Magnetic field modulation using magnetic shield for reducing noise of MTJ sensor

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Introduction

Recently, researches on magnetic tunnel junctions (MTJs) for bio-magnetic field sensors have been conducted. A high sensitivity is required to detect a very small magnetic field such as bio-magnetic field (10^{-8} – 10^{-10} Oe). In addition, it is necessary to reduce the low-frequency noise of MTJ sensors because bio-magnetic field is below several hundred Hz. In this work, we investigated magnetic field modulation using magnetic shield[1) 2)] to reduce the 1/*f* noise in MTJ sensors and improved the detectivity of MTJ sensors in the low-frequency field.

Experimental method

The MTJ sensors with a structure of SiO_2-sub./ Buffer/NiFe(70)/Ru(1)/CoFeB(3)/MgO(1.5)/CoFeB(3)/Pin/ Cap were fabricated. Fig. 1 shows the principle of the magnetic field modulation. The magnetic shield tube made of cobalt-based amorphous soft magnetic alloy was wrapped with copper wires for excitation coil. The chopping current at the frequency of 410 Hz switched the magnetization of the magnetic shield.

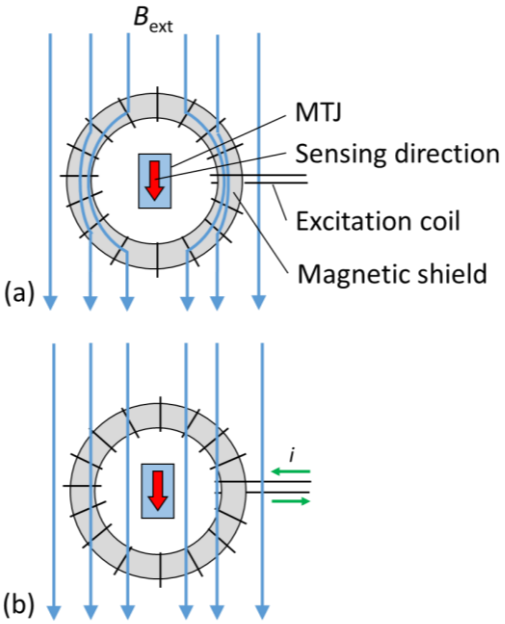

Fig. 1 A principle of the magnetic chopping: (a) unsaturated magnetic shield. (b) saturated magnetic shield.

Experimental results

We found that the external magnetic field of 3.3 Hz was modulated to 406.7 Hz and 413.3 Hz by proposed modulation method. A signal of MTJ sensor was modulated without increasing background noise, as shown in Fig. 2. Detectivity of MTJ sensor was successfully improved by magnetic field modulation using magnetic shield.

This work was supported by the S-innovation program, Japan Science and Technology Agency (JST).

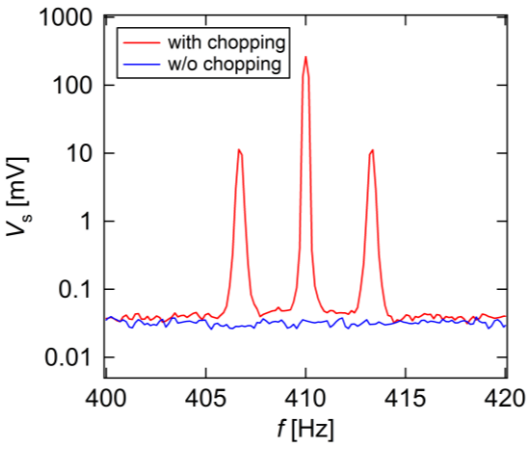

Fig. 2. MTJ sensor signal resulting from magnetic field modulation of 3.3 Hz.

References

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