Influence of in-plane magnetic field on write error rate of voltage-driven dynamic magnetization switching

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Voltage-driven dynamic magnetization switching [1,2] is a promising writing technique for future spintronic devices with ultimate low-power consumption. Although this technique satisfies high write endurance, high speed, and room temperature operation, the write error rate (WER), which should be low for memory application, has not been investigated intensively. In previous study, we investigated the WER of voltage-driven dynamic magnetization switching, and obtained WER of 4×10^{-3} for both P-to-AP and AP-to-P switching [3].

To realize the voltage-driven dynamic magnetization switching, an in-plane magnetic field is necessary, which provides the effective field during the precessional motion of magnetization. In this study, we investigate the influence of an in-plane magnetic field on WER of voltage-driven dynamic magnetization switching.

A film for perpendicularly-magnetized magnetic tunnel junction (p-MTJ), which is consisting of buffer layer / [Co (0.24 nm)/Pt (0.16 nm)]$_7$ / Co (0.24 nm) / Ru (0.46 nm) / [Co (0.24 nm)/Pt (0.16 nm)]$_5$ / CoB (0.4 nm) / W (0.15 nm) / $Co_{12}Fe_{68}B_{20}$ (1.0 nm) / MgO barrier / FeB (1.8 nm) / W (2.0 nm) / cap layer, was prepared by using ultra-high vacuum sputtering machine (Canon-Anelva C-7100). The film was annealed at 350°C for 1 hour and microfabricated into a 120-nm-diameter p-MTJ. The magnetoresistance ratio and resistance-area product are 101% and 370 $\Omega \cdot \mu m^2$, respectively. We investigated the WER from the 10^5 repeated events under different in-plane magnetic field strength.

The switching time becomes shorter as increasing an in-plane magnetic field, resulting in low WER due to little thermal agitation during the precession. However further increase of an in-plane magnetic field increases the WER due to the reduction of thermal stability factor. These results are also reproduced by macrospin model simulation.

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Reference

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