Photo excited precession of magnetization in Co/Pd multilayers grown on various substrates

K. Takahashi¹, N. Nishizawa¹, K. Nishibayashi¹, T. Matsuda¹, Y. Iwasaki¹, Y. Kitamoto², and H. Munekata¹
Imaging Sci. & Eng. Lab., Tokyo Tech.¹ (E-mail: k.takahashi@isl.titech.ac.jp)
School of Interdisciplinary. Grad. Sci. & Eng., Tokyo Tech.²

Aiming at studying novel functionality in optics and photonics with spin degree of freedom, we have been studying photo-excitation of ordered spins in weak excitation regime, and found recently that precession of magnetization could be induced in Co/Pd multilayers (MLs) grown on Si(110) with excitation power as low as 0.25 µJ/cm² at the wavelength λ = 790 nm [1]. Question concerning the use of a Si(110) substrate have been raised in view of substrate heating and physical property of the resultant MLs. We show here that Co/Pd MLs of similar kinds can be prepared on Si(100), GaAs(100), and GaAs(110), and discuss that the photo-excited precession of magnetization (PEPM) is not unique for samples on Si(110).

Samples consisting of [Co/Pd]ₙ / Pd(6.81nm) / Ta(2.18nm) with different Co and Pd layer thicknesses, Co/Pd in the unit of nm, were prepared on various Si and GaAs substrates using DC magnetron sputtering at the substrate temperature of 150°C. All samples have exhibited perpendicular magnetic anisotropy at room temperature (RT). PEPM experiments were carried out by time-resolved magneto-optical spectroscopy on the basis of pump and probe technique using a mode-locked Ti:sapphire laser of 150-fs pulse width at the wavelengths λ = 790 - 895 nm.

Temporal profiles of magneto-optical (MO) signals obtained at λ = 790 nm (P_pump = 1.5 µJ/cm²) are shown in Fig.1 (a) for samples grown on four different substrates. Oscillations due to PEPM are observed in all samples. Shown in Fig.1 (b) is a MO temporal profile for the sample grown on GaAs(100) obtained at λ = 890 nm (P_pump = 18 µJ/cm²) which is longer than the fundamental absorption edge (λ_GaAs = 872 nm) of the substrate. This fact indicates that PEPM is attributed solely to light absorption in MLs. Shown in Figs.2(a)-(c) are static optical data for the 0.45/0.57 MLs sample grown on GaAs(100), from which we are able to derive complex refractive index n = 2.7 + 3.8i, together with dielectric tensor ε_xx = −7.15 + 20.52i and ε_yy = 0.0836 − 0.0362i. Magnitudes of real and imaginary parts of the off-diagonal term appear to be, respectively, five times smaller and six times larger than those of representative MO materials [2].