Radio-frequency magnetic field sensitivity of magnetic vortex in magnetic tunnel junctions

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It is important to develop magnetic field sensors with high sensitivity in medical applications. Recently, magnetic tunnel junction (MTJ) sensor with uniform magnetization layer is studied well [1]. Further, low frequency magnetic field sensitivity of magnetic vortex in MTJ (vortex MTJ) is studied [2], however, radio-frequency (RF) magnetic field sensitivity of vortex MTJ is not yet studied. The magnetization fluctuation mode of magnetic vortex is different from the mode of uniform magnetization, and it is expected that the magnetic field sensitivity of these two magnetization structures is different. Magnetic vortex has a thermal fluctuation noise around RF range, and to research this noise characteristic is essential. Therefore, in this study, we demonstrate the RF magnetic field sensitivity of vortex MTJ.

Figure 1 shows the measurement circuit. RF magnetic field is applied from the wire to the MTJ by RF current source. DC current is applied to MTJ throw bias-tee and RF signal from MTJ is measured by spectrum analyzer. The film stack is Si-substrate / buffer layer / IrMn(6) / CoFe(2.5) / Ru(0.85) / CoFeB(2.1) and CoFe(0.4) reference layer / MgO(1.1) / FeB(5) vortex free layer / MgO(1.1) / Ta(5) / Ru(5) (thickness in nm). Figure 2 shows noise spectrum when DC current and RF magnetic field is applied to MTJ. Resolution band width (RBW) is 100kHz and RF signal is amplified 36dB by an amplifier. RF magnetic field is generated by -45dBm RF current source in the frequency range of 0.1GHz~1.0GHz. Spikes in the Fig. 2 are the observed magnetic field by the vortex MTJ. We will discuss the frequency dependence of magnetic field sensitivity of vortex MTJ.

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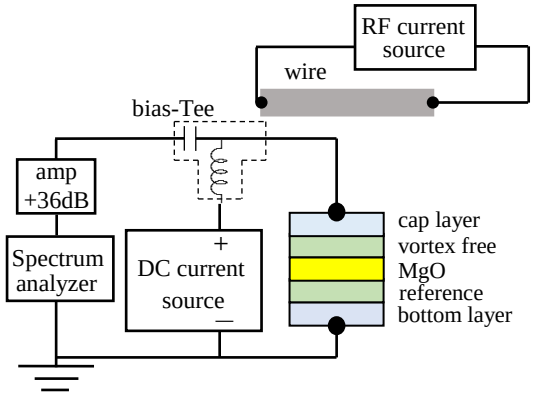

Figure1, measurement circuit

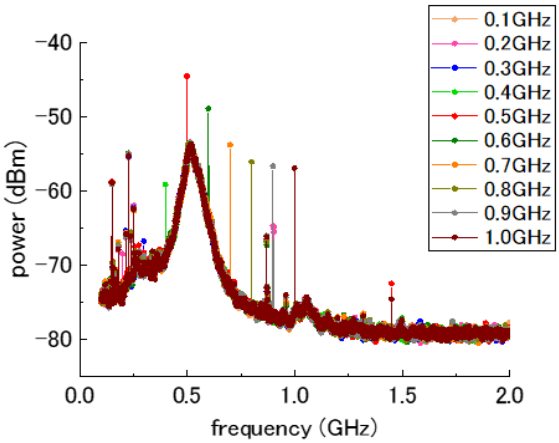

Figure2, noise spectrum when DC current and RF magnetic field is applied to MTJ

[1] S. Cardoso et al., Microsystem Technologies20(4-5), pp793-802 (2014)

[2] H. Weitensfelder, et al., Phy.Rev.Applied10, 054056 (2018)