I.Montoya[1], L.E. Fernandez-Outon[2,3], C. Redondo[1], W. A. A. Macedo[3], R. Morales[4,5]

[1] Chemical Physics Department, Universidad del País Vasco UPV/EHU, 48940 Leioa, Spain.
[2]Departamento de Física, Universidade Federal de Minas Gerais, 31270-901, Belo Horizonte, MG, Brazil
[3]Centro de Desenvolvimento da Tecnologia Nuclear, CDTN , 30123-970 Belo Horizonte, MG, Brazil
[4] Chemical Physics Dept & BCMaterials, Universidad del País Vasco UPV/EHU, 48940 Leioa, Spain.
[5]IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain.

isaac.montoya@ehu.eus

Temperature evolution of antiferromagnetic domains in patterned exchange bias systems

Exchange Bias (EB) phenomenon manifests as an induced magnetic anisotropy in coupled ferromagnetic/ antiferromagnetic (FM/AFM) materials. It can be understood as an alignment and pinning of AFM spins at the FM/AFM interface parallel to FM spins upon cooling below the AFM Néel temperature. The introduction of competing anisotropies, e.g. via lateral patterning of FM/AFM thin films, can give rise to new magnetic properties. For technological reasons, this EB size dependence is of particular interest for the miniaturization of spintronic devices.

Our work investigates the thermal stability of patterned polycrystalline IrMn/FeCo (AFM/FM) bilayers. IrMn/FeCo lines were fabricated by physical etching of continuous bilayers. EB was induced by thermal annealing under external magnetic fields. Two annealing conditions were considered; external field applied either parallel or perpendicular to the line axis. The magnetic effect of imprinted AFM domains was studied at room temperature and low temperature after a field-cooling procedure.

Despite the direction of the annealing field with respect to the lines, the system always shows the same unidirectional anisotropy (EB) axis at room temperature, which is along the line axis. This unexpected behavior is observed even when high magnetic fields are applied during the annealing procedure. This is in contrast to previously reported results.[1]

After annealing, a field-cooling procedure was performed in order to study the stability of AFM domains. The magnitude of the exchange bias field increases at lower temperatures. However, positive cooling fields induce negative EB, while negative cooling fields yield positive EB, even though when the hysteresis loop was negatively shifted at room temperature. Meaning that, the unidirectional anisotropy is set by AFM domains rotating towards the cooling field direction.

This work was supported by grants: EU FP7-MCA-318901, EU H2020-MSCA-734801, Basque PRE-2015-1-0385, Spanish AEI-MINECO FIS2013-45469 and FIS2016-76058, and CNEN, Fapemig, Capes, CNPq.

Figures

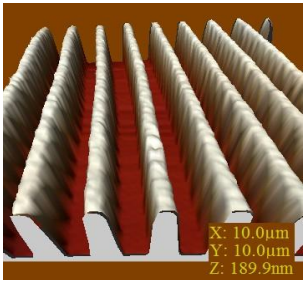

Figure 1: Atomic force microscopy image of patterned IrMn/FeCo bilayer.

References

[1] A. Hoffmann, M. Grimsditch, J.E. Pearson, J. Nogues,W.W.A. Macedo, I.K. Schuller, Phys. Rev. B 67 (2003) 220406.