Optical properties of InAs/GaAsSb sub-monolayer quantum dots with various Sb compositions

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We have investigated optical properties of the InAs/GaAsSb sub-monolayer (SML) quantum dots (QDs) by photoreflectance (PR) and photoluminescence (PL) spectroscopy. To form SML-QDs, a 0.5 ML-thick InAs layer was grown on the GaAs buffer layer and subsequently a 2.5 ML-thick GaAsSb layer (Sb compositions; 0 ~ 19.4%) was followed to cover the InAs layer. The SML-QDs layer consists of 5 cycles of InAs (0.5 ML)/GaAsSb (2.5 ML). After formation of the SML-QDs, 10 nm-thick GaAs layer was used as a spacer layer. 8 periods of SML-QD layers were embedded in each sample.

Fig. 1 and 2 showed the low temperature PL and PR spectra for InAs/GaAsSb (0.5 ML/2.5 ML) SML-QDs, respectively. As increasing the Sb composition, PL emission peak position drastically red-shifted due to the decreasing of the potential barrier height. In the PR spectra, we observed not only QDs related optical transitions but also GaAs band-to-band (E_{GaAs}) and unidentified transitions (UT) as shown in Fig. 2. The amplitude of PR spectra related to SML-QDs transitions are relatively larger than those of the GaAs. This phenomenon can be attributed to the fact that the photo-generated carriers efficiently confined in the SML-QD region. In Addition, we observed sharp transition features between GaAs and QDs due to the interface electronic states of InAs/GaAsSb/GaAs.

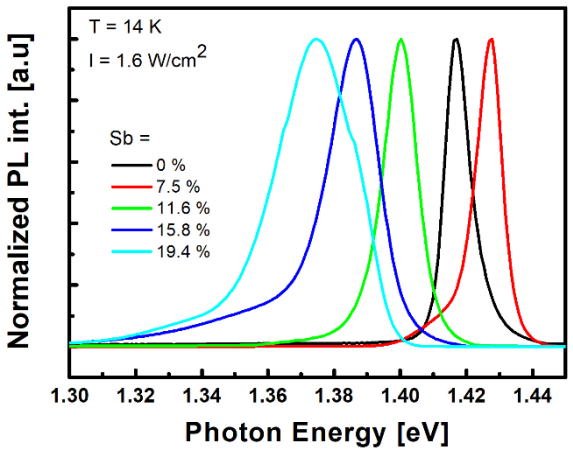

Figure 1. Low temperature PL emission spectra (normalized) for SML-QDs with various Sb compositions.

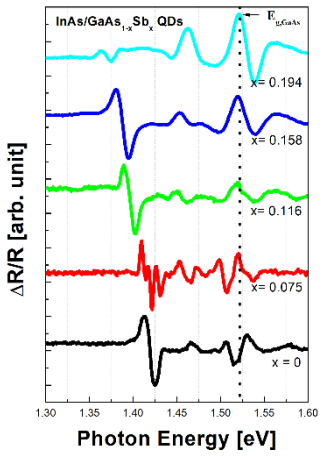

Figure 2. Low temperature PR spectra (normalized) for SML-QDs with various Sb compositions.

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