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

早大先進理工 [1], SINANO-CAS [2]
○ショウ サンウ [1], H. Wu[1], 有竹 貴紀 [1], 中村 芳樹 [1], P. Dai[2], S. L. Lu[2], 竹内 淳 [1]
Waseda Univ. [1], SINANO-CAS [2]
○C. Jiang[1], H. Wu[1], T. Aritake[1], Y. Nakamura[1], P. Dai[2], S. L. Lu[2] and A. Tackeuchi[1]
E-mail address: s112804036@akane.waseda.jp

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} cm^{-3} (sample A) and 3.4×10^{17} cm^{-3} (sample B). The growth temperature of sample A and sample B are 630 ºC and 580 ºC, 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[2] 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) process[5] 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) process[6] is related at 50-77 K, because the contribution of EY process becomes larger as the concentrations of impurities increase.

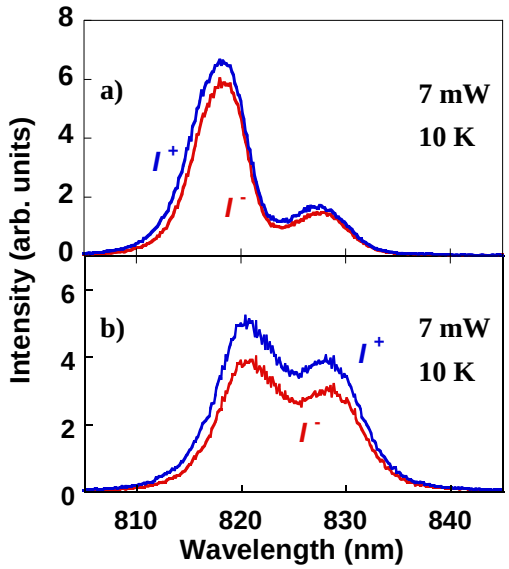

Fig.1 The PL spectra of (a) sample A (8.1×10^{16} cm^{-3}) and (b) sample B (3.4×10^{17} cm^{-3})[2] for excitation power of 7 mW at 10 K

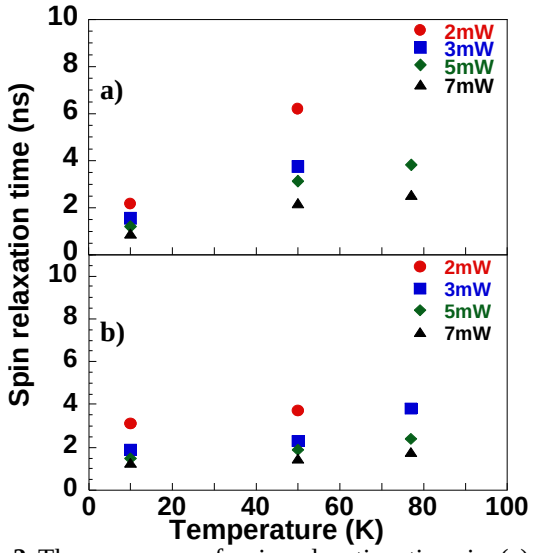

Fig.2 The summary of spin relaxation time in (a) sample A (8.1×10^{16} cm^{-3}) and (b) sample B (3.4×10^{17} cm^{-3}) [2]

[1] G. Fishman et al., Phys.Rev.B. **16**, 2 (1977).
[2] N. Asaka et al., Appl. Phys. Lett. **104**, 112404(2014)
[3] G. B. Scott et al., J. Appl. Phys. **52** , 6888 (1981).
[4] A. Tackeuchi et al., Appl. Phys. Lett. **84**, 3576 (2004).
[5] G. L. Bir et al., Symmetry and Strain-Induced Effects in Semiconductors, Wiley, **27** (1975).
[6] R. J. Elliott, Phys. Rev. **96**, 266 (1954); Y.Yafet, Solid State Phys. **14**, 1 (1963).P