

# AlAs キャップ付 InAs 量子ドットのフォトルミネッセンスに 対する InGaAs 層の影響

Influence of InGaAs layer on photoluminescence of InAs quantum dots with AlAs cap

徳島大院フロンティア<sup>1</sup>, 日亜化学<sup>2</sup> ○盧 翔孟<sup>1</sup>, 川口 晃弘<sup>1</sup>, 中河 義典<sup>1,2</sup>,

熊谷 直人<sup>1</sup>, 北田 貴弘<sup>1</sup>, 井須 俊郎<sup>1</sup>

Univ. of Tokushima<sup>1</sup>, NICHIA Corporation<sup>2</sup>, °X. M. Lu<sup>1</sup>, A. Kawaguchi<sup>1</sup>, Y. Nakagawa<sup>1,2</sup>,

N. Kumagai<sup>1</sup>, T. Kitada<sup>1</sup>, and T. Isu<sup>1</sup>

E-mail: xm-lu@frc.tokushima-u.ac.jp

Photoluminescence (PL) from wetting layer (WL) tends to be dominated for quantum dots (QDs) grown on (113) GaAs substrate<sup>1)</sup>. The WL could be reduced or even removed if an appropriate AlAs layer was deposited on InAs QDs according to a novel mechanism based on phase separation proposed by V. Shchukin<sup>2)</sup>. We have found that 0.5 ML AlAs cap is an effective way to enhance PL of InAs QDs grown on (113)B and obtained PL at room temperature with a center wavelength around 1.0~1.1  $\mu\text{m}$ <sup>3)</sup>. Extending this emission range to 1.2~1.3  $\mu\text{m}$  is a subject of strong interest because of its wide applications for optoelectronic devices. The wavelength of conventional QDs without AlAs cap grown on (001) GaAs have been successfully increased by growing an InGaAs layer on QDs<sup>4,5)</sup>.

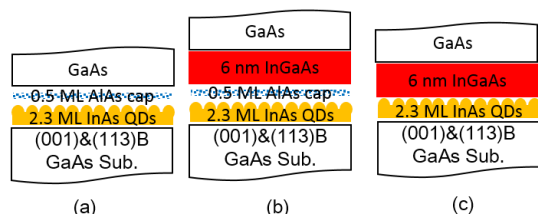


Fig.1. Growth structure of QDs and  $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$  layer

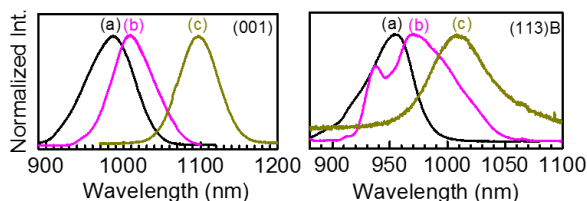


Fig.2. PL (4 K) of QDs with the structure as shown in Fig. 1.

To investigate the influence of InGaAs layer on PL from QDs with AlAs cap, we dealt with three types of QDs grown on (001) and (113)B GaAs substrates by molecular beam epitaxy: the first one was QDs with 0.5 ML AlAs cap as shown in Fig. 1 (a) as reference, the second one was QDs with 0.5 ML AlAs cap and 6 nm  $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$  layer as shown in Fig. 1 (b), and the last one was conventional QDs without AlAs cap but with 6 nm  $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$  layer as shown in Fig. 1 (c). PL (4K)

of these QDs were shown in Fig 2. Both for the QDs grown on (001) and (113)B GaAs substrates, structure (c) without AlAs cap showed a considerable red-shift larger than 60 nm. However, structure (b),  $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$  on QDs with AlAs cap, only caused a slight red-shift less than 20 nm. It is clear that  $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$  layer have noticeably different influence on the wavelength between conventional and AlAs capped QDs, that is to say, the effects of  $\text{In}_{0.15}\text{Ga}_{0.85}\text{As}$  layer might be prevented by AlAs cap.

<sup>1)</sup> T. Takahashi *et al.*: Jpn. J. Appl. Phys. **48** (2009) 04C128. <sup>2)</sup> V. Shchukin *et al.*: Phys. Rev. Lett. **110** (2013) 176101.

<sup>3)</sup> 盧 翔孟 その他: 第 61 回応用物理学会春季学術講演会, No.18a-E15-1, 2014 年 3 月.

<sup>4)</sup> N. Yamamoto *et al.*: Phys. Status Solidi C **8** (2011) 328. <sup>5)</sup> N. Ozaki *et al.*: Jpn. J. Appl. Phys. **53** (2014) 04EG10