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Real time measurement of random magnetization switching in CoFeSiB free layer of a magnetic tunnel junction

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Spin-torque devices, spin-transfer torque magnetic random-access memory (STT-MRAM) for example, are much expected for the applications, because of its advantage in the scaling. To reduce energy consumption in those devices further utilizing thermal effects, we have made magnetic tunnel junctions (MTJs) with a $Co_{70.5}Fe_{4.5}Si_{15}B_{10}$ (at%) free layer which have small coercive field and low resonant frequency (0.6 GHz) [1]. In this work, we have conducted real-time measurement of the MTJ resistance by an oscilloscope to investigate the detailed magnetization dynamics.

We prepared multilayer: Si/SiO_2 sub/buffer/CoFeB (3 nm)/MgO (0.95 nm)/ CoFeSiB (2 nm)/cap by sputtering methods. The film was annealed at 300 ℃ in a magnetic field of 10 kOe and patterned into pillars with 120 nm in diameters. The magnetoresistance (MR) ratio of the sample is 18%. (Fig.1 inset) As shown in the Fig. 1, the parallel magnetization state is stable at zero field and the resistance is increased under negative DC bias, which indicates the excitation of the magnetization dynamics by spin-torque. Figure 2 shows the result of real time measurement at 0 Oe, -0.5 mA. The observed random telegraph noise (RTN) shows very high transition rate as a consequence of a low potential barrier in the soft CoFeSiB free layer. The high-rate RTN may provide a basis of thermally actuated spintronic devices such as a high-speed sensor using a stochastic resonance [2].

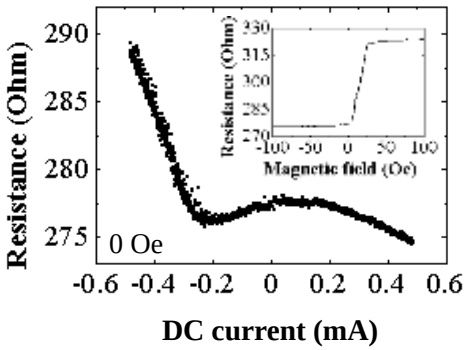

Fig. 1　Resistance versus DC current

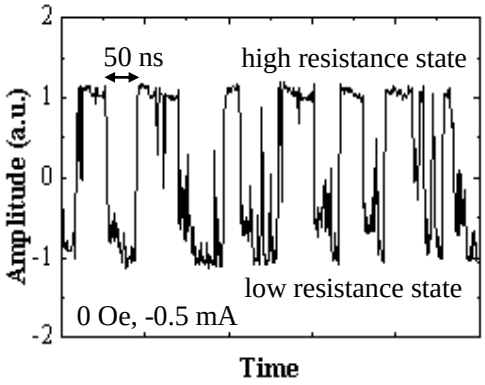

Fig. 2　Random telegraph noise

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