Thermally stable magnonic sensors using spin wave differential circuits

Taichi Goto[1], Naoki Kanazawa[1], Hiroyuki Takagi[1], Yuichi Nakamura[1], Shingo Okajima[2], Takashi Hasegawa[2], Alexander B. Granovsky[3], Koji Sekiguchi[4], Caroline A. Ross[5], Mitsuteru Inoue[1]
[1]Toyohashi University of Technology, 441-8580, Toyohashi, Japan
[2]Murata Manufacturing Co., Ltd., 617-8555, Kyoto, Japan
[3]Moscow State University, 119992, Moscow, Russia
[4]Keio University, 223-8522, Yokohama, Japan
[5]Massachusetts Institute of Technology, 02139, Cambridge, USA

Magnetic field sensors using spin wave propagating in the yttrium iron garnet (YIG) was proposed[1)]. Experimentally its high sensitivity, ~38 pT/Hz, was demonstrated with the artificial magnetic lattice (AML) composed of copper stripes onto YIGs2,3), but the thermal instability of magnetization of YIGs prohibited spin waves from moving to device steps. To solve this issue, we used the spin wave differential circuit (SWDC) comprising two YIG films magnetized in opposite directions. Figure 1 shows the fabricated SWDC. This setup was put into the thermostat chamber and the magnetic-field sensitivity was measured by changing the applied field by Helmholtz coil. Figure 2 shows the thermal sensitivity of circuit A alone, B alone and SWDC. The obtained thermal stability of SWDC was -9.5×10^{3} ° K^{-1}. This was about 2×10^{3} times better than single circuits. The sensitivity to the change of magnetic field was same with single circuit. This prototype of spin wave magnetic-field sensor can be minitualized with decreasing of the thickness and wavelength of spin waves. Details of measurement setup, tuning method of actual device, and fundamental properties of magnonic crystals modulating propagation properties of spin wave will be discussed in the symposium.

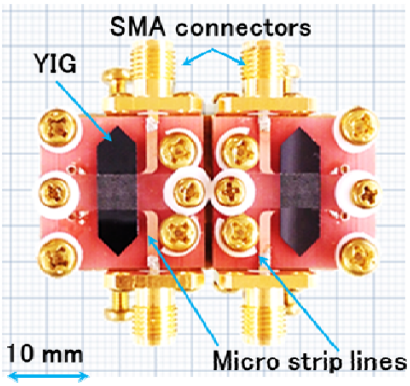

Fig. 1 Top view of the spin wave differential circuit composed of two YIG films placed onto four microstrip lines. Two YIGs are magnetized in opposite direction each other by bulk $Nd_2Fe_{14}B$ magnets embedded in jig composed of brass. Four microstrip lines are electrically connected to the vector network analyzer.

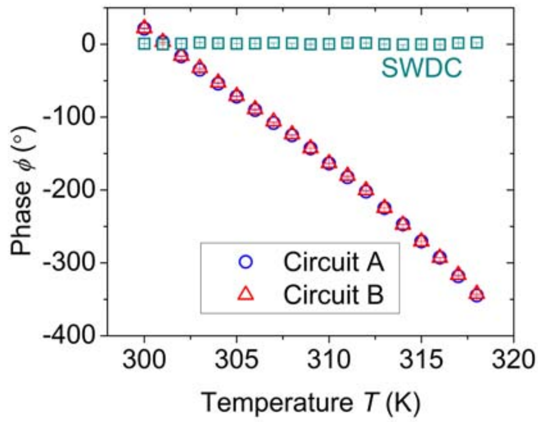

Fig. 2 Phase of spin wave versus temperature. Blue circles and red triangles show that of circuit A and B, respectively. Green squares show that of spin wave differential circuit.

Reference

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