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InGaAsP のスピン緩和時間の温度依存性

Temperature dependence of spin relaxation time in InGaAsP

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III-V semiconductors grown on InP substrates such as InGaP, InGaAs and InGaAsP provide several interesting combinations of energy gap values and offer great promise for multijunction solar cell applications.[1] Previously, we reported the spin relaxation time of InGaAsP bulk grown on an InP substrate to be 1.2 ns at 10 K.[2] Here, we report the temperature dependence of spin relaxation time in InGaAsP.

The sample contains a 200-nm-thick $In_{0.78}Ga_{0.22}As_{0.47}P_{0.53}$ grown by molecular beam epitaxy. To generate a smooth surface, a 50-nm-thick p-doped InP buffer layer was inserted between the InGaAsP and InP substrate. After InGaAsP growth, a 10-nm-thick InP cladding layer was grown. The spin relaxation times were measured by time-resolved spin-dependent pump and probe reflectance measurement. 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 at 300 K for the excitation power of 20 mW at the excitation wavelength of 1.20 μm. 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 relaxation time τ_s, which is twice the relaxation time of the spin polarization[3] is obtained to be 95 ps at 300 K by the exponential fitting. We have measured spin relaxation time at temperature between 10 K and 300 K and for the excitation power between 10 mW and 30 mW. As increasing temperature from 77K to 300 K, the spin relaxation time decreases from 780 ps to 95 ps, whereas the spin relaxation time does not change for the different excitation powers. This result indicates that the D'yakonov-Perel effect is dominant in this sample at temperature over 77 K. [4]

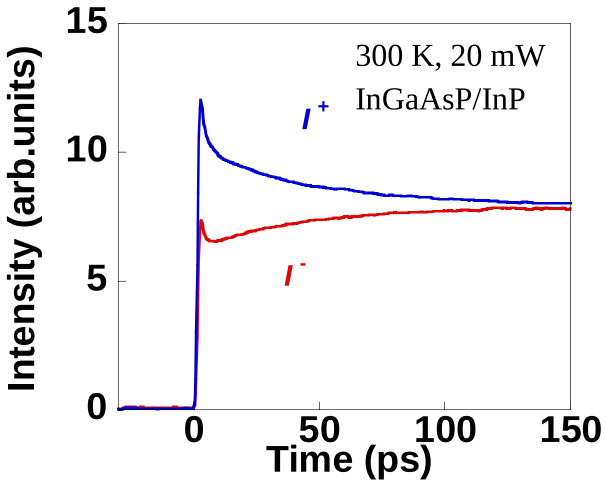

Fig.1 Time evolution of spin-dependent reflectance at 300 K for the excitation power of 20 mW at 1.20 μm.

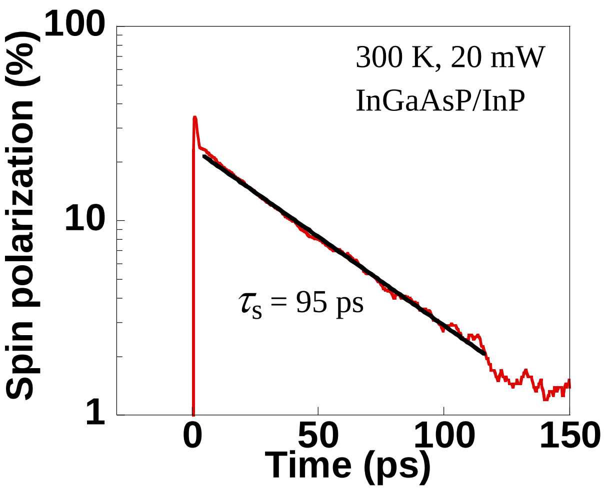

Fig.2 Time evolution of spin polarization at 300 K for the excitation power of 20 mW at 1.20 μm.

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