Observation of Pulse Laser-Induced Propagating Spin Wave in Magnetic Metal/Heavy Metal Layered Structures

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Spin-orbit interaction (SOI) for magnetic metal and heavy metal layered structures is one of the most important topic in the field of current spintronics. In particular, presence of interfacial D'zyaloshinsky-Moriya interaction (i-DMI) is recognized by recent studys of magnetization dynamics, such as domain-wall motion and propagating spin wave (PSW) [1,2]. Previously, we have demonstrated that all-optical space-and-time resolved magneto-optical Kerr effect (STR-MOKE) microscopy is suitable for characterization of PSW in metals [3-5]. In this study, we examined whether PSW can be observed in such layered structures with strong SOI using all-optical STR-MOKE technique.

Si/SiO_2 subs. /Ta(5)/$Ni_{80}Fe_{20}$(Py)(4.5)/Co(0.5)/Pt(3)/Ta(5) films (thickness is in nm) were prepared by magnetron-sputtering method. Fig. 1(a) shows the space-time Kerr imaging of the PSW in a few μm region and Fig 1(b) shows the typical PSW packet. We have successfully obtained propagating properties and dispersion relation by the Gaussian-fitting and the Fourier analysis, as performed before [3-5], even though the Gilbert damping parameter for the films is larger than that of the 20-nm-thick Py films [3-5]. This result will be a first step to explore the various SOI-related effects on the laser-induced spin-wave emission and propagation in metals.

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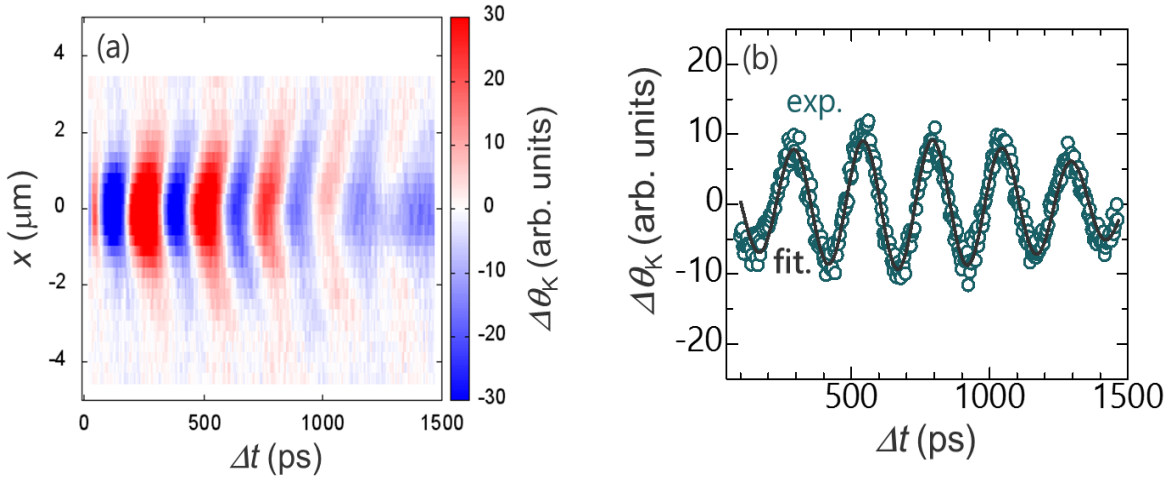

Fig.1 Pulse laser-induced propagating spin wave (PSW) in Py/Co/Pt layered structure. (a) Space-time imaging of pump-induced change in the Kerr rotation angle $\Delta\theta_K$. x and Δt are the pump-probe distance and delay time, respectively. Probe scanning direction is perpendicular to the applied magnetic-field orientation slightly tilted from the film normal. (b) An example of experimentally obtained PSW packet (open circles) and the Gaussian-wave packet fitting (solid curve) with respect to Δt.