Hall effect and magnetoresistance in magnetic multilayers with alternating in-plane and out-of-plane anisotropies

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The magnetotransport properties of $(Py/Au/Co/Au)_N$ (where $Py=Ni_{80}Fe_{20}$ and the subscript N denotes the number of repetitions) obtained by UHV magnetron sputtering have been studied. Additionally, the multilayers (Mls) growths were monitored by the in-situ resistance measurements. In these structures the Co layer thickness (d_{Co}) determines the magnetic anisotropy direction. In particular, for $0.4nm<d_{Co}<1.2$ nm the perpendicular anisotropy and for $d_{Co}>1.2nm$ the in-plane anisotropy is realised [2]. On the contrary, the Py anisotropy direction is always parallel to the layer's plane.

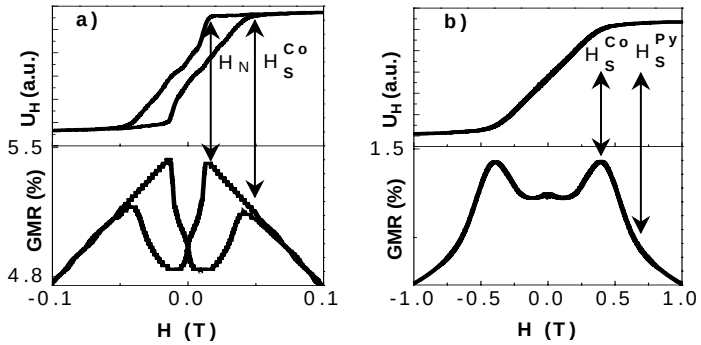

Fig. 1. The $U_H(H)$ and GMR(H) relations of the $(Py/Au/Co(d_{Co})/Au)_6$ Mls with $d_{Co}=0.8nm$ – perpendicular anisotropy of Co (a) and $d_{Co}=1.5nm$ – in-plane anisotropy of Co (b).

The magnetic field dependences of the Hall voltage (U_H) and GMR measured for Mls with alternating in-plane and out-of-plane anisotropy direction $(Py(2nm)/Au(2nm)/Co(0.8nm)/Au(2nm)_6$ and solely in-plane anisotropy direction $(Py(2nm)/Au(2nm)/Co(1.5nm)/Au(2nm)_6$ are plotted in Fig. 1a and Fig 1b, respectively. The GMR(H) and $U_H(H)$ relations in Fig. 1a exhibit all characteristic features for the thin films with magnetization easy axis perpendicular to the sample's plane. A characteristic kink in $U_H(H)$ at H_N, corresponding to GMR maxima, occurs when the domains in Co layer nucleate, and the saturation field H_S^{Co} relates to domains' annihilation. For Mls with $d_{Co}>1.2nm$ (Fig.1b) the Co layers show in-plane anisotropy direction, and the Hall and GMR(H) characteristics are completely different. The two independent saturation fields H_S^{Co} and H_S^{Py} of the Co and Py layers, are seen both in the $U_H(H)$ and in GMR(H) dependences. In addition, the H_N values increase with d_{Co} and decrease with d_{Au}, reflecting the interlayer interaction between ferromagnetic layers due to the domain structure.

[1] F. Albertini *et al.*, J. Magn. Magn. Mater. **240** (2002) 526
[2] F. Stobiecki *et al.*, J. Magn. Magn. Mater. **282** (2004) 32

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