Domain walls in magnetic nanowires: a combined electric and micromagnetic study

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In micro- and nanostructures, the magnetisation changes are strongly related to both the mobility of magnetic domain walls and the magnetocrystalline anisotropy. The behaviour of magnetic domain walls still presents many unclear points. For example the relation between morphology, resistance, migration and annihilation fields has not been addressed using a simultaneous and direct observation. The state of the art in such measurements is up to now very poor: some Japanese[1] have studied the effect of domain walls on the conductivity in manganites. All authors who studied spintronics components using electron holography or Lorentz microscopy (to visualize the domain wall morphology) made the transport study out of the microscope[2], which induces huge problems to reproduce the magnetic conditions of the microscope ex-situ. We have in hand in IPCMS the necessary technical parts to achieve this kind of simultaneous measurement inside the TEM using the objective lens field to change the sample magnetic state.

Wires in different materials and morphologies will be prepared using sputtering, electronic or/and optic lithography on an electron transparent membrane. Using adapted geometries, it is possible to create domain walls in a reproducible way through appropriate magnetic cycling. These domain walls will be studied using simultaneously transport measurements and electron holography to correlate both properties. Holograms will be registered on the latest generation JEOL electron microscope at the IPCMS equipped with a holography biprism. These holograms will be then analysed to extract the magnetic contribution and the magnetic field map. The phases will be simulated in simple configurations and calculated by micromagnetic simulations.

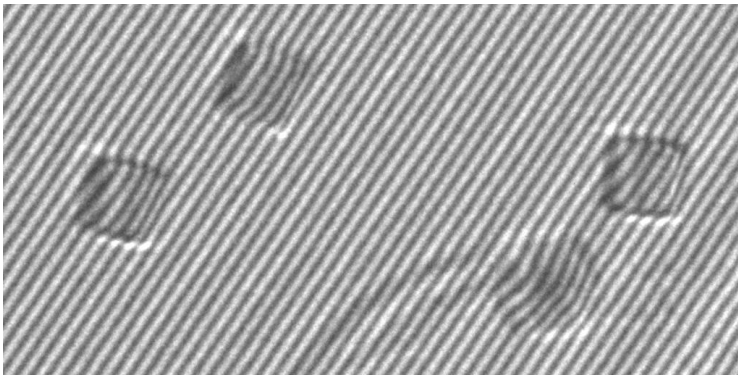

Figure 1 : Electronic hologram of ferrites nanocubes[3]. The fringe deviations are due to the electric and magnetic potentials variations between outside and inside the material.

[1] Murakami Y et al, Simultaneous measurements of conductivity and magnetism by using microprobes and electron holography, Appl. Phys. Lett. **88** 223103 (2006); Shindo D, Murakami Y, Electron holography of magnetic materials, J. Phys. D-Appl. Phys.**, 41,** 183002 (2008)
[2] Klaui M et al, Direct observation of domain-wall pinning at nanoscale constrictions, Appl. Phys. Lett. **87** 102509 (2005)
[3] B.P. Pichon, O. Gerber, C. Lefevre, I. Florea, S. Fleutot, W. Baaziz, M. Pauly, M. Ohlmann, C. Ulhaq, O. Ersen, V. Pierron-Bohnes, P. Panissod, M. Drillon, S. Begin-Colin, Chem.Mater. 23 (2011) 2886