Microwave emission from magnoise in heat-driven magnetic tunnel junction with feedback loop circuit

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Magnetic tunnel junction (MTJ) is attracting attention as the next generation microwave signal sources. Recently, it was reported that the microwave reflectivity (S_{11}) from MTJ is amplified by spin-torque from heat-induced magnetic anisotropy change [1]. In addition, we reported that the transmission signal (S_{21}) is amplified with a similar mechanism [2]. In this study, we investigate the microwave emission from magnoise in MTJ, and characterize transmission amplification by the heat-induced torque with feedback loop circuit.

The film structure is buffer layer / IrMn (7 nm) / CoFe / Ru / CoFeB / MgO barrier (1 nm) / FeB (2 nm) / MgO cap (0.4 nm) / metal cap. Figure 1 shows the set up to measure the magnoise by (a) terminated and (b) loop circuits. The dc voltage is applied to the MTJ through bias-tee. To detect the microwave signal by spectrum analyzer in the loop circuit, we use directional coupler. The directional coupler has 13dB coupling loss. The spectra in terminated circuit is used as the reference signal. Figure 2 shows the comparison between spectra in (a) terminated (red curve) and the (b) loop (blue curve) circuits, respectively. Resolution bandwidth was 0.1 MHz. The blue curve shows sharp peak at 4.12 GHz. The line width was reduced from 76.4 MHz to 2.5 MHz. The peak power spectrum density was increased from 0.28 μW/GHz to 5.71 μW/GHz. This result suggests that the microwave from magnoise was injected to MTJ with loop circuit, and was amplified by the heat-driven MTJ. Therefore, the power of microwave is enhanced by positive feedback.

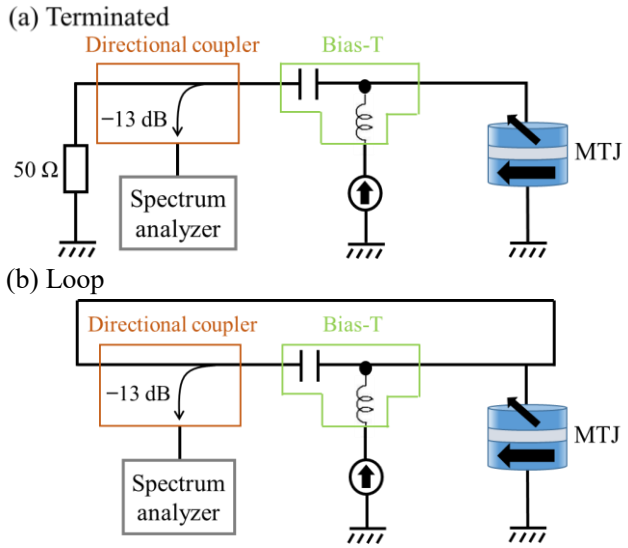

Fig.1: Set up for magnoise measurement in (a) terminated and (b) loop circuits.

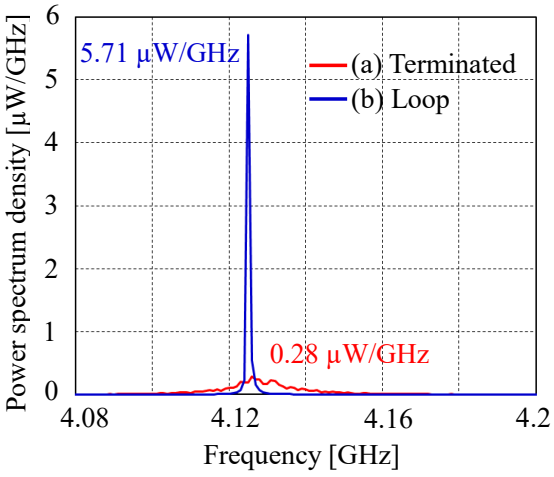

Fig.2: Spectra of magnoise in (a) terminated and (b) loop circuits

[1] M. Goto *et al.*, Nat. Nanotechnol. (2019). [2] Y. Yamada *et al.*, JSAP Autumn meeting (2018)