All-optical investigation of coherent magnon propagation in metallic films

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Dipolar spin-wave frequency is typically in GHz microwave range and its lifetime is quite long in some materials, such as yttrium iron garnet (YIG), thus spin-wave have been widely studied to apply passive and active microwave devices in early days. Most of them could not be commercialized since those were not beyond semiconductor devices. Nowadays, spin-wave or its quantum, *magnon*, is studied with renewed interest as a basis for Magnonics, spin-based information processing technology without electric charge to reduce power consumption.[1)] The Magnonics research is still fundamental, where various basic building blocks have been discussed from the various aspects.[2)] The light-induced coherent magnon may be one of such building blocks, which has been studied during the past few years,[2,3)] because it is applicable to a light coupling for magnon circuit interconnection.[2)] It is also interesting to seek light-induced coherent magnon in metallic films, because magnon dispersion in metallic film hetero-structure can be tuned by the interfacial anti-symmetric exchange interaction and also the externally applied electric field.[4)] However, there have been few reports on the light-induced coherent magnon in metallic films.[5,6)]

Here we present our recent results on the propagating magnon excited in films of magnetic metals by the micro-focused fs pulse laser with the spot diameter of μm scale. The magnon-propagation induced by the laser pulse was detected via the magneto-optical Kerr effect for another weak laser pulse with varying position and delay-time using all-optical scanning pump-probe technique (Fig. 1). The pulse laser-induced coherent magnons propagation was clearly observed and its propagation were highly anisotropic with respect to the direction of magnetization (Fig. 2), being consistent with the anisotropic dispersion of magneto-static surface or backward volume wave. Excitation mechanism of magnon is discussed in terms of ultrafast change of magnetization induced by the pulse laser.[7)] This work was partially supported by KAKENHI No. 16H03846, Nano-spin conversion science No. 26103004, and the center of Spintronics Research Network.

Reference

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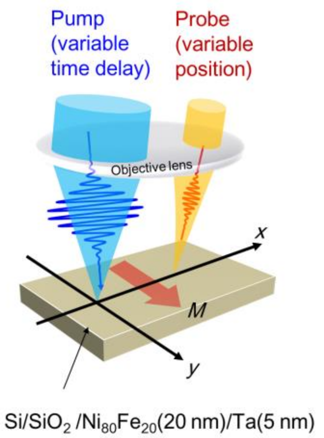

Fig. 1 Schematic illustration of the all-optical spatio-temporal pump-probe measurements for magnetic film under microscope.

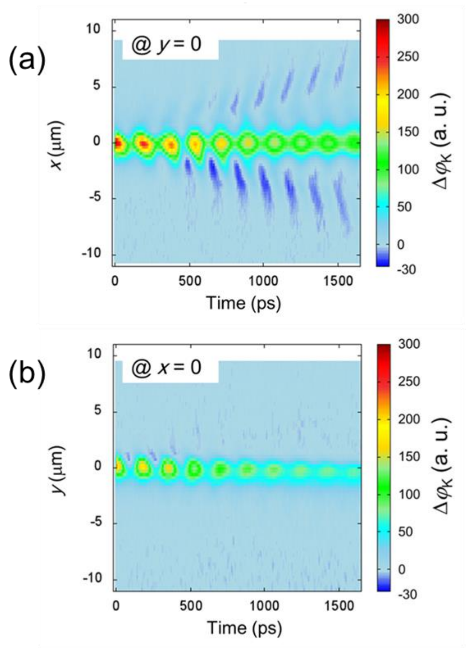

Fig. 2 Spatio-temporal mapping of the experimental data of the pump-pulse-induced change of Kerr rotation angle. The scanning direction of probe beam is (a) *x*- and (b) *y*-axis.