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Modulation of spin precession frequency by spin relaxation anisotropy in a (110) GaAs/AlGaAs quantum well

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In a III-V quantum well (QW), the spin precession frequency depends on the magnitude of external magnetic field as well as the spin relaxation anisotropy [1]. In this work, we study the pump power dependence of the precession frequency of the optically injected spins in a (110) GaAs quantum well.

We grow an n-GaAs/AlGaAs QW on a (110) GaAs substrate, where Si δ doping is employed to hold the Rashba and Dresselhaus spin-orbit interactions by introducing the asymmetric potential profile. We measure the spin dynamics in the QW by a time resolved Kerr rotation (TRKR) method, and determine the spin precessional frequency ω' under an constant magnetic field B_{ext} = 0.497 K at 30 K as a function of the pump power P ranging from 2 to 60 mW.

Figure 1 shows a TRKR signal at P = 10, 20, and 30 mW, where a small shift in ω' is observed with the increase of P. Because B_{ext} is constant, the observed shift is expected to be related to the change of the spin relaxation anisotropy. Figure 2 summarizes the P dependence of ω', where ω' increases gradually with the increase of P, and saturates at ~4.4 GHz above 30 mW. From the results, we derive the parallel and perpendicular spin relaxation times. They increase with increasing P, indicating that the enhancement of electron-electron scattering rate suppresses the spin relaxation.

[1] K. Morita *et al.*, Appl. Phys . Lett. **87,** 171905 (2005).

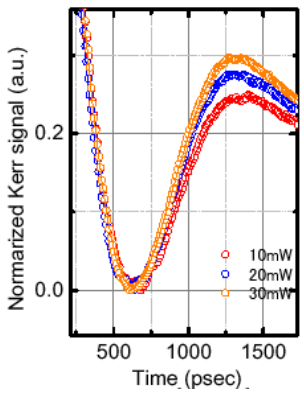

Fig. 1. TRKR signals as a function of pump power.

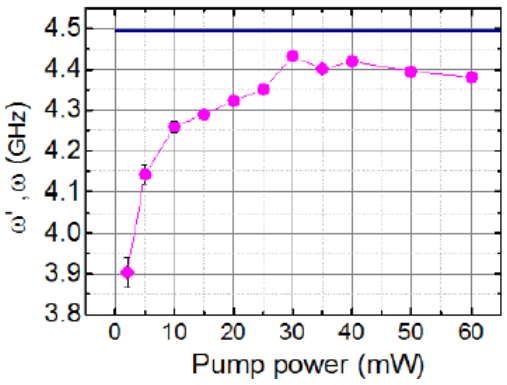

Fig. 2. Pump power dependence of precessional frequency ω'. Solid line is $\omega = g\mu_B B_{ext}$.