Be ドープ p 型 GaAs のスピン緩和の観測 (10-100 K)

Observation of spin relaxation in Be-doped p-type GaAs (10-100 K)

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The experimental analyses of spin relaxation of p-type semiconductors have attracted considerable attention for the development of theories of spin relaxation mechanisms in semiconductors.1 Here, we report spin relaxation times in an Be-doped bulk GaAs grown on GaAs substrate at 10-100 K by time-resolved spin-dependent photoluminescence (PL) measurement.

The sample contains a 577-nm-thick GaAs grown on GaAs substrate by Molecular Beam Epitaxy. The Be concentration is $8.1 \times 10^{16}$ cm$^{-3}$. The spin relaxation times were measured by time-resolved spin-dependent PL measurement at 10-100 K. In the time-resolved spin-dependent PL measurement, the spin polarized carriers were photoexcited by the circularly polarized femtosecond optical pulses generated from a Ti:sapphire laser. The excitation laser wavelength was tuned to 750 nm. The collected luminescence passes through an analyzer consisting of an achromatic quarter-wave plate and a linear polarizer arranged so that right- or left-circularly polarized emission can be selected. The spin-dependent PL is time-resolved using a streak camera with a time resolution of 15 ps.2

Figure 1 shows the time evolution of the spin-dependent PL at 10 K for the excitation power of 7 mW. The blue and red curves indicate the PL intensity of the same ($I_{+}$) and opposite ($I_{-}$) circular polarizations from the pump laser, respectively. Spin polarization was not observed at higher than 100 K. Figure 2 shows the time evolution of spin polarization at 10 K for the excitation power of 7 mW. The spin relaxation time was obtained to be 0.91 ns using a single exponential fitting. The observed spin relaxation time is close to that of Zn-doped p-type GaAs ($\frac{\Delta}{\hbar} = 2.0 \times 10^{13}$ cm$^{-3}$) of 1.0 ms.3

The presence of carrier density and temperature dependence of the spin relaxation time was observed at 10-50 K. Bir-Aronov-Pikus process4 and Elliott-Yafet process5,6 seem to be effective as spin relaxation mechanism.