19p-S2-5

時間分解ポンププローブ計測法による Be ドープ InGaAsP のスピン緩和の観測(10-300 K)

Observation of spin relaxation in Be-doped InGaAsP by time-resolved pump and probe measurement (10-300 K)

早大先進理工 [1]，　SINANO-CAS [2]

○呉 昊 [1]，原澤 遼 [1]，山本 直輝 [1]，有竹 貴紀 [1]，S. L. Lu [2]，L. Ji [2] and 竹内 淳 [1]

○H. Wu [1], R. Harasawa [1], N. Yamamoto [1], T. Aritake [1], S. L. Lu [2], L. Ji [2] and A. Tackeuchi [1]

E-mail address: wuhao@ruri.waseda.jp

Experiments and analyses of spin relaxation of InGaAsP have attracted worldwide attention with the continuous development of solar energy materials and solar cells.[1] Here, we report spin relaxation times in Be-doped InGaAsP grown on an InP substrate observed by time-resolved pump and probe measurement.[2]

The sample contains a Be-doped InGaAsP grown on an InP substrate by molecular beam epitaxy. The Be concentration is 1×10^{17} cm^{-3}. The spin relaxation times were measured by pump and probe measurement at 10-300 K. A Ti-sapphire laser with an optical parametric oscillator was used as the optical source. The pump beam was chopped by an electro-optic modulator at 1.9 MHz to avoid optical noise in the low-frequency region. The excitation laser wavelengths were tuned to 1117 nm at 10 K, and 1161 nm at 300 K.

The time evolution of the reflectance at 10 K for 30 mW is shown in Fig. 1, where I_+ indicates a right circularly polarized excitation with a right circularly polarized probe, while I_- indicates a right circularly polarized excitation with a left circularly polarized probe. Note that the spin polarization was clearly observed. The time evolution of spin polarization $(I_+ - I_-)/(I_+ + I_-)$ is shown in the inset of Fig. 1. The spin relaxation time τ_s, which is twice the relaxation time of the spin polarization, is evaluated to be 1.62 ns. Figure 2 shows the spin relaxation times at 10 K for the excitation powers of 10 mW, 20 mW and 30 mW. The observed excitation power dependence of the spin relaxation time shows that Bir-Aronov-Pikus process[3] is significant at 10 K.

At 300 K, the spin relaxation time is evaluated to be 128 ps for the excitation power intensity of 30 mW. Spin relaxation time at 300 K is considerably faster compared with that at 10 K. Therefore, Elliott-Yafet process[4] or D'yakonov-Perel' process[5] seems to be effective as the temperature increases.

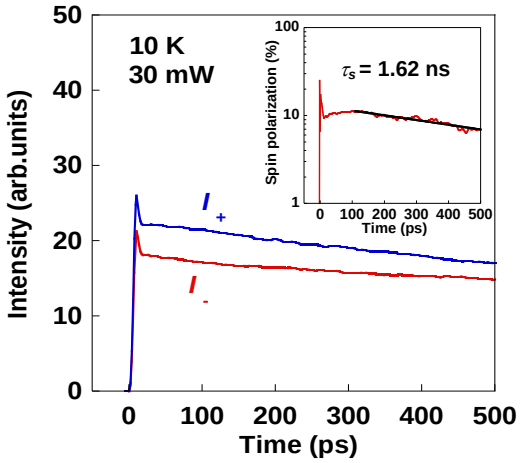

Fig.1. Time evolutions of spin-dependent reflectance and (inset) spin polarization for the excitation power of 30 mW at 10 K.

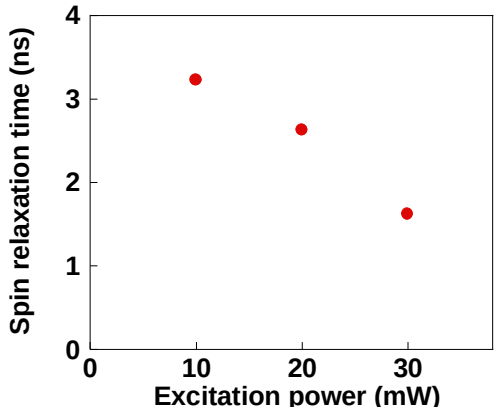

Fig.2. Spin relaxation times of Be-doped InGaAsP at 10 K for different excitation powers.

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