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MOCVD 法による Ge/Si 上 InAs/GaAs 量子ドットの発光特性における AlGaAs/GaAs バッファ層のアニール効果

Effect of Annealing of GaAs/Al(Ga)As Buffer Layer on the Photoluminescence Intensity of InAs/GaAs Quantum Dots Grown on Ge/Si Substrate by MOCVD

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Since the proposal by Arakawa and Sakaki [1], research in the field of quantum dots (QDs) has been gaining increasing interest due to their unique properties [1]. Recently, Ge-based Si substrate has been proposed as a potential platform for the monolithic integration of III-V-on-Si for silicon photonics application [2]. Here, we report on the effect of annealing of GaAs/Al(Ga)As buffer layer (BL) on the photoluminescence (PL) intensity of InAs/Sb:GaAs quantum dots (QDs) directly grown on Ge/Si substrate by metal organic chemical vapor deposition (MOCVD). A smooth GaAs/Al(Ga)As BL (Fig. 1 inset (a)) was first grown on a large Ge/Si wafer by a three-step growth method [2]. After the growth, the wafer was removed from the reactor, cleaved into several pieces and then transferred into the reactor again. Before the growth of QDs, the wafers were subjected to annealing under TBA at different temperature between 450 to 800^{o}C for 10 min. High density InAs QDs were grown on GaAs/Al(Ga)As/Ge/Si wafer according to the Sb-SMG technique [3, 4]. Figure 1 shows the effect of annealing temperature of the BL on the RT PL intensity of QDs grown on Ge/Si substrate. The QDs yield emission at 1.3 μm with a FWHM of ~ 32 meV. Of considerable significance is that the PL intensity of QDs grown on Ge/Si substrate is strongly dependent on the annealing temperature of the GaAs/Al(Ga)As BL. The strongest PL intensity for QDs grown on Ge/Si is obtained from the sample with the BL annealed at 600^{o}C, and is almost comparable to that of reference QDs grown on GaAs substrate (Fig. 1 inset (b) (purple curve)). The increase in the QD PL intensity due to annealing of the BL may be attributed to the reduction in the density of defects generated at the GaAs/Ge/Si interface and propagating to the QD active layer. These results are promising for the realization of monolithically integrated QD laser for silicon photonics application.

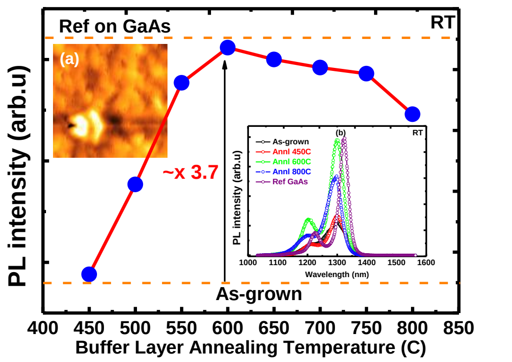

Fig. 1 Effect of annealing of GaAs/Al(Ga)As buffer layer (BL) on the RT PL intensity of QDs grown on Ge/Si substrate. Inset (a) shows the 5 x 5 μm^2 AFM image of the BL. Inset (b) compares the RT PL spectra of QDs grown on Ge/Si substrate at different BL annealing temperatures and with a reference QD sample grown on GaAs substrate (purple curve)

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