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

The sample contains a Be-doped InGaAsP grown on an InP substrate by molecular beam epitaxy. The Be concentration is $1\times10^{17}$ 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 $I_r$ indicates a right circularly polarized excitation with a right circularly polarized probe, while $I_l$ 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 ($I_r - I_l)/(I_r + I_l)$ is shown in the inset of Fig. 1. The spin relaxation time $\tau_s$, 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 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 or D’yakonov-Perel’ process 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.