

Evaluation of write error rate for voltage-induced dynamic switching in perpendicularly magnetized magnetic tunnel junctions

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Voltage-control of magnetic anisotropy is a promising technique for ultimate spintronic devices with ultra-low power consumption. The dynamic magnetization switching triggered by the sub-ns pulse voltage has been demonstrated [1,2]. One of the important issues for the practical application is the evaluation and improvement of the write error rate (WER). In this study, we investigated the WER of voltage-induced dynamic magnetization switching in perpendicularly magnetized magnetic tunnel junctions (MTJs).

A film 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) / Co₁₂Fe₆₈B₂₀ (1.0 nm) / MgO barrier / FeB (1.8 nm) / W (2.0 nm) / cap layer were deposited by using sputtering (Canon-Anelva C-7100). The film was annealed at 350°C for 1 hour and microfabricated into a 120-nm-diameter MTJ. The magnetoresistance ratio and resistance-area product are 106% and 400 $\Omega \cdot \mu\text{m}^2$, respectively. We investigated the WER from the 10⁵ repeated events at each conditions of external magnetic field and pulse duration

First we observed the bidirectional switching and oscillatory behavior of switching probability. This clearly indicates that the observed switching originates from the voltage torque. Figure 1 shows the WER as a function of pulse duration. The smallest WER was obtained at the half rotation time of the magnetization precession. Under the optimized condition, the WER less than 10⁻² was demonstrated both AP to P switching and P to AP switching.

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[2] S. Kanai *et al.*, *Appl. Phys. Lett.* **101**, 122403 (2012).

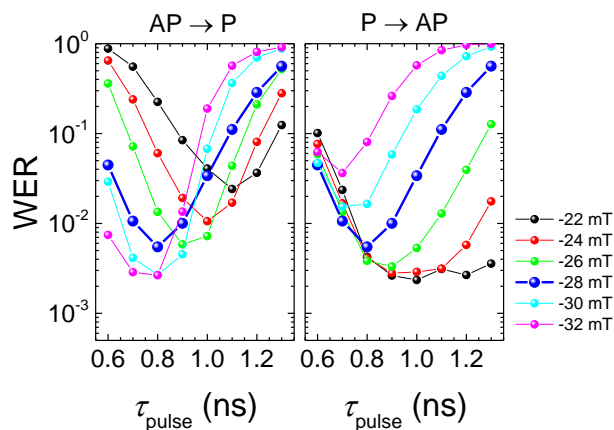


Figure 1 write error rate as a function of pulse duration under various magnetic field. The magnetic field was tilted 60 degree from film normal.