Stochastic skyrmion dynamics by in-plane alternating electric current

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Magnetic skyrmions have unique and diverse properties, which have attracted attention in spintronics in terms of device applications. One of the important properties is the Brownian motion at near room temperature [1-2]. In recent years, Brownian / probabilistic computers have attracted attention, and the application of skyrmions to such novel computers is expected [3-4]. In order to improve the computational speed of these computers, increasing the diffusion coefficient of the skyrmions is essential. The techniques of increasing the diffusion coefficient have been reported, such as increasing temperature [1], applying gate voltage [2], and magnetic field noise [5]. However, the effect of electric-current noise on the diffusion coefficient has not been studied. This study demonstrates that low-frequency in-plane alternating electric current acts as external noise and increases skyrmions' mean square displacement (MSD), which is necessary to evaluate the diffusion..

A skyrmion film consisting of Ta(5)|$Co_{16}Fe_{64}B_{20}$(1.2)|Ta(0.2)|MgO(1.5)|SiO_2(3.0) (described by nm) were deposited on a thermally oxidized silicon substrate by magnetron sputtering. The motion of the skyrmions was observed by magneto-optical Kerr effect (MOKE) microscope when the alternating current *I* was applied in the in-plane direction under the perpendicular magnetic field *H* of 3 Oe (Fig. 1). First, we observed the Brownian motion of the skyrmions without the alternating current. Second, MSDs were obtained from the trajectories of the skyrmions under various alternating currents. As a result, MSD increases with alternating current. The result is attributed to the depinning of the skyrmions by applying alternating current. This research was supported by ULVAC, Inc., JST CREST Grant number JPMJCR20C1 Japan and JSPS Grant-in-Aid for Scientific Research (S) Grant Number JP20H05666.

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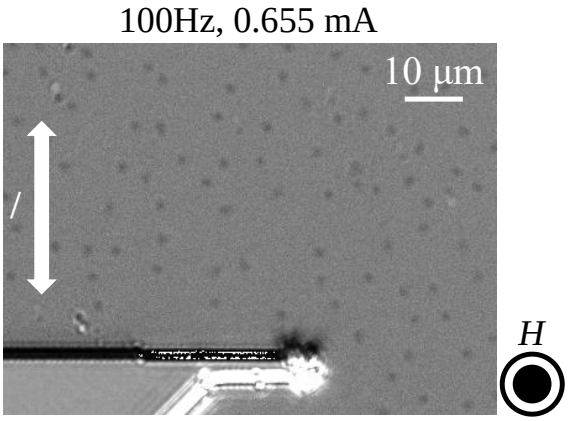

Fig. 1 MOKE microscope observation of skyrmions with the alternating electric current of 0.655 mA (Root mean squared value) and 100 Hz