Time-resolved imaging of spin wave transmission through an air gap

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Magnetization control using ultrashort optical pulses has been extensively studied in recent years. One of the nonthermal control of magnetization is based on the inverse Faraday effect, where circularly polarized pulses generate the effective magnetic field along the propagation vector in a transparent material, leading to spin wave generation[1,2]. Spin wave reflection at the sample edge or transmission through an air gap has been reported in finite-size samples[3,4]. In the present study, we report on time- and phase-resolved imaging of photo-induced spin wave's transmission through an air gap using pump-probe technique with a CCD camera.

In the experiment, a bismuth-doped rare earth iron garnet crystal with a thickness of 110 μm was used as a sample. Circularly polarized pump pulses with a time duration of 150 fs were employed to excite the sample via the inverse Faraday effect. Faraday rotation of time-delayed probe pulses was measured. Figure 1 shows the transmission of spin wave excited in the left hand sample through an air gap to the right hand sample, where the gap width was 40 μm and the time delay was 1000 ps. The center wavelength of the spin waves was observed to be 100-200 μm meaning that the spin waves were dipolar-dominated magneto-static waves. The relation between transmission, phase and the gap width was analyzed. The experimental results were compared with simulation results.

Reference

1) T. Satoh *et al.*, Nature Photon. **6** (2012) 662.
2) I. Yoshimine *et al.*, J. Appl. Phys. **116** (2014) 043907.
3) M. P. Kostylev *et al.*, Phys. Rev. B, **76** (2007) 184419.
4) T. Schneider *et al.*, EPL **90** (2010) 27003.

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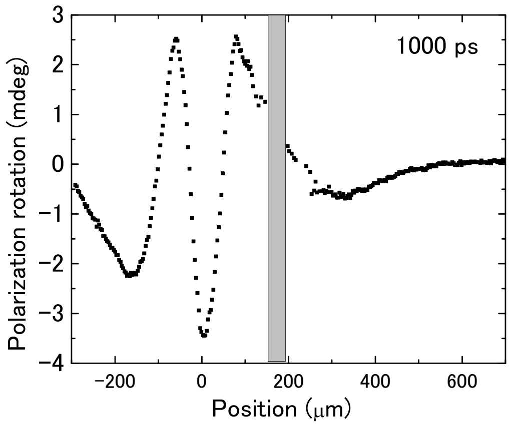

Figure 1　Spin wave transmission through an air gap with a width of 40 μm.