二重層構造を有する InAs/GaAs 長波長量子ドットの成長

Growth of InAs/GaAs Bilayer Quantum Dots with Long-wavelength Emission

○詹文博[1]，權晋寛[1]，渡邉克之[1]，岩本敏[1, 2]，荒川泰彦[1]
1. 東大ナノ量子機構 2. 東大生研
○W. Zhan[1], J. Kwoen[1], K. Watanabe[1], S. Iwamoto[1, 2], and Y. Arakawa[1]
1. NanoQuine, 2. IIS, Univ. of Tokyo, Japan
Email: wbzhan@iis.u-tokyo.ac.jp

Since the concept of quantum dots (QDs) was firstly proposed [1], studies on self-assemble InAs/GaAs QDs and its applications to QD lasers have been widely reported around the world. Because of its advantages in low threshold current density, high efficiency and temperature insensitivity, O-band InAs QD lasers on GaAs have been realized with high performance. Even monolithic InAs QD lasers on on-axis Si (100) has been reported [2]. However, there are few reports on C-band InAs QD lasers on GaAs substrates to date, including InAs/GaAs bilayer QDs [3] and InAs QDs in metamorphic InGaAs matrix [4]. In this report, we demonstrate growth of InAs/GaAs bilayer QDs capped with $In_{0.2}Ga_{0.8}As$ strain reduced layer (SRL) and the photoluminescence (PL) peak wavelength at nearly 1.45 μm with a narrow linewidth of 19.5 meV at room temperature (RT).

Samples were grown on Si-doped GaAs (100) substrates by using a conventional solid-source molecular beam epitaxy (MBE). The structure of InAs/GaAs bilayer QDs was shown as the inset of figure 1. After oxide desorption, the bilayer QDs were buried in AlGaAs barrier layers. The bilayer QDs included seed layer with 2.6 ML InAs and active layer with 3.7 ML InAs, respectively. 10 nm GaAs spacer layer was grown to separate seed layer and active layer. Another bilayer QDs were grown on the top for observing the morphology of surface QDs. Figure 1 shows the PL spectrum of the sample without InGaAs SRL. The peak from ground state (GS) was observed at 1367 nm, while one from single QD layer with similar InAs coverage was at around 1260 nm. Such wavelength extension could be ascribed to the strain relaxation in active layer which was caused by strain field generated from seed layer. Another sample with InGaAs SRL was prepared as shown in inset of figure 2. The active layer was capped by 4 nm $In_{0.2}Ga_{0.8}As$ before deposition of GaAs cap. The InGaAs SRL contributed further strain relaxation inside active layer and red shift of the GS emission to 1442 nm. Meanwhile, narrower linewidth of 19.5 meV was achieved.

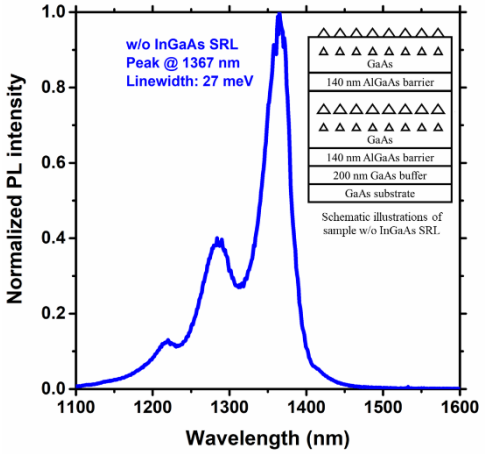

Fig. 1 RT PL spectrum of InAs/GaAs bilayer QDs w/o InGaAs SRL. Inset: sample structure.

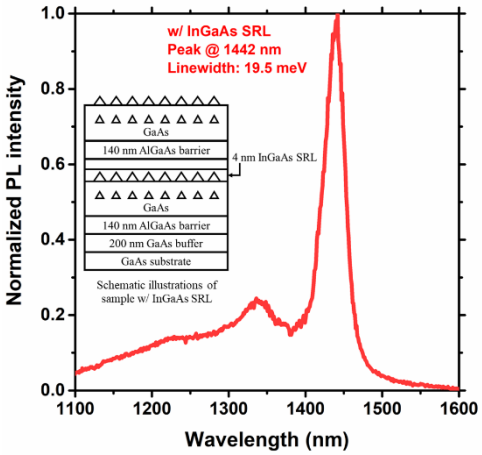

Fig. 2 RT PL spectrum of InAs/GaAs bilayer QDs w/ InGaAs SRL. Inset: sample structure.

Acknowledgements: This paper is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

References

[1] Y. Arakawa and H. Sakaki, Appl. Phys. Lett. **40**, 939-941 (1982).
[2] J. Kwoen, *et. al.*, Opt. Express **26**(9), 11568-11576 (2018).
[3] M. A. Majid, *et. al.*, IEEE J. Sel. Topics Quantum Electron **17**(5), 1134-1342 (2011).
[4] Z. Mi, *et. al.*, J. Vac. Sci. Technol. B **26**(3), 1153-1156 (2008).