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Spin-torque magnetic resonance in CoFeSiB with low magnetic anisotropy

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Magnetic tunnel junctions (MTJs) have been much expected for realizing a highly sensitive microwave detectors. We have tried to realize it by using amorphous soft magnetic material, $Co_{70.5}Fe_{4.5}Si_{15}B_{10}$ (at%). A small coercive field and a macrospin behavior even after micro-fabrication can be expected in such materials. In the previous study, we fabricated the MTJs with a CoFeSiB free layer (coercive field ~ 25 Oe). In the MTJ, a high rate random telegraph noise (RTN, period~50 ns) was observed [1]. In such MTJs, thermal fluctuation may assist the spin-torque-induced magnetic resonance, and enhance the sensitivity (stochastic resonance, SR) [2]. The sensor utilizing SR may enable highly sensitive microwave detectors. In the present study, we have investigated the spin-torque-induced magnetic resonance in the CoFeSiB.

We prepared multilayer structure of Si/SiO_2 sub/buffer/CoFeB (3 nm)/MgO (0.84 nm)/CoFeSiB (2 nm)/cap by sputtering. The film was patterned into pillars with 120 nm in diameters. The tunnel magnetoresistance was 21% (Fig. 2 inset). Figure 1 shows a time evolution of the MTJ resistance measured by an oscilloscope. This resistance change is a RTN originating from the magnetization switching. The angle change in the CoFeSiB magnetization direction was estimated to be ~175 deg. Figure 2 shows the spin-torque magnetic resonance spectra [3]. Under the magnetic field of 5 Oe, the spectrum increases around 0.06 GHz, where the RTN in Fig. 1 was observed. We think this increase is caused by the resistance oscillation driven by the spin-torque synchronized with the RTN. We have also measured the input RF power dependence, and this low-frequency peak amplitude was proportional to the input power. This indicates that there is no thermal assist in the phenomena. However, by optimizing the magnetic field and DC bias condition, the SR might be observed.

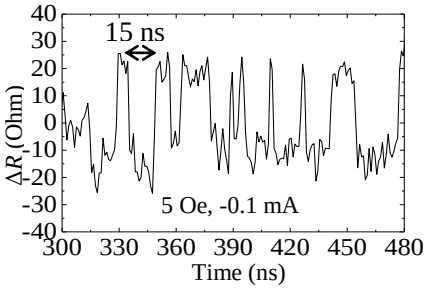

Fig. 1　Random telegraph noise

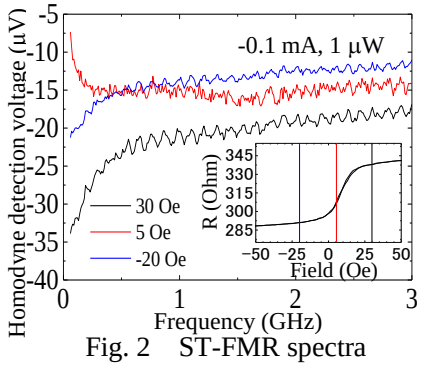

Fig. 2　ST-FMR spectra

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