Numerical Evaluation of Skyrmion Stability on CoFeB and GdCo

Kyushu Univ., °(B) Ryuta Satone, Yuichiro Kurokawa, and Hiromi Yuasa

E-mail: satone.ryuta.739@s.kyushu-u.ac.jp

In recent years, skyrmion in a magnetic layer next to a heavy metal layer has been attracting attention as a new information carrier owing to its nano-scale size, fast transport by small electric current. In typical, however, the transport velocity is increased by increasing the size and electric current, which leads trilemma. On the other hand, the transport velocity can be increased by high spin mixing conductance, and which can be increased by inserting ultra-thin layers into the interface of the magnetic and heavy metal layer [1]. In that case, it is important to maintain the skyrmion by providing the necessary Dzyaloshinsky-Moriya interaction (DMI) even through the inserted ultra-thin layer. In this study, we estimate the required DMI value to maintain the skyrmion when CoFeB or GdCo is used as magnetic layer.

The simulation was performed using mumax3 [2]. The magnetization is assumed to align in $-z$ direction at t=0. The uniformity of magnetic anisotropy constant was determined with reference to [3]. The external magnetic field was varied from 0 to 0.15 T and the DMI was varied from 0.0 to 1.0 mJ/m^2. The saturation magnetization and magnetic anisotropy constants of CoFeB and GdCo used in the simulation are shown in the table [3][4]. Figures 1 (a) (b) show the calculated results where the black and white means the magnetization in $-z$ and $+z$ direction, respectively. We can observe the stable skyrmion in the conditions surrounded by blue lines. Two examples enclosed by the green squares were enlarged in Figs. 1. (c) (d). The results are the important information to realize the high spin mixing conductance and high DMI simultaneously.

	M_s(A/m)	K_u(J/m^3)
CoFeB[3]	1.0*10^6	6.8*10^5
GdCo[4]	3.34*10^5	9.35*10^4

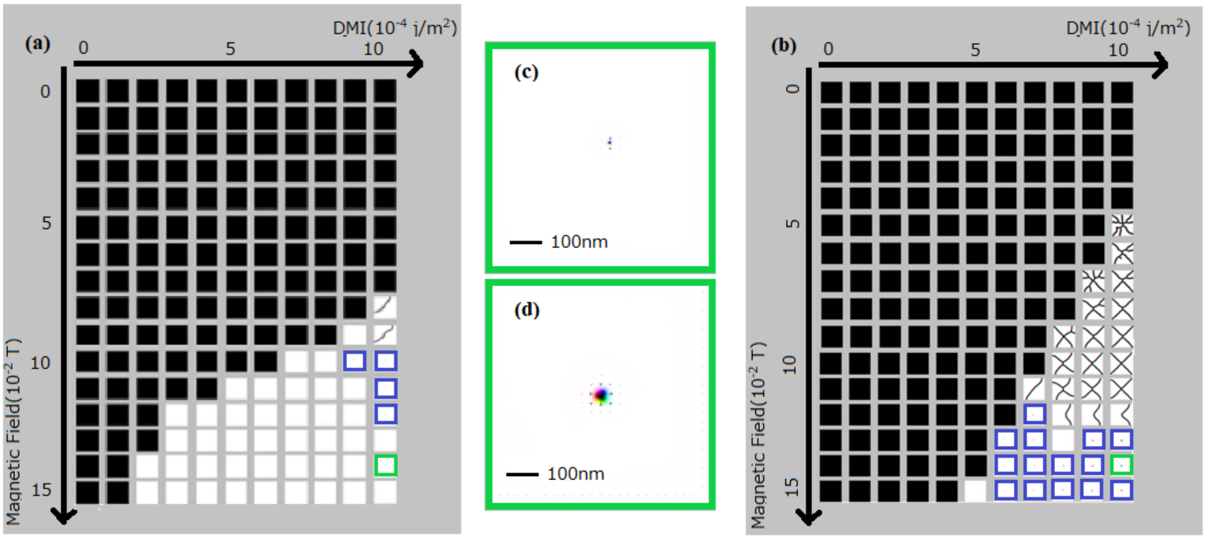

Figure 1 Magnetization maps for CoFeB (a) and GdCo (b). (c) and (d) are examples of enlarged images.

References

[1] T. Niimura *et al.*, Phys. Rev. B **102**, 094411 (2020). [2] A. Vansteenkiste *et al.*, AIP Adv. **4,** 107133 (2014). [3] S. Yang *et al.*, Adv. Mater. **10,** 1002 (2021). [4] O. Inyang *et al.* Sci. Rep. **10,** 9767 (2020).