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GaAs(111)A 基板上の歪み緩和 InGaAs 成長

Growth of Strain-Relaxed InGaAs on GaAs (111)A

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1. Introduction

Recently, we have demonstrated high quality entangled photon emission from the highly symmetric GaAs quantum dots (QDs) on AlGaAs (111)A grown by droplet epitaxy. To extend this approach and realize the entangled photon emission at telecom wavelength (1.5μm range), we need to apply droplet epitaxy to InAs/GaAs (111)A system. However, it is well-known that the typical emission wavelengths of InAs QDs directly grown on GaAs are shorter than 1.3μm due to the large lattice-mismatch between InAs and GaAs. To achieve QD emission at 1.5μm range, it is necessary to form InAs QDs on strain-relaxed InGaAs/GaAs(111)A. In this study, we investigated the growth of $In_{0.3}Ga_{0.7}As$ on GaAs(111)A and show the effects initial layer grown at low temperature.

2. Experimental

We grew $In_{0.3}Ga_{0.7}As$ on GaAs (111)A using conventional molecular beam epitaxy (MBE). After the growth of 50 nm GaAs buffer layer at 500°C, 20 nm thick $In_{0.3}Ga_{0.7}As$ was grown at 300°C. Then, 60 nm thick $In_{0.3}Ga_{0.7}As$ was grown at 450°C (Sample A). For comparison, we also grew a reference sample in which 100 nm thick $In_{0.3}Ga_{0.7}As$ was directly grown on GaAs at 450°C (sample B). The samples were characterized by atomic force microscope (AFM) and photoluminescence (PL).

3. Results and discussion

Figure (a) and (b) shows the surface morphology of the samples A and B. In both cases, straight line patterns are visible, which might be caused by some kind of defects. The density of the straight line in sample A is higher than that of sample B. In between straight lines, flatter surface are observed in sample A than that in sample B. While step and terrace structure is visible in sample A, sample B exhibits corrugated surface. Figure (c) shows PL spectra of the both samples measured at 7 K. Intense and sharp emission are clearly visible in sample A, suggesting the formation of high quality InGaAs layer. In contrast, sample B shows weak and broad emission, suggesting the low crystal quality of sample B.
From the results, it is suggested that the lattice-mismatch strain is effectively relaxed during the growth of InGaAs at 300°C and high quality InGaAs can be grown at 450°C.

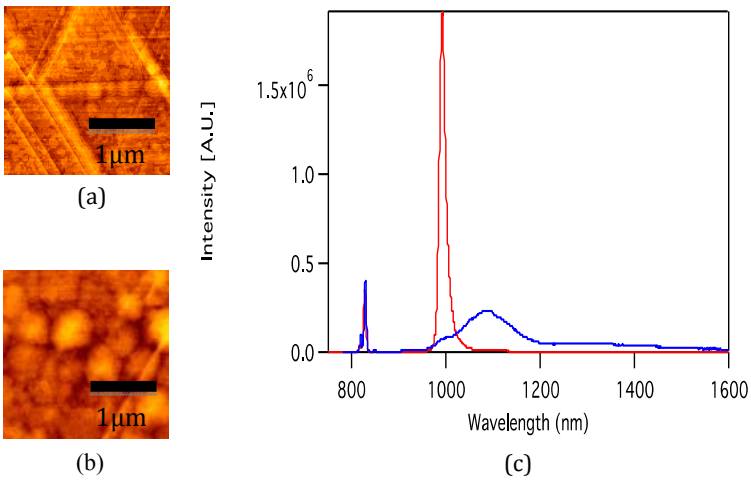

Figure: AFM images of Sample A (a) and Sample (b). (c) PL spectra of Sample A (red) and Sample B(blue)