Observation of Brownian motion of magnetic skyrmion and its control by voltage AIST ¹, Osaka Univ.²

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Magnetic skyrmion gathers a gread deal of attention as a new tool for spintronic information processing, such as a race track memory [1] and logic. In these systems, information bit is coded in the skyrmion and its position is controlled precisely by applying electric-current or electric-field. On the other hand, thermally-activated random walk of skyrmion can be used as a token in Brownian computing system, where fluctuating tokens are employed in computational paths defined by the circuit topology [2]. For this purpose, we tried to observe the Brownian motion of skyrmion at room temperature.

For the formation of stable skyrmion using interfacial Dzyaloshinskii-Moriya interaction, we prepared multilayer structures consisting of Ta/W(5 nm)/FeB(1 nm)/Ir(t_{Ir})/MgO(2.4 nm)/ITO deposited mainly by sputtering on thermally-oxidized Si substrate. Inserted Ir thickness dependence of polar MOKE hysteresis curves is shown in Fig. 1(a). Direct insertion of ultrathin Ir layer on FeB surface caused monotonic

reduction in the perpendicular magnetic anisotropy and transition of magnetic easy axis from out-of-plane to in-plane direction were observed. Figure 1(b) shows an example of polar MOKE microscope image for the structure with t_{Ir}~0.1 nm. Under the application of small perpendicular magnetic field of around -3 to -7 Oe, formation of magnetic skyrmion could be confirmed at room temperature. In addition, by optimizing the inserted Ir thickness, Brownian motion of skyrmion was also observed. In the presentation, electrical control of diffusion length of the Brownian motion by voltage-controlled magnetic anisotropy will also be discussed.

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References

[1] A. Fert *et al. Nat. Nanotechnol.* 8, 152 (2013).
[2] J. Lee *et al. Int. J. Unconventional Comp.* 12, 341 (2016).



Fig. 1 (a) Inserted Ir thickness dependence of polar MOKE hysteresis curves for the FeB (1 nm)/Ir ($t_{\rm lr}$)/MgO structures and (b) example of polar MOKE microscope image of skyrmion.