Domain structure and magnetization reversal in multisegmented cylindrical nanowires

Cristina Bran, Eider Berganza, Jose Angel Fernandez-Roldan, Miriam Jaafar, Rafael P. del Real, Agustina Asenjo, Oksana Chubykalo-Fesenko and Manuel Vazquez

Institute of Materials Science of Madrid, CSIC. 28049 Madrid. Spain

Cylindrical magnetic nanowires, NW, with multisegmented character are proposed in nanotechnology applications as magnetoresistive reading heads, barcode units for security systems, specific tactile sensors, magnetoplasmonics, MRI markers or biochemical functionalization of different segments [1]. These applications require full understanding of the NWs domain structure and magnetization process.

Most recent results for CoNi/CoNi (FM/FM) and CoFe/Cu (FM/M) NWs will be overviewed. The magnetic behavior depends on the crystalline nature of FM segments that can balance shape anisotropy. Particularly, we will address CoFe and CoNi FM segments with crystalline anisotropy, either hcp or fcc structure, depending on the relative weight of elements.

NWs with respective alternating segments were electrochemically grown (130 nm diameter, with magnetic segments around 1 micron long, and metallic segments 20 nm long). Surface wa scharacterized by magnetic force imaging, magnetooptic Kerr effect and photoemission electron microscopy, PEEM, combined with X-ray magnetic circular dichroism, XMCD (that provides also internal magnetic configuration), and complemented with micromagnetic simulations.

For CoNi/CoNi NWs, a periodical modulation in magnetic anisotropy is observed with transverse domains, imaged by PEEM/XMCD, together with more conventional vortex domains configurations [2], which is confirmed by micromagnetic simulations.

For CoFe/Cu NWs, vortex structures form at the ends of magnetic segments to determine the switching mode in each segment, and reversal propagates under magnetostatic interaction. Unidirectional propagation of the reversal process is confirmed by suitable geometry tailoring of magnetic segments.

[1] A. Mourachkine et al., Nano. Lett., 8, 3683 (2011); S. Da Col et al. Phys. Rev. B 89 (2014) 180405; M. Bañobre et. al., J. Mater. Chemistry B, DOI 10.1039c7tb00574a (2017)

[2] C. Bran et al., Phys. Rev. B.96 (2017) 125415; E. Berganza et al., Sc. Rep. 7 (2017) 11576