SPIN MOMENTUM TRANSFER – September 3 – 5, Kraków, Poland 2008

Electrical and micromagnetic characterization of magnetic disks and rings

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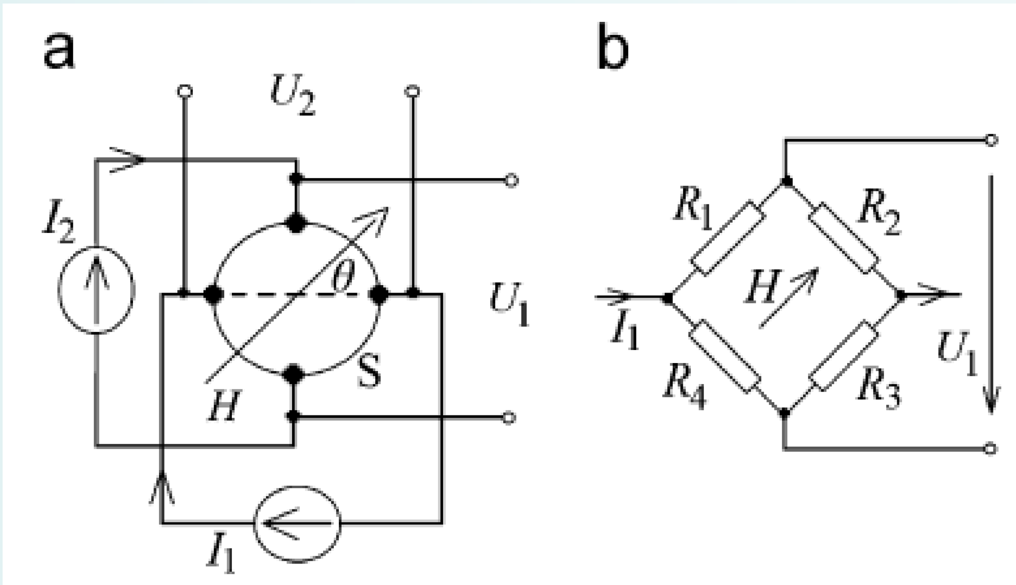
Magnetic thin films deposited onto oxidized Si wafers:

- $Ni_{80}Fe_{20}$(10 nm) (Permalloy) – Py
- FeMn(3 nm)/$Ni_{80}Fe_{20}$(10 nm)/Cu(4 nm)/$Ni_{80}Fe_{20}$(10 nm) - ML
- $Ni_{80}Fe_{20}$ (2 nm)/Al_2O_3(1 nm)/$Ni_{80}Fe_{20}$(2 nm) - PyAlOPy

We made Planar Hall Effect measurements using a special setup [1] and micromagnetic simulations [2] in order to improve the response of these structures used for sensing applications in rotating magnetic fields ➔ *U~sin2θ*



(a) PHE experimental setup [1] and (b) the equivalent circuit [3]

Two measurements were made for each value of the angle θ:

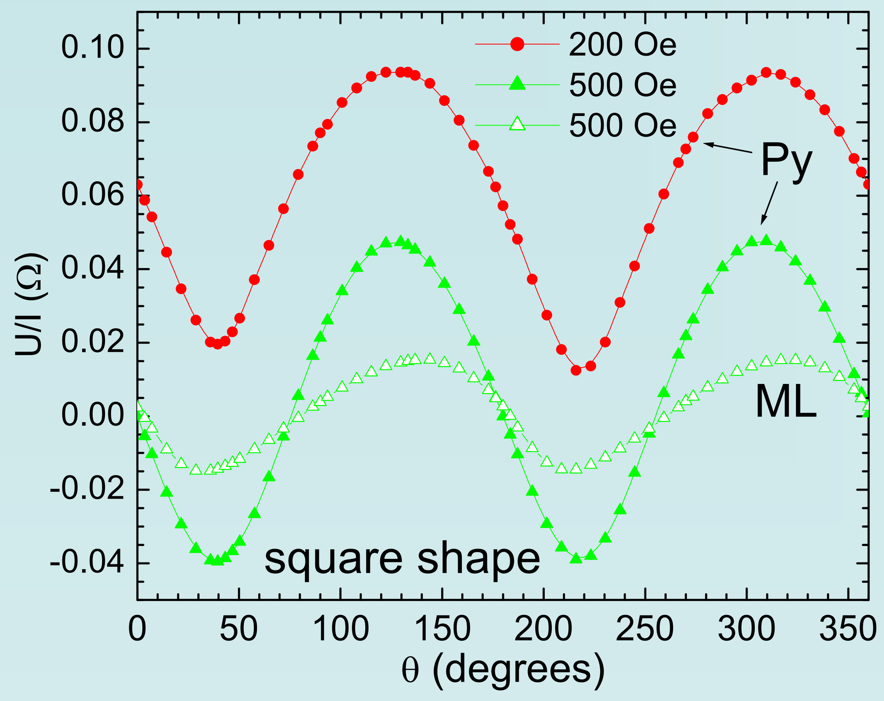
I_1 ON and I_2 OFF ➔ U_1

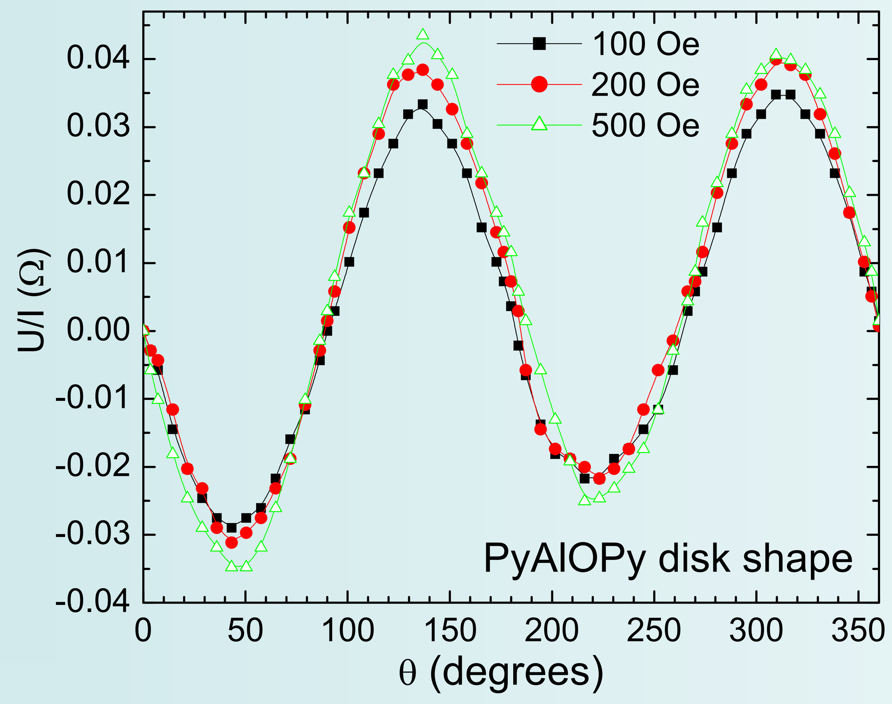
I_2 ON and I_1 OFF ➔ U_2

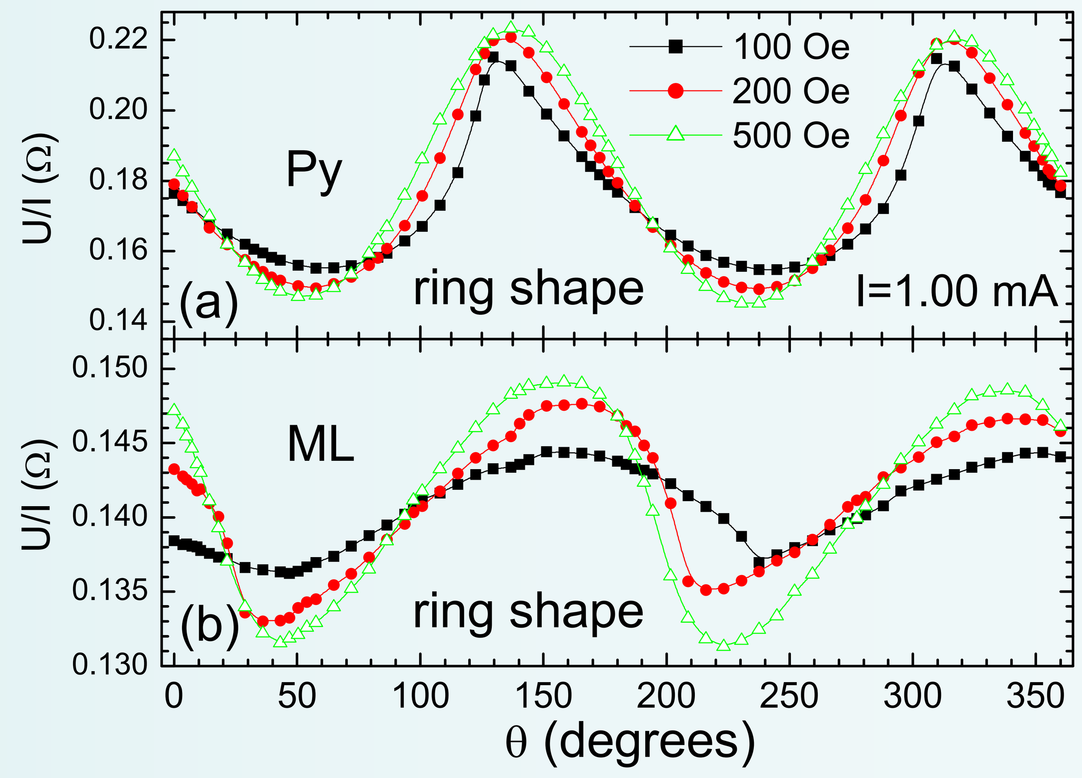
Usually I_1=I_2

The calculated signal is:

$$\frac{U}{I} = 0.5\left(\frac{U_1}{I_1} + \frac{U_2}{I_2}\right)$$

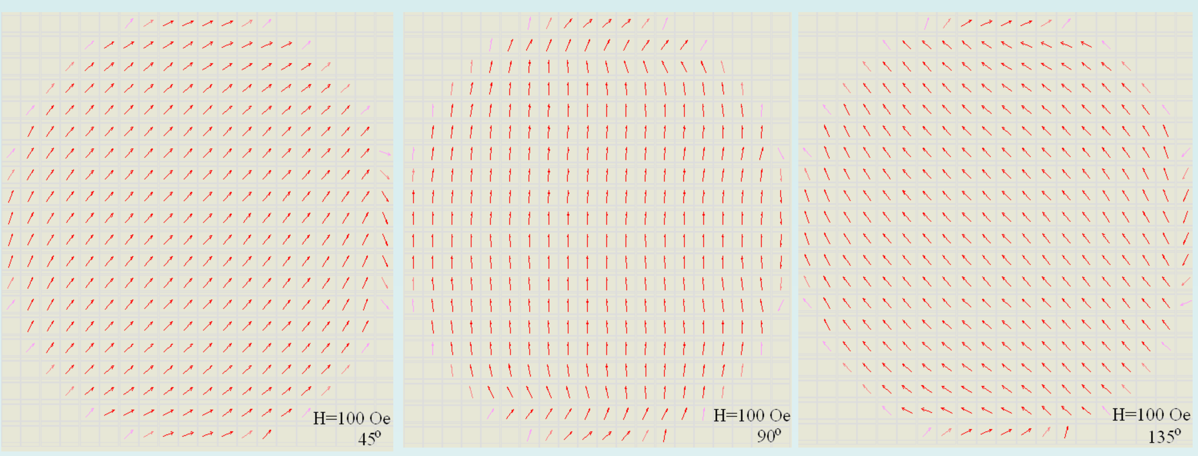




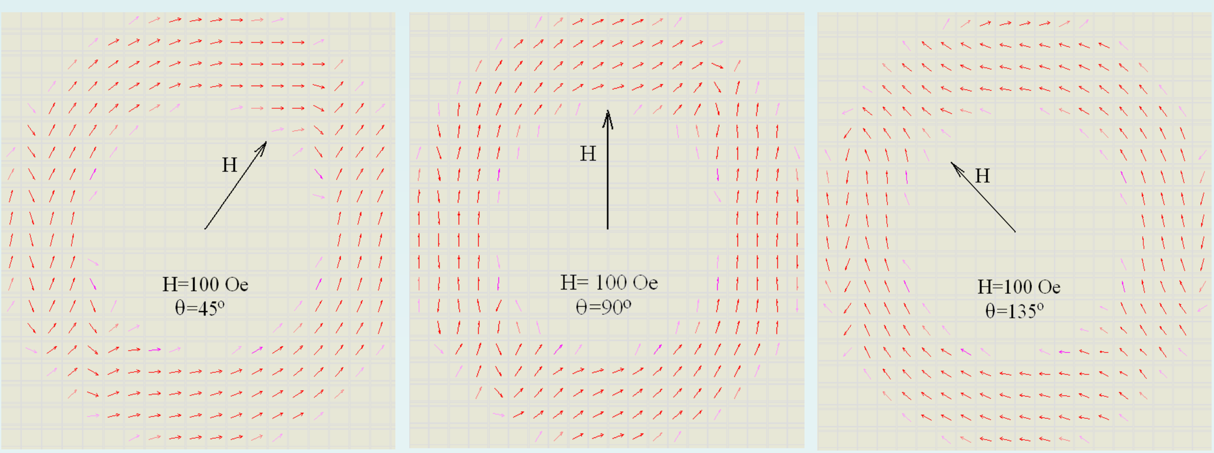


- contacts misalignments and hysteretic effects ➔ the angular behaviour of the PHE voltage is distorted

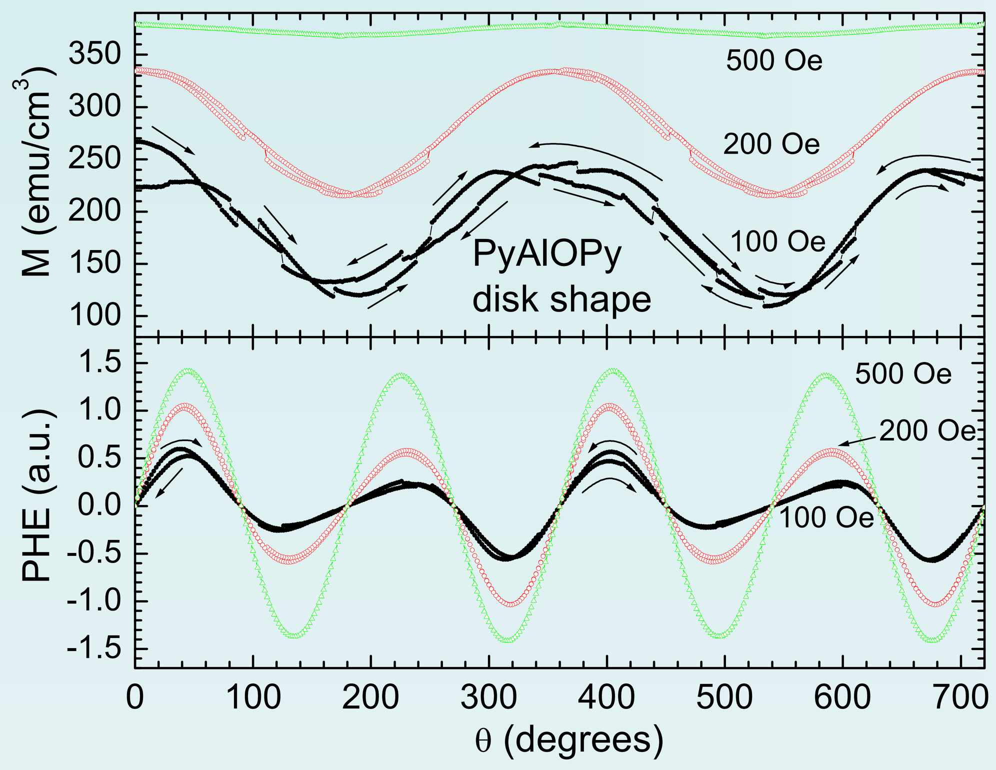
Micromagnetic simulations for disk and ring shape structures



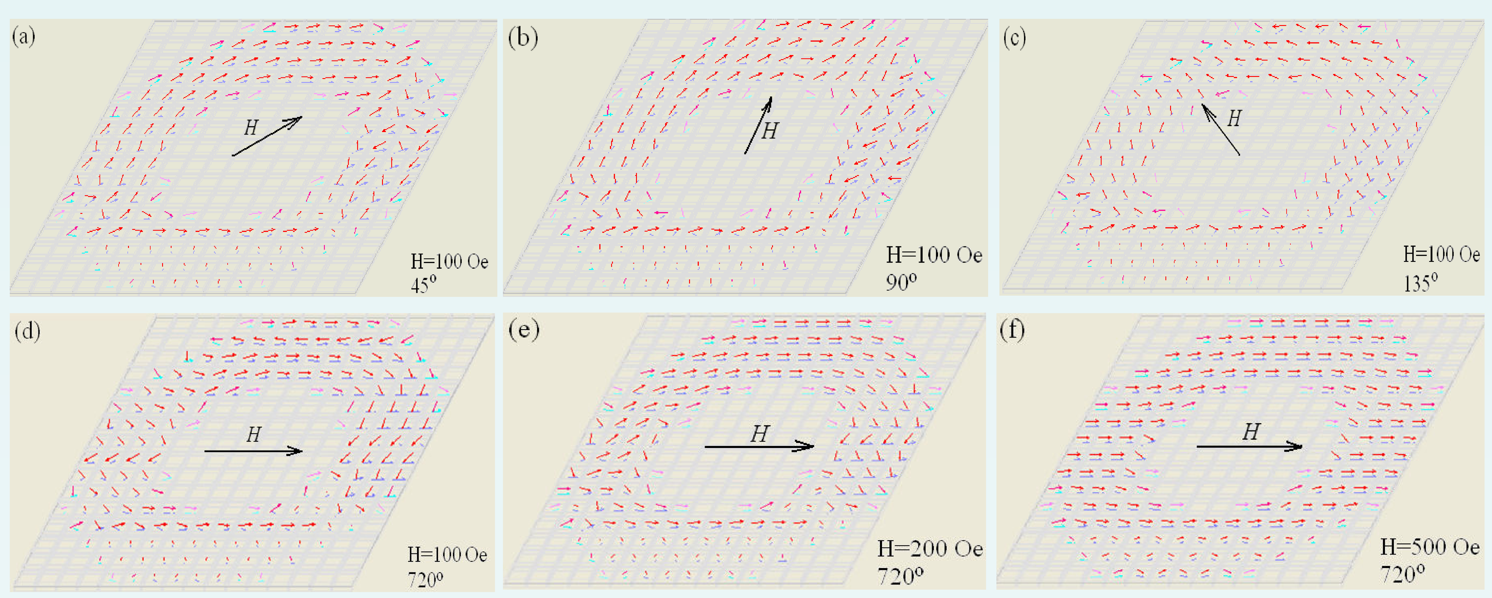
Micromagnetic simulations for PyAlOPy disk shape structure



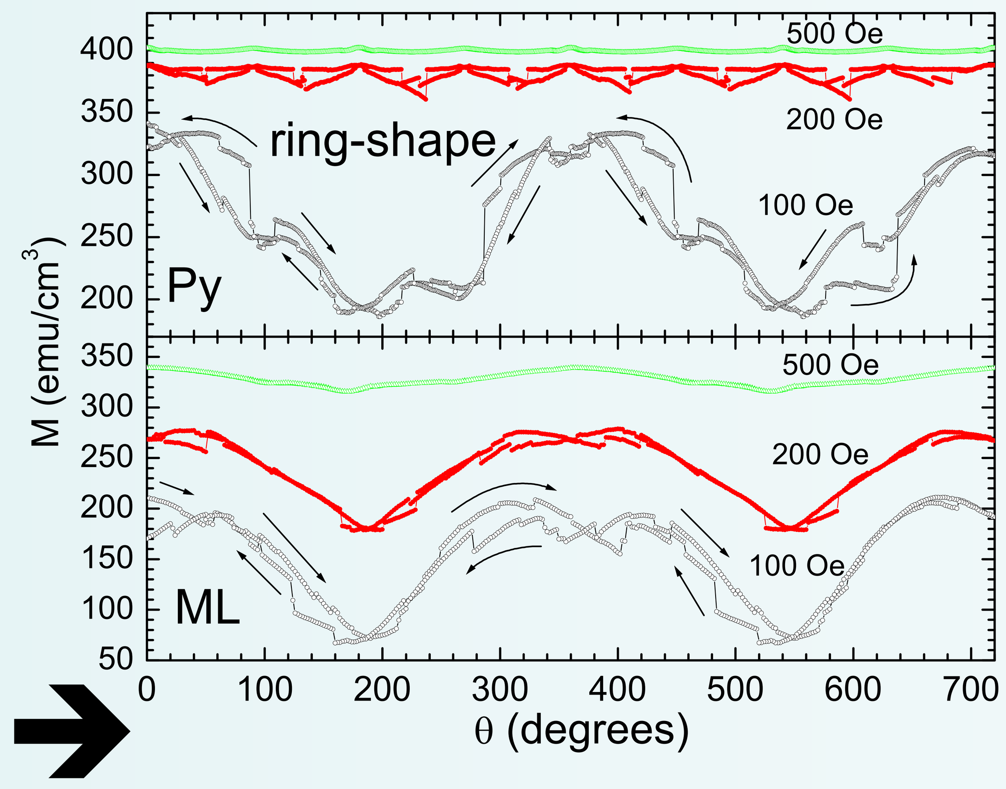
Magnetic moments orientations in a Py ring shape structure for different field orientations



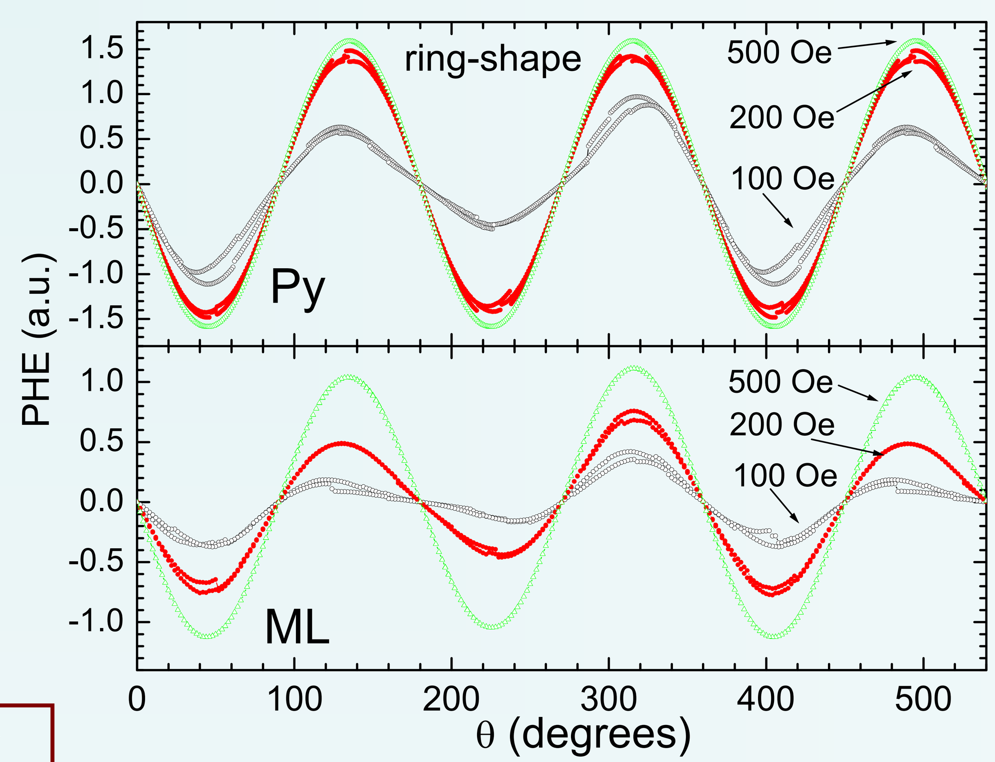
Micromagnetic simulations of the angular dependence of the magnetization and PHE signal for the PyAlOPy disk shape structure



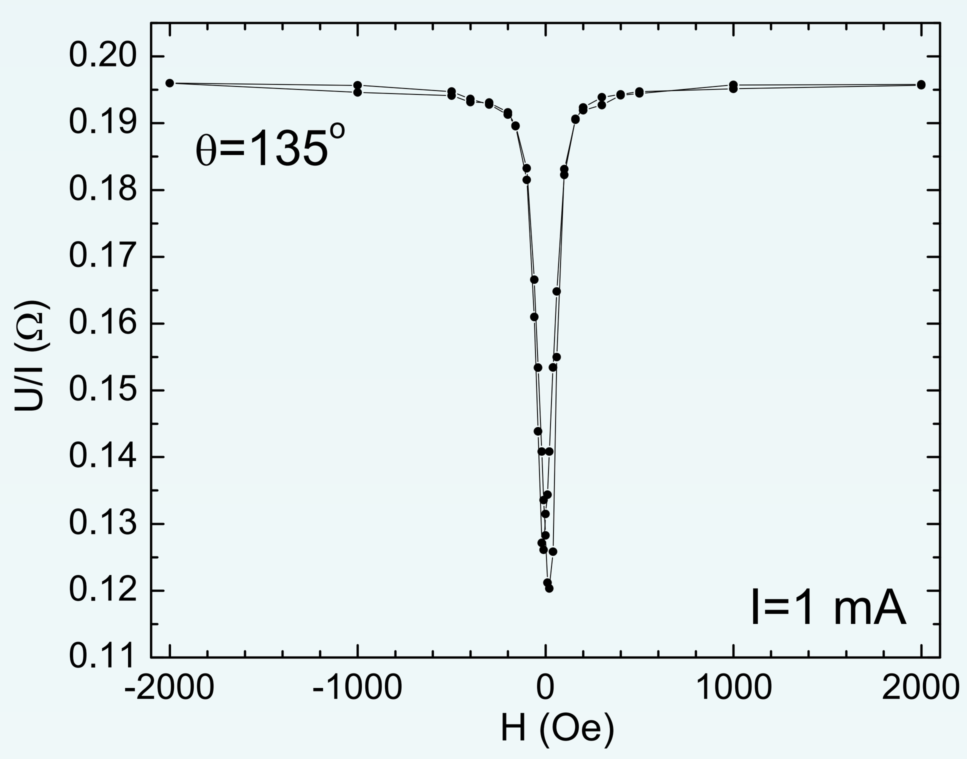
Magnetic moments orientations in a ML ring shape structure for different field orientations



Comparative results of the micromagnetic simulations regarding the angular dependence of the magnetization and PHE signal in Py and ML ring shape structures. We can see clear hysteretic effects at low fields. The coupling between magnetic layers bring also additional distortions of the PHE signal. The arrows are guides for the eyes.



H>200 Oe for practical applications



Field dependence of the PHE signal for a ring-shape $Ni_{80}Fe_{20}$(10 nm) thin film; *H* is applied in the film at an angle θ=135°

Despite of their simplicity, the $Ni_{80}Fe_{20}$(10 nm) structures are very convenient to be used to build low cost rotation sensors and magnetic field sensors based on the PHE

References:

[1] M. Volmer, J. Neamtu, Journal of Magnetism and Magnetic Materials, 316 (2007) e265-e268

[2] M. Volmer, J. Neamtu, Physica B 403 (2008) 350–353

[3] C. Prados, D. Garcia, et al., Appl. Phys. Lett. 67 (1995) 718

[4] E.M. Epshtein, A.I. Krikunov, Yu.F. Ogrin, J. Magn. Magn. Mater. 258-259 (2003) 80

[5] J.C.S. Kools, et al., IEEE Trans. Magn., 31 (1995) 3918

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