Voltage effect on the spin-wave eigenmodes in the 65-nm-diameter CoFeB nanomagnet

Osaka Univ.¹, CSRN²,AIST³, ^oJaehun Cho^{1,2}, Shinji Miwa^{1, 2}, Kay Yakushiji³, Shingo Tamaru³, Hitoshi Kubota³, Akio Fukushima³, Shinji Yuasa³, and Yoshishige Suzuki^{1, 2, 3} E-mail: cho@spin.mp.es.osaka-u.ac.jp

Voltage effects on the magnetic properties are being actively studied because of its expectations to provide new functions in the spintronics devices. The magnetic anisotropy (Fe/MgO) [1], the Curie temperature (Co) [2], as well as the asymmetric exchange interaction (DMI) [3] have been successfully controlled by external voltage. In this work, we analyze the voltage induced changes of eigen-mode frequencies of the magnetic resonance in the 65 nm CoB/FeB nanomagnets to characterize the voltage controlled magnetic anisotropy and exchange interaction.

We prepared CoFeB(1.7 nm)/MgO-based magnetic tunnel junctions (MTJs) by magnetron sputtering systems. The designed junction has a circular shape (65 nm). Since the ferromagnetic counter electrode has an in-plane magnetization, the MTJ is very sensitive to the fluctuation of the CoFeB free layer magnetization along the perpendicular direction. Thermally excited ferromagnetic resonance spectra were measured with spectrum analyzer using lock-in technique [4]. The block diagram of the measurement setup is shown in Fig. 1(a). The resonance fields of spin-wave eigenmodes at 6.5 GHz under different bias voltages are shown in Fig. 1(b). From the voltage-induced change in eigenmode frequencies, we evaluate the voltage induced magnetic properties by comparison with micromagnetic simulations.

This work was partially supported by ImPACT program. JC thanks JSPS Research Fellow (No. P16362).



Fig. 1(a) The Block diagram of the measurement setup.

(b) Voltage effect for resonance field of spin wave eigenmodes.

- 1. T. Murayama et al., Nat. Nanotech. 4, 158-161 (2009).
- 2. D. Chiba et al., Nat. Mater. 10, 853-856 (2011).
- 3. K. Nawaoka et al., Appl. Phys. Expr. 8, 0640041-0630044 (2015).
- 4. J. Cho et al., Phys. Rev. B 94, 184411 (2016).