楕円柱形状の記録層による電圧誘起ダイナミック磁化反転の書き込みエラー率の低減

Reduction of Write-Error Rates in Voltage-Induced Dynamic Precessional Switching by Elliptical Cylinder Recording Layers

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Voltage-induced dynamic precessional switching in magnetic tunnel junctions (MTJs) is a writing technique for novel voltage-controlled magnetoresistive random access memories (VC-MRAMs), which are expected to be the ultimate non-volatile memory with ultralow power consumption [1]. However, the high write-error rate (WER) of the voltage-induced dynamic switching hinders the reliable operation of VC-MRAMs. Therefore, substantial reduction of the WER is required for developing VC-MRAMs.

In this study [2], we conducted theoretical study on voltage-induced dynamic precessional switching and show that, as shown in Fig.1, the WER in the elliptical-cylinder MTJ at negative $K_{\mathrm{eff}}^{(+V)}$ can be an order of magnitude lower than that in the conventional circular-cylinder MTJ at $K_{\mathrm{eff}}^{(+V)} = 0$ kJ/m^3. Here, $K_{\mathrm{eff}}^{(+V)}$ represents an effective perpendicular anisotropy constant during voltage pulse. The external magnetic field is applied parallel to the minor axis of the ellipse as is the case for heavily damped precessional switching [3-5].

We also clarified that the WER is reduced by a decrease in a voltage-pulse duration. In the elliptical-cylinder shaped MTJ, the optimal voltage-pulse duration can be reduced by the negative $K_{\mathrm{eff}}^{(+V)}$.

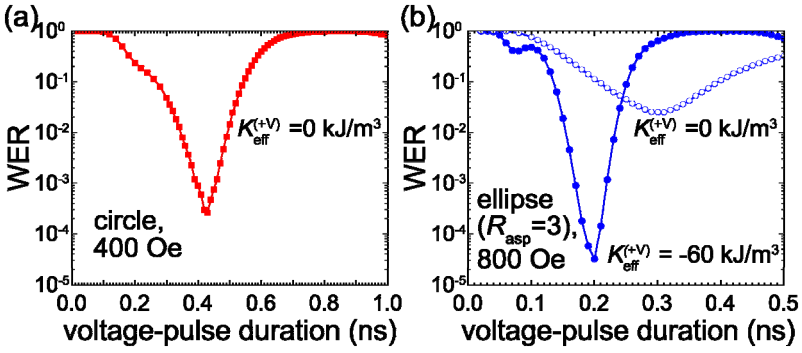

Fig. 1 Calculated voltage-pulse duration dependence of WER at temperature 300 K. (a) corresponds to a circular-cylinder MTJ. (b) corresponds to an elliptical-cylinder MTJ with aspect ratio (R_{asp}) 3.

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References [1] Y. Shiota *et al.*, Nat. Mater., Vol. 11, p. 39 (2012). [2] R. Matsumoto *et al.*, submitted. [3] R. Matsumoto *et al.*, Appl. Phys. Express, Vol. 12, p. 053003 (2019). [4] R. Matsumoto *et al.*, AIP Adv., Vol. 9, p. 125123 (2019). [5] R. Matsumoto *et al.*, Phys. Rev. Applied, Vol. 18, p. 054069 (2022).