Be ドープの異なる GaAs バルクのスピン緩和時間の比較

The comparison of spin relaxation in Be-doped GaAs with different Be concentrations at 10-77 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 Previously, we observed two photoluminescence (PL) peaks shown in Fig. 1 for Be-doped GaAs bulk.2 We concluded that the shorter wavelength PL peak is attributed to the recombination of excitons bound to neutral Be acceptors.3 In this study, we report the spin relaxation of that peak in Be-doped GaAs bulk with different Be concentrations observed by time-resolved spin-dependent PL measurement at 10-77 K.

The samples contain a 577-nm-thick Be-doped GaAs grown on GaAs substrate by Molecular Beam epitaxy. The Be concentrations are 8.1×10^{16} \text{cm}^{-3} (sample A) and 3.4×10^{17} \text{cm}^{-3} (sample B). The growth temperature of sample A and sample B are 630°C and 580 °C, respectively. In the time-resolved spin-dependent PL measurement, the spin polarized carriers were excited 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. A streak camera with a time resolution of 15 ps was used in the spin-dependent PL.4

The obtained spin relaxation times for sample A and sample B are shown in Fig. 2. At 10-77 K, spin relaxation time decreases as the carrier intensity increases in both samples. The fact indicates that Bir-Aronov-Pikus (BAP) process5 is dominant at 10-77 K. Figure 2 indicates that the spin relaxation times of sample A is close to sample B at 10 K. Although the spin relaxation time of sample A is slightly longer than sample B at 50-77 K. The fact implies that Elliott-Yafet (EY) process6 is related at 50-77 K, because the contribution of EY process becomes larger as the concentrations of impurities increase.

References