particular magnetization dynamics and move domain walls. This will require the development of electrical contacting processes. For all aspects, special effort will be made on simulated images and simulations micromagnetism. The work includes participation in micro-magnetic simulations to support the physical understanding of the measurements.

The laboratories

The student will be inserted in a larger action on magnetic nanowires and nanotubes conducted in the spin textures team, involving researchers and young scientists from Spintec laboratory, Institut Néel and beyond. As such, while having a well-defined independent topic, she/he will benefit from a collaborative environment with weekly group meetings and support from other members. Transmission electron microscopy will be conducted at the PFCN Grenoble nano-characterization platform, in close collaboration with LEMMA and LETI laboratories (contacts: Jean-Luc Rouvière, David Cooper. International networking with chemists expert groups in Darmstadt and Erlangen (Germany) is also scheduled.

Salary

The topic is funded by CEA, with a monthly gross salary of 2040€. The candidate will benefit from CEA workers conditions, such as subsidized local transportation, sporting activities etc.

Application

If you are interested in this topic, please contact Olivier FRUCHART at SPINTEC (olivier.fruchart@cea.fr). Applications must include a CV, motivation and recommendation letters. Applicants must have a taste for experimental physics and

collaborative work, display understanding of condensed matter physics and have computer skills. The position is readily available and should be filled as soon as possible.

More information

Web site: http://www.spintec.fr/research/spin-textures/

[1] Three-dimensional magnetism, A. Fernández-Pacheco, O. Fruchart et al., Nat. Comm. 8, 15756 (2017). (DOI: 10.1038/ncomms15756) (HAL: 01536109)

[2] Magnetic nanowires and nanotubes, M. Staňo, O. Fruchart, in: Handbook of magnetic materials vol.27, Ed. Ekkes Brück, Elsevier. In press. [arXiv: 1808.04656]

[3] Imaging flux-closure domains and domain walls in electroless-deposited ferromagnetic nanotubes, M. Staňo, O. Fruchart et al., SciPost Physics 5 (4), 038 (2018) (DOI: 10.21468/SciPostPhys.5.4.038) (arXiv:1704.06614)