$GaIn_{0.36}N_{0.006}AsSb_{0.015}/GaN_{0.01}AsSb_{0.11}/GaAs$ 量子井戸のスピン緩和時間の温度及び励起光強度依存性

Temperature and Excitation power dependences of spin relaxation time in $GaIn_{0.36}N_{0.006}AsSb_{0.015}/GaN_{0.01}AsSb_{0.11}/GaAs$ quantum well

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Diluted nitride GaInNAs/GaAs quantum well(QW) structures are expected to be the light source for a long-wavelength-range diode laser.[1] The use of Sb was found to help maintain a 2D growth mode at high In and N compositions and to improve the QW optical properties.[2,3] By adding GaNAsSb intermediate barriers, 1.61 μm emission from a GaInNAsSb QW was achieved at room temperature.[4] In this study, we report the temperature and excitation power dependence of the spin relaxation time in GaInNAsSb/GaNAsSb/GaAs QW observed by time-resolved pump and probe measurements.[5]

The sample consists of 8 nm-thick $GaIn_{0.36}N_{0.006}AsSb_{0.015}$ well sandwiched by 5 nm-thick $GaN_{0.01}AsSb_{0.11}$ intermediate barriers and 100 nm-thick GaAs barriers grown by molecular beam epitaxy on a GaAs(100) substrate. In the pump and probe measurements, laser energy was tuned near the wavelength of the photoluminescence peak. A Ti:sapphire laser with an optical parametric oscillator was used as the optical source. The time resolution of this measurement system is 200 fs.

Figure 1 shows the time evolutions of the reflection intensity of cocircular (I^+) and anticircular (I^-) polarization at 10 K for the excitation power of 15 mW. The inset shows the time evolution of spin polarization. We observed the double exponential decay with time constants of 9.5 ps and 110 ps. Fast relaxation component of 9.5 ps can be attributed to the non-radiative recombination related to non-uniformity of Sb composition.

Figure 2 shows the spin relaxation times for different excitation powers at 10–150 K. At 10-50 K, we have observed weak temperature dependence and the carrier density dependence showing that the spin relaxation is mainly governed by Bir-Aronov-Pikus process.[6] At temperatures over 50 K, we have observed the strong temperature dependence and no carrier density dependence showing that the spin relaxation is mainly governed by D'yakonov-Perel' process[7] or Eliott-Yafet process.[8]

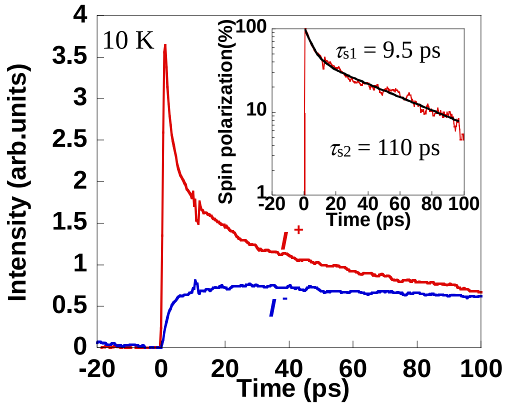

Fig. 1. Time evolutions of the reflection intensity and spin polarization (inset) at 10 K for the excitation power of 15 mW.

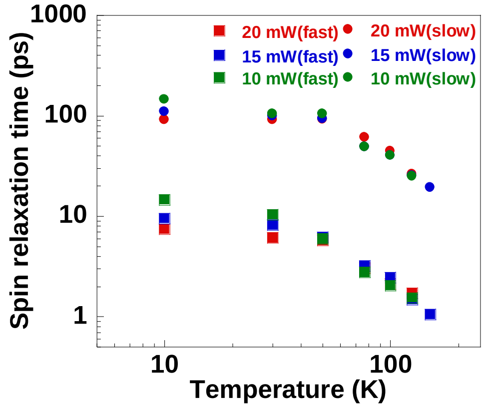

Fig. 2 Spin relaxation times for different excitation powers at 10–150 K.

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