Temperature dependence of spin relaxation time in (110)-oriented GaAs/AlGaAs quantum wells

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To maintain spin polarization in non-magnetic materials is key issue to effectively utilize the spin information in operating spintronics devices such as spin-controlled laser [1]. A (110)-oriented GaAs/AlGaAs quantum wells (QWs) has attracted much attention since a very long electron spin relaxation time (τ_s > 1 ns) was reported at room temperature (RT) [2]. We have recently succeeded in fabricating (110) GaAs/AlGaAs QWs, which can meet crucial demands (very flat surface, high emission efficiency and long τ_s value) for the practical spin laser, by optimizing growth conditions [3]. Such a high-quality sample would give us a good opportunity to clarify its effective spin relaxation mechanism by measuring the τ_s value as a function of temperature (T). Here, we report on a unique T dependence of the τ_s for the (110) GaAs/AlGaAs QWs.

Several undoped samples with 20 periods of GaAs(10 nm)/$Al_{0.3}Ga_{0.7}As$(20 nm) QWs were fabricated on semi-insulating GaAs(110) substrate using molecular beam epitaxy (MBE) under the different V/III (As_4/Ga) flux ratios and growth temperature (T_g) [3]. The τ_s value was evaluated by polarization- and time-resolved photoluminescence (PL) measurements. Mode-locked Ti: Sapphire laser and the streak camera were respectively used as the pump laser and the PL detector. Excitation wavelength of the pump laser was fixed at 750 nm.

Figure 1 shows the dependence of the τ_s value on T for the (110) QWs (V/III ratio of 60 and T_g of 500 ^{o}C) which has the longest carrier lifetime at RT (4.4 ns) among our samples. It is clear that the τ_s takes a maximum around 150 K, indicating that there are at least two major spin relaxation mechanisms. It has been generally accepted that the increase with T is due to the alleviation of Dyakonov-Perel dephasing mechanism. Dohrmann *et. al.* pointed out that the decrease in τ_s at high T can be caused by the electron scatterings between different QW subbands [4]. The effect of the growth conditions on the τ_s - T plot would give us useful information to clarify the origin of the maximum in the τ_s - T as well as the effective spin relaxation mechanism at high T.

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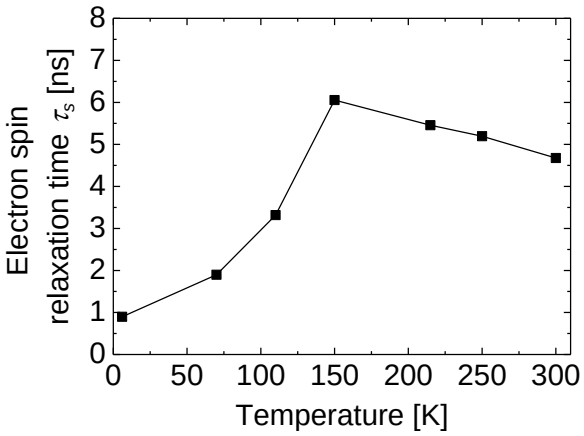

Figure 1 Temperature dependence of the τ_s in the (110) GaA/AlGaAs QWs grown with V/III ratio of 60 and the T_g of 500°C.

Reference

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