高スピン偏極電子源用
GaAs/GaAsP 歪補償超格子のスピン緩和の観測

Observation of spin relaxation in GaAs/GaAsP strained-compensated superlattice

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Highly spin-polarized electron sources are intensively developed for applications in high-energy physics and particles physics. Strained superlattice (SL) structures composed of a GaAs-related semiconductors are known to be most effective as the photocathode of a spin-polarized electron beam. A structure with 24-periods of GaAs/GaAsP strain-compensated SL layers demonstrated a maximum spin-polarization of 92% with a high quantum efficiency of 1.6 %.[1-3] The increase of the superlattice periods can be effective for the improvement of the quantum efficiency. However, there is a limit of the layer thickness caused by the spin relaxation time. In this study, we have investigated the spin relaxation time of GaAs/GaAsP strain-compensated SL by time-resolved pump and probe measurements.

Figure 1 shows the strained-compensated SL sample structure. After the growth of a 600-nm-thick AlGaAsP buffer layer on GaP substrate, 24-periods GaAs/GaAsP strain-compensated SL layers were grown. Subsequently, the SL structures were coated with a highly doped 5-nm-thick GaAs layer. All layers were doped with Zn.

In the pump and probe measurements, spin-aligned carriers are excited by a circularly polarized optical pulse generated from a Ti-sapphire laser.[4] The photon energy was tuned near the photoluminescence peak wavelength for the transition from the conduction band to the valence band. The PL spectra of GaAs/GaAsP strain compensated SL is shown in Fig.2. The time resolution of this measurement system is about 200 fs, which was obtained from the time convolution of the optical pulses.

Figure 3 shows the time evolution of spin polarization at room temperature for the excitation power of 110 mW at 781 nm. The measured spin relaxation time of GaAs/GaAsP strain-compensated SL is 104 ps. The conventional 4.5 nm thick-GaAs MQWs show the spin relaxation time of 32 ps at room temperature.[4] The present slow spin relaxation time indicates that GaAs/GaAsP strain-compensated SL is suitable for the highly spin-polarized electron source.

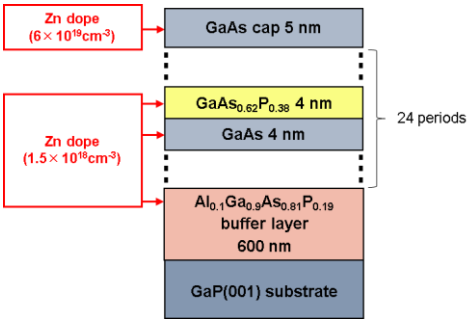

Fig.1 Sample structure of GaAs/GaAsP strain-compensated SL.

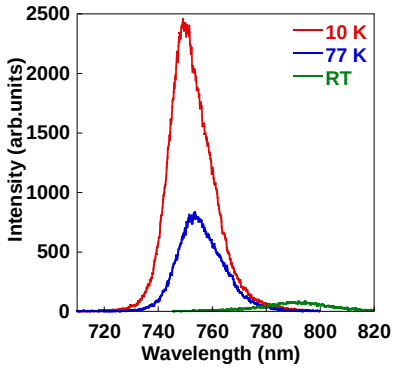

Fig.2 PL spectra of GaAs/GaAsP strain-compensated SL at 10 – RT.

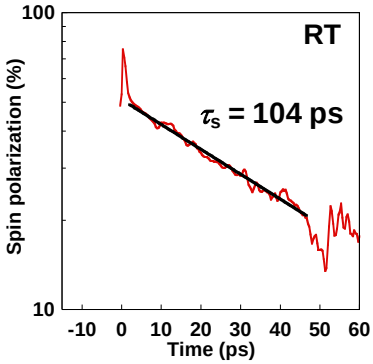

Fig.3 Time evolution of spin polarization at RT for excitation power of 110 mW.

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