High-output microwave detector using voltage-induced ferromagnetic resonance

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Rectification of microwave using magnetic tunnel junction (MTJ) is the promising candidate for the high sensitive microwave detector. Recently, the application of the DC bias to MTJs has been found to enable highly sensitive microwave detection at room temperature, exceeding the detection sensitivity of semiconductor Schottky diode detectors. [1] However the high-output voltage is limited under a lower current application than that of the destabilization current of the free layer magnetization. Therefore even if the DC bias application increases the detection sensitivity, the sensitivity drastically decreases when a large DC bias current and/or a large input RF power is applied.

In this study, we demonstrate the high-output microwave detection using voltage-induced ferromagnetic resonance (FMR). [2] An MTJ film was prepared by sputter deposition on thermally oxidized Si wafer: buffer layer/IrMn (10 nm)/$Co_{70}Fe_{30}$ (2.0 nm)/Ru (0.7 nm)/$Co_{16}Fe_{64}B_{20}$ (3.0 nm)/MgO (2.0 nm)/ $Co_{16}Fe_{64}B_{20}$ (2.0 nm)/ capping layer. The MTJ film was patterned into the pillar-shaped structure of 1 × 4 μm^2. Then, the film was annealed at 300°C for 2.0 h in a 600-mT in-plane magnetic field, which defined the pinned layer exchange-bias direction parallel to the long axis of the MTJ pillars.

Figure 1 shows the homodyne detection voltage for the input RF frequency of 2.0 GHz as a function of external magnetic field under the DC bias voltage of 0.0 V (triangle) and -1.0 V (circle), respectively. Under zero bias voltage, the spectrum with anti-Lorentzian structure was observed in the FMR excited by voltage-torque. Under bias voltage application of -1.0 V, the shape of spectrum changes from an anti-Lorentzian structure to a Lorentzian structure, and clear enhancement of the peak voltage was observed. This can be understood by the non-linear effect due to the asymmetric magnetization-potential in the free layer. In the presentation, we will discuss the bias voltage and input power dependence.

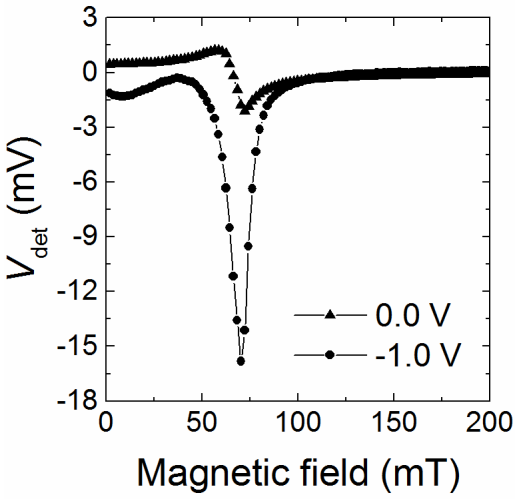

Fig. 1 The homodyne detection voltage (V_{det}) as a function of external magnetic field.

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[1] S. Miwa *et al.*, *Nature Materials* **13,** 50 (2014) [2] Y. Shiota *et al.*, *Appl. Phys. Lett.* **105,** 192408 (2014)