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Spin-Wave Propagation Detected using All-Optical TR-MOKE Microscope in Permalloy Films

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Manipulation of spin-wave has attracted much attention for development of low power consumption device, such as spin-wave logic circuit. Spin-wave is generally excited by using microwave strip lines. Recently, spin-wave propagation in ferrimagnetic insulators excited by pulse laser was reported[1]. This technique is more advantageous than electrical excitation because of wide frequency band width. Sub-Terahertz magnetization dynamics can be detected using time-resolved magneto-optical Kerr effect (TR-MOKE) technique[2]. In this study, we investigated spin-wave propagation of permalloy thin films in micrometer region excited by pulse laser and detected using the TR-MOKE.

The 20-nm-thick permalloy film with an in-plane anisotropy field of 5 Oe was prepared by magnetron sputtering method. In TR-MOKE, Ti: Sapphire laser with repetition rate of 84 MHz was used and a wavelength of pump (probe) laser was 400 (800) nm. Pump and probe lasers were focused with the objective lens and the spot diameter of pump and probe beam were ~ 3 and 1 μm, respectively.

Figure 1 shows TR-MOKE signals with different distance L between the center of pump and probe laser spots, which direction is orthogonal to magnetic easy axis. External magnetic field of 1.7 kOe was applied perpendicular to the film plane. At L = 0, an ultrafast demagnetization is observed at zero delay time. When L is non zero, the spin-wave packets are observed and the center of wave packets systematically delay with increasing L. Group velocity of the spin-wave packet was estimated from the delay time and L to be 5~10 km/s, which is roughly consistent with the calculated value of magnetostatic surface spin-wave mode (MSSW). On the other hand, the propagation length of wave packet was shorter than that of MSSW mentioned above when the propagation direction was parallel to magnetic easy axis, which was consistent with slower group velocity predicted in magnetostatic backward volume mode (MSBVM).

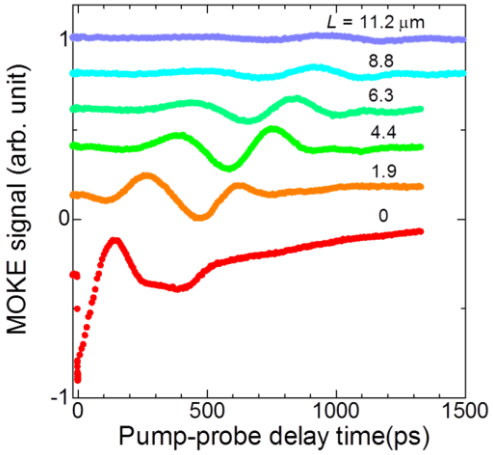

Fig. 1 Time-resolved Kerr signals with different distance L between pump and probe beam spots. Propagation direction is orthogonal to magnetization direction.

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[1] T. Satoh *et al.* Nature Photonics **6**, 662 (2012),

[2] S. Iihama *et al.*, Jpn. J. Appl. Phys. **52**, 073002 (2013)