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Nonlinear stochastic spin-dynamics in CoFeSiB under spin-torque excitation

阪大院基礎工 [1]，産総研ナノスピン [2]

冨田博之 [1,2]，○三輪真嗣 [1,2]，梅山真理子 [1]，久保田均 [2]，松本利映 [2]，薬師寺啓 [2]，

福島章雄 [2]，湯浅新治 [2]，水落憲和 [1]，新庄輝也 [1]，鈴木義茂 [1,2]

Osaka Univ.[1], AIST Spintronics Research Center [2]

H. Tomita[1,2], ○S. Miwa[1,2], M. Umeyama[1], H. Kubota[2], R. Matsumoto[2], K. Yakushiji[2],

A. Fukushima[2], S. Yuasa[2], N. Mizuochi[1], T. Shinjo[1], Y. Suzuki[1,2]

E-mail: miwa@mp.es.osaka-u.ac.jp

Rectification effect in magnetic tunnel junctions (MTJs) can be used for realizing a highly sensitive microwave detectors [1], and a nonlinear effect has demonstrated a larger sensitivity (12000 mV/mW) than that of the semiconductor Schottky diode detectors using MgO-based MTJs [2]. As another kind of the nonlinear effects, the magnetic resonance under large thermal fluctuation, which is called *stochastic resonance*, is also a potential candidate. [3,4] In the present study, we have investigated the nonlinear stochastic spin-dynamics in the soft-magnetic CoFeSiB under spin-torque-induced magnetic resonance. The relation between the spin-dynamics and a thermal stavility in the CoFeSiB magnetization has been particularly characterized.

We prepared $Co_{20}Fe_{60}B_{20}$ (at%, 3 nm)/MgO (0.84 nm)/ $Co_{70.5}Fe_{4.5}Si_{15}B_{10}$ (2 nm) MTJs by magnetron sputtering systems. The film was post-annealed at 300℃, 1 T. The junction size was ϕ 120 nm. Figure 1(a) shows a time evolution of the MTJ resistance which expresses the magnetization dynamics in the CoFeSiB under 1.5 mT, 0.1 mA. Then we applied the magnetic field nearly perpendicular to the film plane with keeping state probabilities of high and low resistance states identical. Figure 1(b) shows the mean-transition time (τ_0) evaluated from the magnetization switching behaviors. By changing the magnetic field strength (H), a clear change in the τ_0, which may relate the thermal stability in the CoFeSiB, has been observed. We will show how the change in the τ_0 affects the spin-torque induced stochastic resonance. This work was supported by a Grant-in-Aid for Scientific Research (S) (No. 23226001) and NSG Foundation.

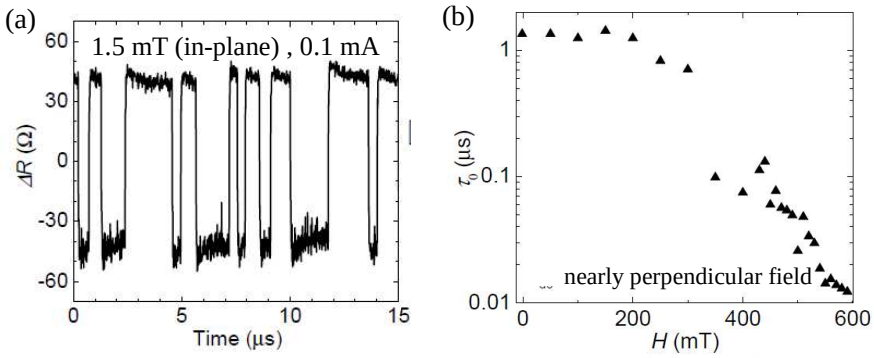

Figure 1 (a) Magnetization dynamics in CoFeSiB
(b) Mean-transition time v.s. magnetic field

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