18a-D7-11　低温成長 GaAs のサブピコ秒ホールスピン緩和の観測

Sub-picosecond hole spin relaxation in low-temperature grown GaAs

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Low-temperature grown GaAs (LT-GaAs) is expected to be used for ultrafast all-optical switching devices.[1] LT-GaAs was found to be highly strained, containing roughly 1-2% excess arsenic being incorporated during growth as As antisite defects. These As-related defects contribute to the ultrafast nonradiative recombination of photoexcited carriers.[2] Previously, we reported that the electron spin relaxation times of the fast component in a LT-GaAs are on the order of picosecond at 10 K.[3] In this study we have investigated the hole spin relaxation of LT-GaAs by time-resolved spin-dependent pump and probe measurements.

The sample is 1-μm-thick LT-GaAs which was grown at 260 °C by molecular beam epitaxy. In the pump and probe measurements, spin-aligned carriers were created when electrons were excited by a circularly polarized optical pulse generated from a Ti-sapphire laser.[4] The photon energy was tuned to the resonant excitation of the lowest electron-heavy-hole exciton. The time resolution of this measurement system was 200 fs, which was obtained from the convolution of the optical pulse width.

Figure 1 shows the time evolution of the reflectance of cross-linear and anti-circular polarization at room temperature for the excitation power of 70 mW at 834 nm. Cross-linear polarization indicates that both pump and probe beams are linear polarization, but they are orthogonal. We observed a clear fast exponential decay which corresponds to the time evolution of carrier population. This fast decay can be attributed to non-radiative recombination induced by low temperature growth. Anti-circular polarization indicates a right circularly polarized excitation and a left circularly polarized probe. The inset shows the time evolution of spin polarization. The spin relaxation time at room temperature was obtained to be 0.91 ps using a single exponential fitting. In the valence band, spin numbers are not good quantum numbers except for the Γ point.[5] Hence hole spin relaxation time is expected to be sub-picosecond order. Therefore, the observed fast spin relaxation can be attributed to hole spin relaxation.

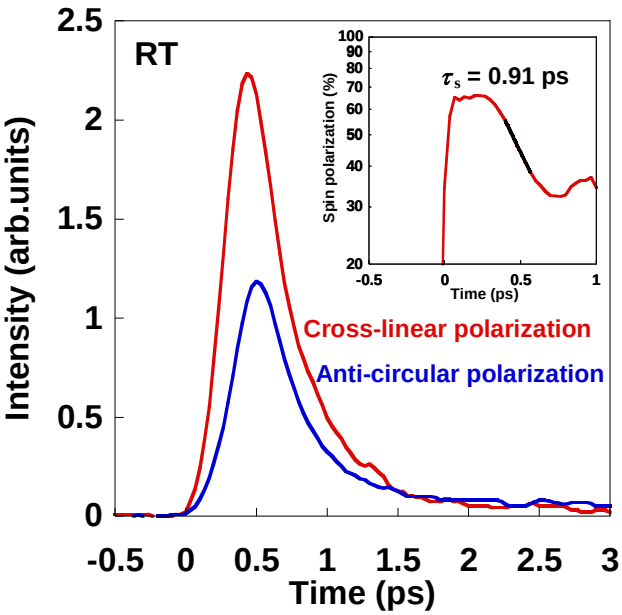

Fig.1 Time evolution of the reflectance of cross-linear and anticircular polarization at room temperature for the excitation power of 70 mW at 834 nm. The inset shows the time evolution of the spin polarization.

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