Magnetization statics and dynamics in Co ultrathin layered structures modified by adjacent transition metal layers

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Magnetic anisotropy, coercivity field and Dzyaloshinskii-Moriya interaction (DMI) were studied (by polar magneto-optical Kerr effect and by Brillouin light scattering BLS spectroscopy) in double wedges samples $Pt/TM(d_{TM})/Co(d_{Co})/Pt$ and $Pt/Co(d_{Co})/TM(d_{TM})/Pt$ where **TM** transition metal (W or Re [1,2,3]). Large DMI was determined for both Re and W located at buffer or at overlayer. In comparison to symmetric $Pt/Co/Pt$ trilayers changes in magnetic anisotropy and coercivity field are (i) large for the cases when TM insertion layers are placed at bottom interface, it is explained by Re induced Co fcc to hcp transition [3]; W induced dead layer creation (ii) small when TM insertion layers are placed at the top interface, the changes are related mainly with surface anisotropy modification at the top interface. While decreasing d_{Co} (for both Re or W buffer) from ferromagnetic state with square hysteresis (typical for ultrathin magnetic film with perpendicular magnetic anisotropy PMA) soft ferromagnetic SFM state with PMA is achieved before final reaching superparamagnetic state. At SFM micrometer-sized thermal fluctuating domains were observed; domain size drastically decreases, fluctuations increase when decreasing d_{Co}. Domain geometry is discussed considering DMI contribution to domain wall energy.

Spin waves (SW) state freezing into domain structure state could be related [4] with the spin reorientation transition (e.g. driven by in-plane applied magnetic field) between large field induced homogeneous in-plane state (with SW) and out-of-plane magnetization state, with split into domain structure. Freezing was studied in $(Re/Co/Pt)$ multilayers.

SW frequency hysteresis was observed in $Ir/Co/Pt$ multilayers with DMI [5] by BLS. Samples are characterized by quality factor (the ratio of the magnetic uniaxial anisotropy and demagnetization energies) $Q < 1$. By micromagnetic simulations hybrid magnetization distribution was deduced : large in-plane magnetized core modulated by out-of-plane domains with periods of about 100 nm. It is consistent with domain observations by longitudinal magneto-optical Kerr effect-based microscopy and magnetic force microscopy. BLS hysteresis is related with magnetization core switching.

References:

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