Detrimental effect of interfacial Dzyaloshinskii-Moriya interaction on perpendicular spin-transfer-torque magnetic random access memory

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1. 서론

Recently, perpendicular magnetic anisotropy based spin-transfer torque magnetic random access memory (STT-MRAM) is drawing a great attention to researchers studying MRAM due to its advantages of having the density of DRAM, fast response time of SRAM and the non-volatility of flash memory. [1]

Moreover, recent studies has shown that the spin orbit coupling, which results in the interfacial perpendicular magnetic anisotropy, and the inversion symmetry breaking at the interface between free layer and heavy metal of magnetic tunnel junction (MTJ) results in antisymmetric exchange interaction named as Dzyaloshinskii-Moriya interaction (DMI).[2]

We numerically studied the effect of DMI and size of the cell on switching current density at room temperature and thermal stability at 0K which are the important factors for commercialization of STT-MRAM. [3] We used for exchange stiffness constant, for anisotropy constant, for saturation magnetization and for DMI constant for cells with diameter of.

2. 실험방법과 결과

First, we studied the effects of DMI and cell diameter on the thermal stability that is a good parameter for determining the retention time of the data. According to our study with String method [4], the larger DMI constant lead to the smaller thermal stability as shown on Figure 1(a).

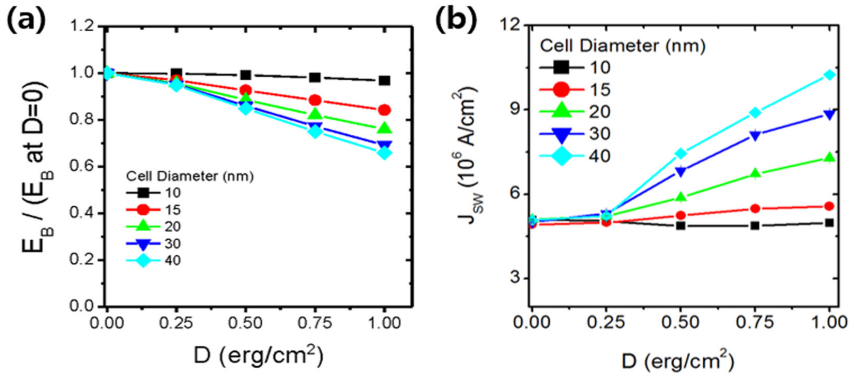

Fig. 1. (a) Normalized thermal stability as a function of DMI constant.
(b) Switching current density as a function of DMI constant. Both thermal stability and switching current density is less effected by DMI constant as the diameter of the cell is decreased.

Next, we calculated the switching current density at room temperature as a function of DMI constant. We found that the current density increased as DMI constant got larger due to its tendency to keep its skyrmion number maintained. [5]

3. 고찰 및 결론

In conclusion, we showed that DMI deteriorates both the switching current and the thermal stability of the device. Hopefully, the DMI effect vanished as the device diameter, as required in the commercialization of STT-MRAM, got smaller.

4. 참고문헌

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