MAR07-2006-002048

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Electric and Magnetic Field control of Exchange Bias[1]

CHRISTIAN BINEK, University of Nebraska-Lincoln

Exchange bias (EB) and its accompanying training effect are fundamental interface phenomena in coupled magnetic thin films with significant impact in spintronic applications. Here we report on the electric field control of the EB in innovative antiferromagnetic (AF)/ferromagnetic (FM) heterostructures and the magnetic field control of the EB training effect in exchange coupled all FM bilayer systems. Electric control of the EB is realized in Cr_2O_3 (111)/$(Co/Pt)_3$ heterostructures by taking advantage of the magnetoelectric (ME) properties of the AF pinning layer [1]. An electric field induces excess magnetization in the ME Cr_2O_3 film. Exchange coupling between the induced magnetization and the CoPt thin film gives rise to electrically controlled perpendicular EB. Bias fields are measured by means of AGFM, SQUID-magnetometry and polar Kerr-rotation. Electrically controlled EB is proposed for novel spintronic applications such as pure voltage control of magnetic configurations in spin valve-type architectures. The latter provide an attractive alternative to current-induced switching of the magnetization [2]. In addition, training of the EB effect is studied in novel all FM heterostructures of exchange coupled soft and hard FM thin films [3]. FM bilayers show remarkable analogies to the conventional AF/FM EB systems. Not only do they exhibit a tunable EB effect, they also show a distinct training behavior upon cycling the soft layer through consecutive hysteresis loops. In contrast to conventional EB systems, all FM bilayers allow the observation of training induced changes in the bias-setting hard layer by means of simple magnetometry. Initialization of the EB is achieved at constant temperature exclusively by means of magnetic fields. Our experiments show unambiguously that EB training is driven by deviations from the equilibrium spin configuration of the pinning layer. The experimental data show excellent agreement with our theoretical predictions including the subtle dynamic enhancement of the EB training which evolves with increasing field sweep rates.

[1] P. Borisov, A. Hochstrat, X. Chen, W. Kleemann, and Ch. Binek, Phys. Rev. Lett. 94, 117203 (2005).
[2] Ch. Binek, B.Doudin, J. Phys. Condens. Matter 17, L39 (2005).
[3] Ch. Binek, S. Polisetty, Xi He and A. Berger, Phys. Rev. Lett. 96, 067201 (2006).

[1]Financial support by NSF through CAREER DMR-0547887, NRI and Nebraska MRSEC.