Hysteresis of the frequency spin wave excitations in Ir/Co/Pt multilayers with Dzyaloshinskii-Moriya interaction


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Multilayered systems consisting of ferromagnetic layers alternating with non-magnetic heavy metal layers exhibiting perpendicular magnetic anisotropy (PMA) and Dzyaloshinskii-Moriya Interaction (DMI) are now intensively studied because of interesting physics and potential applications e.g. skyrmion-hosting systems [1]. The evolution of topological skyrmions as a function of Co thickness $d$ has been recently studied across the Spin Reorientation Transition (SRT) in (Pt/Co($d$)/Ta)$_N$ ($N$ – number of repetitions) multilayers using Lorentz Transmission Electron Microscopy [2]. Close to the SRT, it is possible to perform Brillouin Light Scattering (BLS) studies of spin wave excitations even without applying external magnetic fields $H$.

In the present work, we investigated (Ir/Co($d$)/Pt)$_N$ multilayers with negative effective uniaxial anisotropy and large DMI. The samples were deposited by magnetron sputtering with $N=1$ or $N=6$. Using Longitudinal Magneto Optical Kerr Effect (LMOKE) and magnetic force microscopies we determined the following magnetization configuration: large macrodomains (several dozen micrometers size) with in-plane “core” magnetization which are modulated by small nanodomains (about 100 nm size) differentiated by out-of-plane magnetization. Using BLS spectrometer, the hysteresis behaviors of the DMI sensitive: Stokes $f_S$ and anti-Stokes $f_{AS}$ frequencies as well as their frequencies difference $\Delta f$ as the functions of the in-plane magnetic field were observed. The BLS signal is related to the in-plane “core” magnetization component of domains. The hysteresis of $\Delta f(H)$ is correlated with the switching of the large macrodomains observed with LMOKE. These experimental results are supported by micromagnetic simulations.

References: