

課題番号 : F-21-TT-0026
利用形態 : Equipment use
利用課題名(日本語) : 酸化物薄膜によるパッシベーションと蛍光
Program Title (English) : Passivation by oxide thin film and enhancement of luminescence
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キーワード/Keyword : Atomic layer deposition, InAs, Surface quantum dots, passivation, Al₂O₃

1. 概要(Summary)

Quantum nanostructures such as InAs quantum dots (QDs) have attracted attention for their potential for high performance optoelectronic applications such as solar cells, detectors and lasers in last few decades [1]. While InAs devices for wavelengths ca. 1 μ m have already been realized using buried QDs (BQDs), those for longer wavelength remained as a challenge. It has been pointed out in case of the surface QDs (SQDs), stress is only induced by the bottom interface of the surface, allowing more strain relaxation and longer wavelength photoluminescence (PL) compare to BQDs [2]. The biggest challenge in SQDs is the surface states, which act as trap sites and decrease the photoluminescence intensity [3]. Here, Al₂O₃ was used for removing the surface states and enhancing the PL from InAs SQDs.

2. 実験(Experimental)

【利用した主な装置】

原子層堆積装置 (PEALD)

【実験方法】

Molecular beam epitaxy-grown InAs surface quantum dots were *ex situ* passivated by PEALD using trimethylaluminum and oxygen as precursors. Passivation capping with 2, 10, 15 and 30 nm of Al₂O₃, were performed by 20, 100, 150 and 300 ALD cycles, respectively, at 200°C.

3. 結果と考察(Results and Discussion)

Figure 1 shows the PL spectra of samples with varied Al₂O₃ cap thickness. In each spectrum, there

are two main peaks: one for the BQDs at ca. 1050 nm and another for the SQDs at ca. 1400 nm. The intensity of the long wavelength PL from SQDs, together with BQDs, increased with Al₂O₃ cap thickness. The PL intensity enhancement is attributed to the increase in radiative recombination probability by removal of InAs native oxides and surface states, achieved by Al₂O₃ capping.

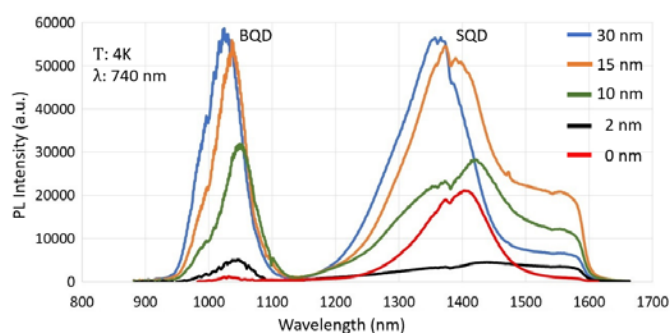


Fig.1: Photoluminescence spectra of stacked quantum dot structures with 0, 2, 10, 15 and 30 nm thick Al₂O₃ cap.

4. その他・特記事項(Others)

References:

- [1] P. Bhattacharya *et al.*, Annu. Rev. Mater. Res. **34**, 1 (2004).
- [2] H. Saito *et al.*, Appl. Phys. Lett. **79**, 19 (1998).
- [3] B. L. Liang *et al.*, Appl. Phys. Lett. **89**, 043125 (2006).

5. 論文・学会発表(Publication/Presentation)

”Photoluminescence enhancement of InAs surface quantum dots by Al₂O₃ passivation,” H. Mohammadi, R.C. Roca, Y. Zhang, H. Lee, Y. Ohshita, N. Iwata and I. Kamiya, The 69th JSAP Spring Meeting 2022, Mar 22-26.

6. 関連特許(Patent)

None.