Propagating Properties Depending on 80NiFe-Films Thickness for Pulse Laser-Induced Spin Wave

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Propagating spin wave (PSW) has been mainly studied by using micro-wave antenna for realizing future’s spin-based logic devices [1]. Nowadays, pulse laser-induced PSW is actively being investigated in magnetic metals and insulators [2, 3]. In magnetic metals, which have much smaller propagation length, an excitation mechanism and detail properties of PSW are not well understood. In particular, excitation mechanism has a fundamental issue because of heating effect. Here, we report propagating properties depending on 80NiFe-(Py)-films thickness for pulse laser-induced spin wave.

The Py films (thickness d = 20, 50 and 100 nm) were prepared by magnetron sputtering method. PSW was observed by space-and-time resolved magneto-optical Kerr effect (STR-MOKE) [3]. The power of pump and probe beam are about 15 and 5 mW respectively. The external magnetic field $\mu_0 H_0 = 0.3$ T was applied with $\theta_0 = 5$ deg., where $\theta_0$ is measured from normal direction of the film surface. PSW is detected in the direction perpendicular to the magnetization. Fig. 1 shows the space-time mapping of pump-laser induced change in Kerr rotation angle $\Delta \theta_k$. The PSW was clearly observed, which exhibit Gaussian-type wave packets. The propagation length $\lambda$, which is shown in Fig. 2 as a function of the group velocity $v_g$, was estimated. They are consistent with those expected from the relation, $\lambda = v_g \tau$, with life time $\tau$ which was separately determined (dashed-line in Fig. 2).

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Fig. 1: Space-time mapping of pump-laser induced change in Kerr rotation angle $\Delta \theta_k$. $\Delta t$ is pump-probe delay time, and $x$ is scanning direction.

Fig. 2: Propagation length $\lambda$ vs group velocity $v_g$ with different thickness $d$. The dashed line is calculated with $\tau = 1350$ ps.