# Observation of interface electronic states from InAs/GaSb multi quantum wells grown by molecular beam epitaxy

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We have investigated optical transitions in the InAs/GaSb multiple quantum wells (MQWs) by photoreflectance (PR) and photoluminescence (PL) spectroscopy with various temperatures and excitation intensities. PR measurements were performed using a 405 nm laser diode as an excitation source. The probe beam obtained from a tungsten-halogen lamp dispersed through a monochromator. The reflected beam was collected by using a Si (400 ~ 1100 nm: high energy region) and InGaAs (1200 ~ 2400 nm: low energy region) photodiodes. The PR was employed to investigate the inter-band transitions such band-to-band ($E_{GaSb}$), spin-orbit split off ($\Delta_0$), $E_1$ and $\Delta_1$ of GaSb [1] as well as their interface quantum states (IQS).

Fig. 1(a) and (b) show the room temperature PR spectra at near band transition and above band transition for InAs/GaSb (5 ML/50 nm) MQW, respectively. PR spectra of the InAs/GaSb MQWs showed the $E_{GaSb}$, the Franz-Keldysh oscillation (FKO) and IQS. We confirmed the transition energies from 0.72 eV, 1.52 eV, 2.07 eV and 2.53 eV corresponding to the $E_{GaSb}$, $E_{GaSb}+\Delta_0$, $E_1$ and $E_1+\Delta_1$, respectively. Moreover, at room temperature PR spectrum, we observed sharp transition features due to the IQSs from the interface of InAs/GaSb. At near 1.2 eV region, we found unidentified transitions (UIS) and which were investigated by excitation intensity and temperature dependent PR. At low temperature PR and PL results, we found the QS transition between confined electrons states in InAs QW and GaSb valence band at energy of 0.506 eV as shown in Fig. 2

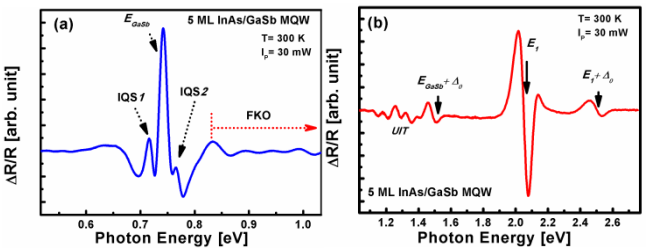


Figure 1 Room temperature PR spectra at near band transition and above band transition for InAs/GaSb (5 ML/50 nm) MQW.

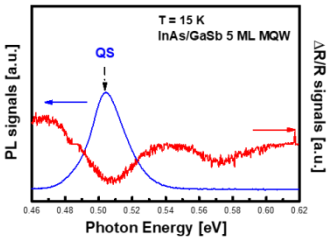


Figure 2 Low temperature PR and PL spectra for quantum well transition for InAs/GaSb (5 ML/50 nm) MQW.

[1] J. S. Hwang, S. L. Tyan, M. J. Lin and Y. K. Su, Solid State communications **80**, 891 (1991).

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