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低温成長 GaAs の 10 K におけるスピン緩和の観測

Observation of carrier spin relaxation at 10 K 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 In this study we have investigated the 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.³ 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 at 10 K for the excitation power of 50 mW. In this measurement, we used the linear orthogonal polarization to avoid the observation of coherent artifact. The fast decay time of 1.6 ps was obtained using a double exponential fitting. This fast decay which corresponds to the time evolution of carrier population seems to be caused by non-radiative recombination related to defects.

Figure 2 shows the time evolution of the reflectance of cocircular (I^+) and anticircular (I^-) polarization at 10 K for the excitation power of 50 mW. I^+ indicates a right circularly polarized excitation and a right circularly polarized probe. I^- indicates a right circularly polarized excitation and a left circularly polarized probe. The inset shows the time evolution of spin polarization: $(I^+ + I^-)/(I^+ - I^-)$. The spin relaxation time at 10 K was obtained to be 203 ps using a single exponential fitting. The spin relaxation time of high temperature grown GaAs bulk

was measured to be 1.8 ns.⁴ The observed fast spin relaxation suggests the relevance of Elliott-Yafet process.^{5,6}

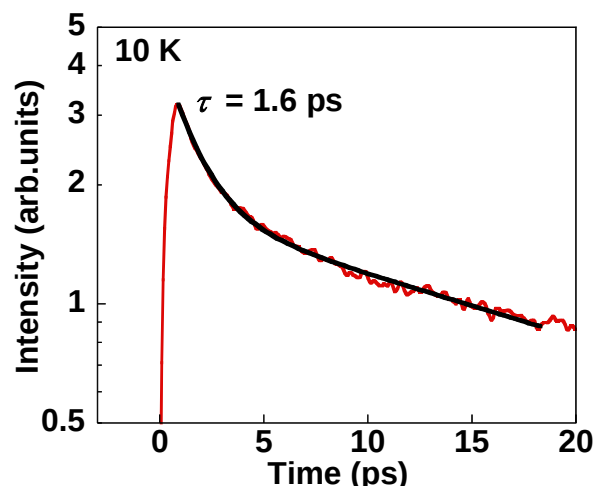


Fig.1 Time evolution of the reflectance at 10 K for the excitation power of 50 mW.

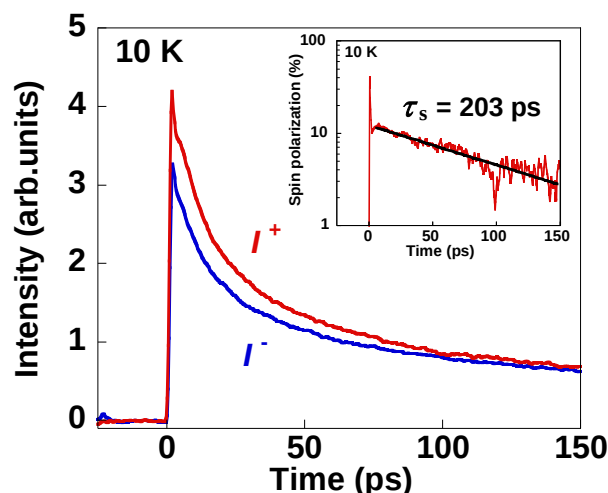


Fig.2 Time evolution of the reflectance of cocircular (I^+) and anticircular (I^-) polarization at 10 K for the excitation power of 50 mW. The inset shows the time evolution of spin polarization.

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