# In-plane aspect ratio dependence of thermal stability and intrinsic critical current in CoFeB/MgO magnetic tunnel junctions with perpendicular anisotropy

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We reported the presence of in-plane anisotropy in nanoscale CoFeB/MgO magnetic tunnel junctions (MTJs) with a perpendicular magnetic easy axis, which were designed to have a circular shape [1]. In this work, to investigate the influence of the anisotropy on the properties of MTJs, we fabricate elliptical MTJs with various in-plane aspect ratios (ARs), and evaluate their thermal stability factor $\Delta$ and intrinsic critical current $I_{C0}$ for magnetization switching.

A stack structure is Ta/Ru/Ta/CoFeB (1 nm)/MgO (1.3 nm)/CoFeB (1.8 nm)/Ta/Ru on a sapphire substrate. The two CoFeB layers have a perpendicular magnetic easy axis, and the top layer is a free layer. A circular MTJ with a 100 nm diameter with AR = 1 and elliptical MTJs with AR = 2, 3 are fabricated on a coplanar waveguide, where AR is defined as the ratio of the long to short axis of the ellipse. All the MTJs are designed to have the same junction area. The in-plane magnetic-field angle dependence of the junction resistance shows that the in-plane anisotropy field increases with increasing AR, and its value of ~40 mT for the MTJs with AR = 3 is consistent with that expected from the shape-dependent demagnetizing factors.

To evaluate $\Delta$ and $I_{C0}$, we measure magnetization switching probability as a function of magnetic-field and current pulses [2]. In analysis for the current induced switching, we adopt the exponent $n$ = 1 and 2 in the equation for switching probability [3,4]. Figure 1 shows the aspect ratio dependence of $\Delta$ and $I_{C0}$, where $\Delta$ and $I_{C0}$ do not show clear dependence of AR in agreement with magnetization switching through the nucleation of domains.

This work was supported in part by JSPS through FIRST program, R&D Project for ICT Key Technology of MEXT, Grants-in-Aid for Scientific Research from JSPS (No. 26889007) as well as MEXT (No. 26103002), ASPIMATT program from JST, and ImPACT program of CSTI.

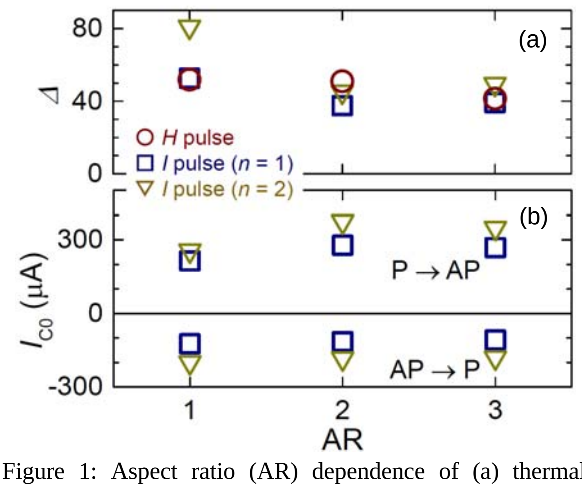


Figure 1: Aspect ratio (AR) dependence of (a) thermal stability factor $\Delta$ and (b) intrinsic critical current $I_{C0}$ for elliptical MTJs.

## References

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