Stochastic motion of skyrmions by perpendicular alternating magnetic field

Osaka Univ. [1], CSRN-Osaka[2], ◦Minori Goto[1, 2], Hikaru Nomura[1, 2], and Yoshishige Suzuki[1, 2]

E-mail: goto@mp.es.osaka-u.ac.jp

Magnetic skyrmion motion has attracted attention in spintronics because of its rich physical phenomena and possibilities of applications. Moreover, stochastic motions of skyrmions have a potential for being a Brownian computing [1-2]. To enhance the calculation speed, increase in a skyrmion diffusion coefficient is significant. One of the ways for enhancement of diffusion coefficient is applying magnetic field noise. While a skyrmion motion under external alternating magnetic field has been investigated [3], effect on a diffusion coefficient has never been clarified. We demonstrate the enhancement of diffusion coefficients of magnetic skyrmion under low frequency alternating magnetic field used as a role of external magnetic field noise.

The skyrmion film composed of Ta(5)|Co-Fe-B(1.3)|Ta(0.24)|MgO(1.5)|SiO_2(2.9) (described in nm) was deposited on a thermally oxidized silicon substrate by a magnetron sputtering. The perpendicular magnetic field of 0.3 mT was applied by a permanent magnet, and the perpendicular alternating magnetic field was applied by an air core coil. The skyrmion was observed by a magneto-optical Kerr effect microscope. As shown in Fig 1, stretching motion of the string-shaped skyrmions were observed. From the trajectories of skyrmions, we characterized the diffusion coefficient under the various alternating magnetic fields (Fig. 2). We found that the diffusion coefficient exponentially increases by the alternating magnetic field in the region of (ii). This result is attributed to a depinning of magnetic skyrmions by the alternating magnetic field. This research and development work was supported by ULVAC, Inc., MIC, and JSPS Grant-in-Aid for Scientific Research (S) Grant Number JP20H05666.

[1] T. Nozaki *et al.*, Appl. Phys. Lett, **114**, 012402 (2019), [2] Y. Jibiki *et al.*, Appl. Phys. Lett, **117**, 082402 (2020), [3] D. -H. Kim *et al.*, Sci. Rep. **7**, 3660 (2017)

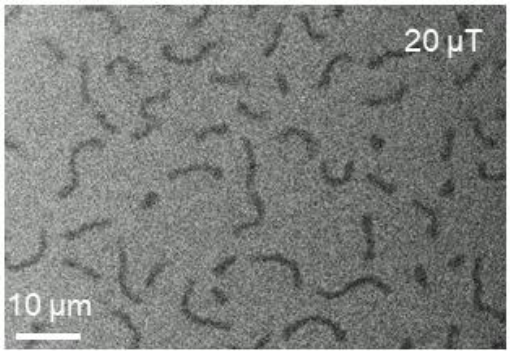

Figure 1 MOKE microscope image of skyrmions under the alternating magnetic field of 20 μT.

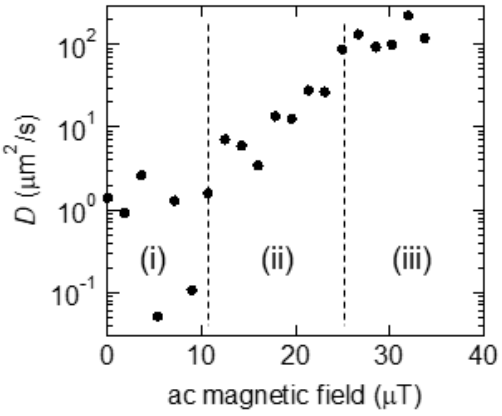

Figure 2 Alternating magnetic field dependence of diffusion coefficient.