SPIN-ORBIT TORQUE MAGNETOMETRY BY WIDE-FIELD MAGNETO-OPTICAL KERR EFFECT

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Magneto-optical Kerr effect (MOKE) is known to be a convenient way to detect the surface magnetization in thin film samples. In MOKE measurement, a polarized light shine on the sample, then light reflected and passed through the analyzer. Since light that is reflected from a magnetized surface can change in both polarization and reflected intensity, the analyzer should pick up a variation when the magnetization switches from pointing up-ward to pointing down-ward. Thus, we can easily get a hysteresis loop if dealing with magnetic materials with perpendicular magnetic anisotropy (PMA).

In this work, we present a quantitative analysis on the dampling-like spin orbit torque (DL-SOT) by polar wide-field MOKE. Through current-induced hysteresis loop shift measurements [1], we quantify the DL-SOT efficiency of a Ta-based heterostructure with bar-shaped geometry, Hall-cross geometry, and unpatterned geometry to be $|\xi_{DL}| \approx 0.08$. Unlike other conventional methods, which require the patterning of thin films into micron-sized or nano-sized devices, our proposed technique can be employed to accurately estimate DL-SOT efficiency from as-deposited films [2], as shown in Fig. 1. This approach will benefit future SOT-MRAM development since researchers are allowed to determine current-induced SOT efficiencies at the early stage of thin film development.

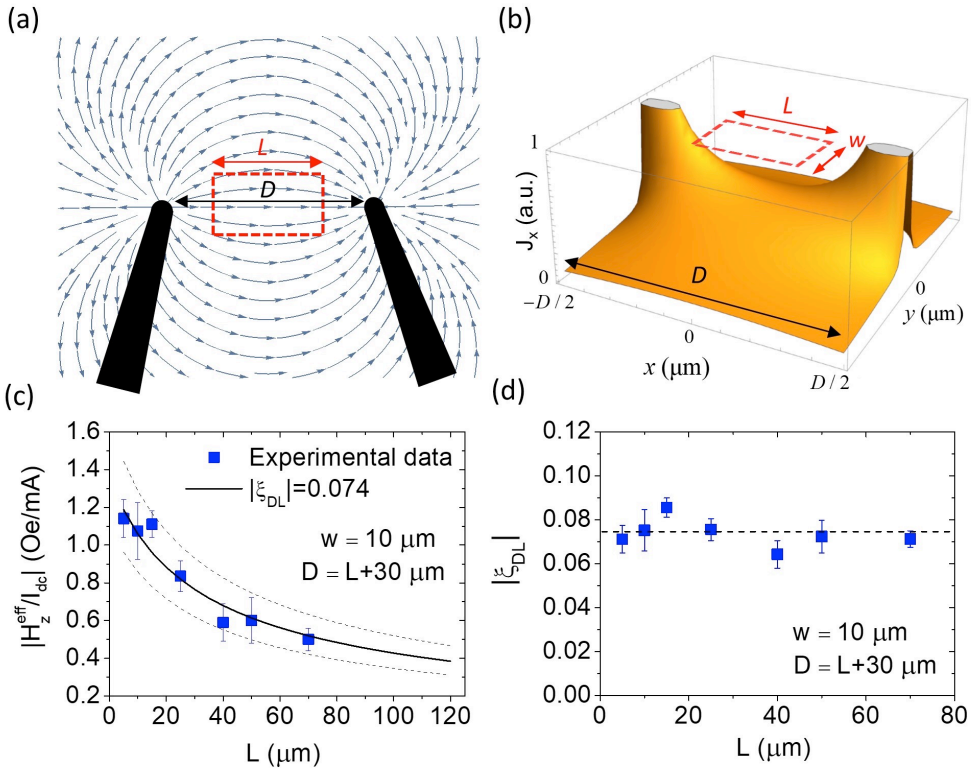

Fig. 1 (a) Streamline plot of the current density vector field J(x,y) and (b) the calculated x component of current density $J_x(x, y)$ for two-probe configuration. The dashed box represents the probing area. (c)

Optically-determined current-induced effective field per current plotted as a function of probing area length L for a Ta(4)/CoFeB(1.4)/Hf(0.5)/MgO(2) unpatterned film with PMA. (d) Estimated DL-SOT efficiency as a function of L. The dashed line represents the mean of all results, $|\xi_{DL}| = 0.074$.

REFERENCES

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