GaSb/AlSb 多重量子井戸におけるスピン緩和時間の観測（Ⅱ）

Spin relaxation time of GaSb/AlSb multiple quantum wells (II)

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In recent years, there has been growing interest in III–V antimony-based semiconductor materials due to the wide range energy gap at the longer wavelength. Previously, we reported the temperature and excitation power dependence of spin relaxation time in GaSb/AlSb multiple quantum wells (MQWs) with well width of 13.4 nm.[1] In this paper, we report the picosecond spin relaxation in another GaSb MQWs sample, which contains wider well, observed by time-resolved pump and probe measurements.[2]

The sample contains GaSb buffer layer, 25 periods of GaSb well layer (48 nm thick) and AlSb barrier layer (44 nm thick), and 700-nm-thick GaSb cap layer grown on GaAs substrate by molecular beam epitaxy. The spin relaxation process was observed by pump and probe reflection measurements.

We used a Ti:sapphire laser with an optical parametric oscillator as the light 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 wavelength was adjusted to 1530 nm at 10 K, and 1542 nm at 150 K.

Figure 1(a) shows the time transition of spin-dependent reflection intensity for the excitation power of 50 mW at 10 K. I^+ (I^-) indicates a right circularly polarized excitation with a right (left) circularly polarized probe. The abrupt signal changes at ±12 ps are due to the reflection at the back side of the substrate. The time evolution of spin polarization, obtained by $(I^+ - I^-)/(I^+ + I^-)$, is shown in fig. 1(b). The spin relaxation time (τ_s), which is twice the relaxation time of the spin polarization,[2] is obtained to be 60 ps. The spin relaxation can be assigned to electron spin relaxation. The quantum confinement energy (E_{1e}) of the sample is evaluated to be 3 meV.

Figure 2 shows the relation between E_{1e} and τ_s of the sample and our previous results (GaSb bulk and GaSb MQWs with well width of 13.4 nm) at 10 K.[1,3] The decrease of τ_s for the thinner quantum well is explained by the Bir-Aronov-Pikus process through the increase of the spatial overlap of electrons and holes.[4]

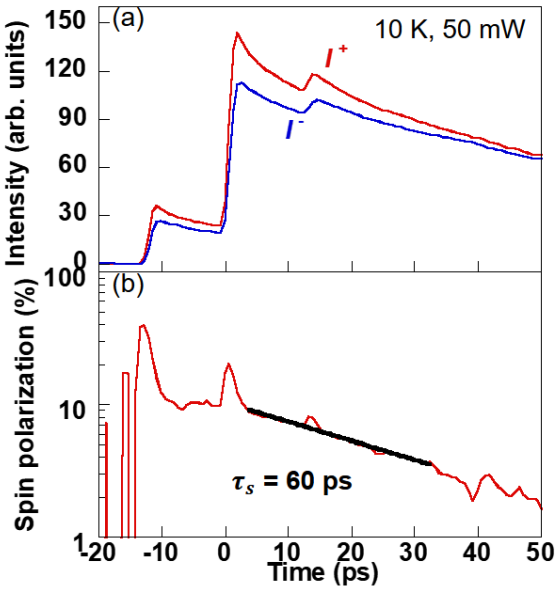

Fig.1 Time evolutions of (a) spin-dependent reflection intensity and (b) spin polarization at 10 K in GaSb/AlSb MQWs for the excitation power of 50 mW at 1530 nm.

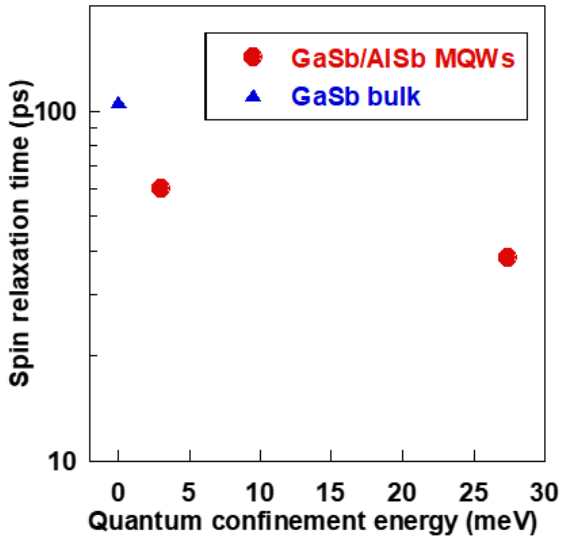

Fig.2 The relation between quantum confinement energy and the spin relaxation time of two GaSb/AlSb MQWs and GaSb bulk at 10 K.

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[4] G. L. Bir et al., Zh. Eksp. Teor. Fiz. 69, 1382 (1975).