Experimental and micromagnetic characterization of exchange biased structures for sensing applications

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We present, in this contribution, experimental results and micromagnetic analysis of the magnetization dynamics in exchange biased structures of the type IrMn/NM(x)/Permalloy used to deposit tunable spintronic sensors. NM denotes nonmagnetic layer as Cu, Ru or MgO. The thickness of the NM layer was varied between 0 and 0.8 nm. The magnetic properties, by VSM and AC susceptibility measurements, anisotropic magnetoresistance (AMR) and planar Hall effect (PHE) behaviour were investigated for continuous thin films with dimensions 5×5 mm^2 as deposited and after magnetic annealing at 200 and 250 °C under a field of 1 T for 15 and 30 minutes respectively. We show that AMR and PHE measurements can be precise and sensitive methods to characterize the exchange coupling, H_{EB}, between the Permalloy layer and the antiferromagnetic layer and the coercive field. The small hysteretic effects observed in the field behaviour of the PHE signal were explained by micromagnetic simulations. Values between 2 and 35 Oe, for H_{EB}, and a field sensitivity of the PHE signal up to 20 µV/Oe were obtained for our structures for a driving current of 1 mA. These results show the possibility to build high sensitivity tunable spintronic PHE sensors. Cross shaped PHE sensors, ring and diamond shaped AMR bridge sensors (often known as planar Hall effect bridge (PHEB) sensors) were used for simulations to obtain the signal behaviour in function of the structure geometry, thickness and nature of the NM layer.

The micromagnetic simulations will be compared with experimental data obtained on patterned structures with such geometries and provides useful information for the future development of novel spintronic sensors, MRAM applications, micro compass, and biosensors.