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時間分解ポンププローブ反射計測による InGaAsP バルクのスピン緩和の観測

Observation of spin relaxation in an InGaAsP bulk by time-resolved pump and probe reflectance measurement

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In recent years, manipulation on spin dynamics in semiconductors has attracted intense interest because of the potential applications in emerging areas such as "spintronics".[1] $In_{1-x}Ga_xAs_yP_{1-y}$ lattice-matched to InP has the advantage of a wide tuning range of the bandgap from 0.92 to 1.65 μm by changing the composition (x and y) of the solid solution.[2] Here, we report the observation of spin relaxation in InGaAsP bulk grown on an InP substrate by the time-resolved spin-dependent pump and probe reflectance measurement.

The sample contains a 1500-nm-thick InGaAsP bulk grown on an InP substrate. The spin relaxation times are measured by time-resolved spin-dependent pump and probe reflectance measurement at 10 K. A Ti-sapphire laser with an optical parametric oscillator was used as the optical source for the pump and probe experiment. The laser energy was tuned to near the photoluminescence peak. Initially, spin aligned carriers are generated in the sample by circularly polarized pump pulse, and the reflected circularly polarized time-delayed probe pulse from the sample is then detected. Consequently, the population change of the spin polarized carriers is measured through the change of intensity of the reflected probe pulse. The time resolution in this system of 200 fs is determined only by the optical pulse width of 140 fs.

Figure 1 shows the observed time evolution of spin-dependent reflectance of sample at 1.131 μm at 10 K for the excitation power of 12 mW. I_+ indicates a right circularly polarized excitation and a right circularly polarized probe. I_- indicates a right circularly polarized excitation and a left circularly polarized probe. Figure 2 shows the time evolution of spin polarization of the sample, $(I_+ - I_-) / (I_+ + I_-)$. The spin polarization is observed to rise up until 100 ps after the photo-excitation. The spin relaxation time τ_s, which is twice the relaxation time of the spin polarization[3] is obtained to be 5.8 ns at 10 K by the exponential fitting. This spin relaxation time of 5.8 ns is longer than that of InGaAs bulk of 0.91 ns at 10 K.[4]

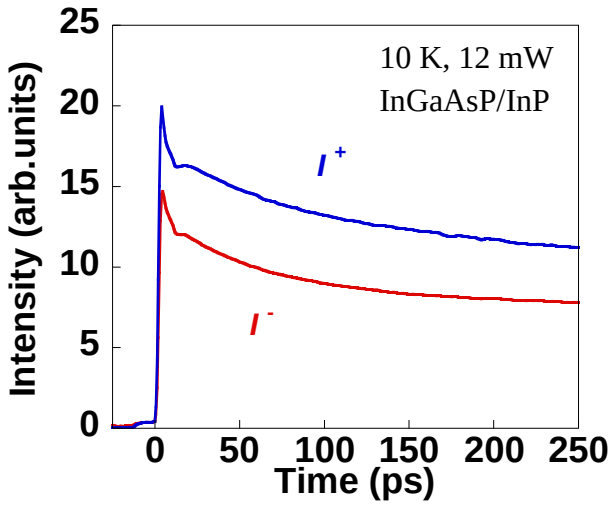

Fig.1 Time evolution of spin-dependent reflectance at 1.131 μm for the excitation power of 12 mW at 10 K.

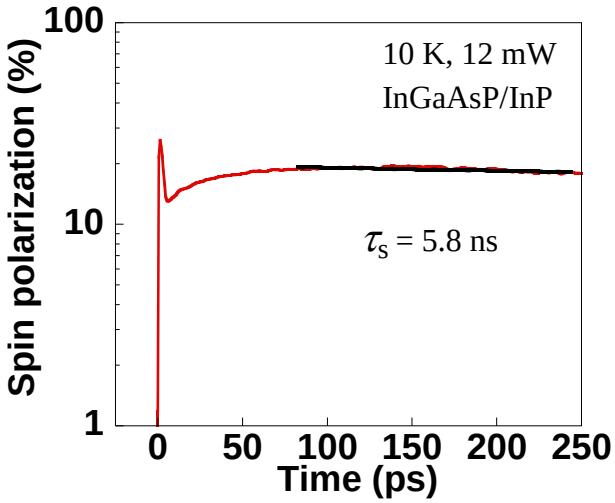

Fig.2 Time evolution of spin polarization at 1.131 μm for the excitation power of 12 mW at 10 K.

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