Electroless deposition of magnetic nanotubes and core-shell nanowires for a 3D spintronics

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Stage pouvant se poursuivre en thèse : Oui

Résumé :

Proposals have been made to develop a spintronic technology in three dimensions, to lift foreseen limitations of areal density faced by any 2D-based technology such as hard disk drives. Chemical synthesis is the best route to deliver 3D systems such as dense arrays of wires, and joint work between chemists and the spintronic community are emerging. These systems also offer opportunities for new fundamental science of domain walls and spin waves, due to the confined geometry, different topology (circular boundary conditions), and curvature-specific physics [1].

In this context we are pioneering the study of magnetic nanotubes, yet another novel geometry. These are obtained by electroless plating, also widely used in industry for deposition of coatings on various surfaces, including non-conducting and of high-aspect ratio. The purpose of the present proposal is to open routes to fabricate multi-layered nanotubes, or in other words, core-shell. The motivation is to apply the standard concepts required to implement nanomagnetism and spintronics in a planar technology, to a 3D geometry (eg: ferro/metal/ferro for giant magneto-resistance).

Sujet détaillé :

Electroless plating relies on reduction of metallic ions from dissolved salts by a reducing chemical agent. By performing the deposition in nanoporous templates one can deposit large arrays of magnetic nanotubes with diameters down to 100 nm [2]. Various material can be deposited ranging from simple metals to more complex compounds [3] - e.g. NiCoB (see Fig., our own work [4]). Core-shell structures will be sought by combining successive electroless plating steps, and/or with Atomic Layer Deposition and/or direct electroplating. This will be done on existing facilities. Structural characterization will be performed using atomic force microscopy, scanning and possibly also transmission electron microscopy, chemical analysis by Energy Dispersive X-ray spectroscopy. Magnetic properties will be evaluated on both arrays of tubes (magnetometry, tubes still in the template) and on isolated tubes dispersed on a flat substrate by focused Kerr (magnetooptics) or magnetic force microscopy. Support of micromagnetic simulation is provided.

The project is led as a collaboration between INAC/Spintec (O. Fruchart) and Institut Néel (L. Cagnon, M. Stano). It is part of a larger effort involving international collaborations (TU Darmstadt, FAU Erlangen, Synchrotrons).

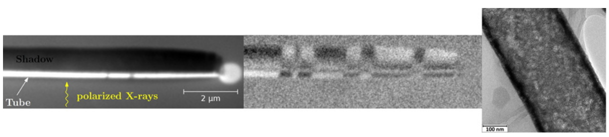
References:

[1] Streubel et al., J. Phys. D: Appl. Phys. 49 , 363001 (2016).

[2] Li et al., CrystEngComm 16, 4406 (2014).

[3] Richardson et al., ECS Trans. 64 (31), 39-48 (2015).

[4] Schaefer et al., RSC Adv., 6, 70033 (2016)



Compétences requises :

Physics/Chemistry at bachelor level. A taste for experimental and multidisciplinary work is appreciated. Welcome: physical chemistry, nanomagnetism, characterization techniques