Magnetic properties of Pt/Co/Pt trilayers with W insert layer

W. Dobrogowski,[1] R. Gieniusz,[1] U. Guzowska,[1] Z. Kurant,[1] I. Sveklo,[1] A. Wawro,[2] and A. Maziewski[1]

[1] *Laboratory of Magnetism, Faculty of Physics, University of Bialystok, Bialystok, Poland*

[2] *Institute of Physics Polish Academy of Sciences, Warsaw, Poland*

Ultrathin ferromagnetic films with asymmetric neighboring layers of heavy and/or transition metals attract much interest due to their potential applications as new type of magnetic memories [1, 2]. Here we report the epitaxial symmetric magnetic trilayers Pt/Co/Pt modified by inserting W layer at the bottom or top interfaces in wide the ranges of Co, W layers thicknesses. It is an extension of the analysis reported in [3]. The exemplary double wedge geometry sample consists of Co magnetic layer (continuous wedge with thickness ranged d_{Co}=0÷3 nm) and orthogonal nonmagnetic overlayer (underlayer) of W (steps with thicknesses d_W=0, 0.1, 0.2,. . . , 0.7, and 3.0 nm) resulting in 2D matrix-like W/Co/Pt (Pt/Co/W) stacks with corresponding (d_{Co}, d_W) thicknesses. The influence of (d_{Co}, d_W) on magnetization parameters using static (magnetooptical Kerr effect) and dynamical (Brillouin light scattering) methods were studied. Double wedge stacks with wider range of W thickness (until 10nm) were also studied. The thickness of magnetic dead layer d0 depends on d_W and quickly saturates at d_W 0.5 nm for both sample sets. Then for Pt/Co/W its value becomes constant for d_W>1 nm, while for W/Co/Pt saturation occurs at d_W ∼3 nm and further monotonic increase is observed. For W/Co/Pt stacks the strong reduction of coercivity field and transition to in-plane magnetization is observed with d_W increase, while for Pt/Co/W sample we found increase in coercivity with small influence on spin reorientation thickness. Surface magnetic anisotropy decreases and volume anisotropy increases with d_W for both stacks. Dynamical characteristics measured by Brillouin light scattering (BLS) in Damon-Eshbach mode determine the strength of interfacial Dzyaloshinskii-Moriya interaction (iDMI) and spin wave (SW) damping for selected d_{Co} thicknesses as a function of d_W. Characteristic d_W thickness for iDMI appearance is about 0.1 nm for both samples. A sufficiently large value of iDMI is determined for the range d_W=1.5÷3 nm in W/Co/Pt (1.7 pJ/m) samples. Our findings demonstrate the efficiency of thin W interlayer on modification of magnetic parameters in Pt/Co/Pt trilayer. Knowledge about W thickness driving ultrathin Co magnetic parameters is important for next steps studies of interlayer coupling and nanostructures designing, e.g. synthetic antiferromagnetic racetracks.

References:

[1] A. Fert, et al., Nat. Rev. Mater. 2 (7) 17031 (2017)
[2] W. Legrand, et al., Phys. Rev. Materials 6, 024408 (2022)
[3] Z.Kurant et al., J.Magn.Magn.Mat. 558, 169485 (2022)

This work is supported by the National Science Center in Poland under the project OPUS-19 (2020/37/B/ST5/02299).