Effect of Spin pumping on Gilbert Damping for Thin Permalloy Films Detected by using Time-Resolved Kerr Effect

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Recently, we have observed the enhancement of Gilbert damping for permalloy (Py) thin films using ferromagnetic resonance (FMR) [1] due to the effect of spin diffusion driven by the precession of magnetization, the so-called spin pumping [2]. For a deep understanding of the effect on the damping, direct observation of the motion of magnetization should be investigated. In this work, precession of the magnetization in Py layer of some types of multilayer films was studied using ps-time-scale magneto-optical Kerr effect (MOKE). The current pulses were generated by an optical switch synchronously triggered by a mode-locked Ti-sapphire fs-laser. Magnetization measurements were accomplished through polarization analysis of the reflected light in an optical bridge. A static external magnetic field was applied to the orthogonal direction of the pulse field. Magnetization precession signals for Cu/Py/Cu films were successfully detected for various intensity of static and pulse magnetic fields. The frequency of the precession becomes high with increasing the static magnetic field. In contrast the oscillation disappeared for Pt/Py/Pt films. These MOKE signals were fitted very well using Landau-Lifshitz-Gilbert (LLG) equation of motion with the damping coefficient alpha of 0.008 and 0.015 for Cu/Py/Cu and Pt/Py/Pt stacking structures, respectively. Such dependence of the stacking structure on the damping coefficient corresponds to the FMR measurements considered to be due to the effect of spin pumping.

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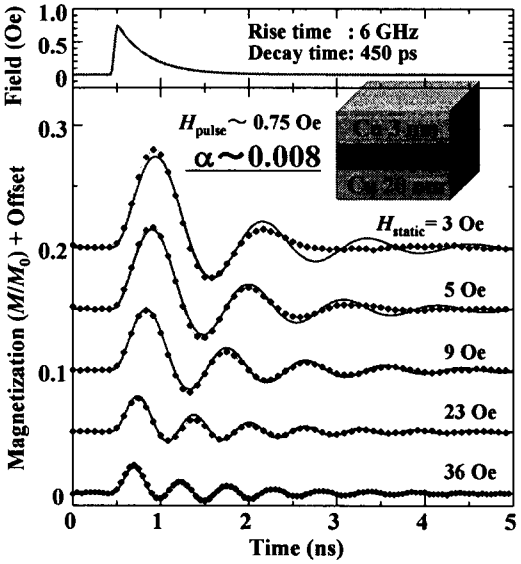

Fig.1. Magnetization precession of a Py thin film as measured by a time-resolved pump-probe MOKE experiment. Fitting curves were calculated using LLG equation of motion with various damping parameter values α of 0.008.

References

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