Temperature dependent-photoreflectance of InAs/GaAs quantum dot

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We performed temperature dependent-photoreflectance (TDPR) of InAs/GaAs quantum dot (QD) structure with above- and below-pump source, which are 633 nm He-Ne laser and 975 nm laser diode (LD), respectively. Above-pump source can excite energy states of GaAs bulk and InAs while below-pump source excites only InAs QD regions. Using both of two different pump sources, Temperature behavior of InAs/GaAs quantum dot was studied in this work.

Fig. 1 (a) and (b) exhibit the TDPR spectra with various temperatures. A 900 nm short pass filter (SPF) was used to reduce photoluminescence (PL) signal. We observed GaAs band edge transition and Franz-Keldysh oscillation (FKO). GaAs related signals follow general blue-shifted with decreasing temperature. In addition, FKO periods changes with decreasing temperature because the junction electric field (*F*) is closely related to FKO period [1]. We evaluated the strength of *F* by using fast Fourier transform (FFT) methods.

Fig.1 (c) shows the evaluated *F* as a function of temperature. For below pump, a peculiar temperature behavior was revealed. There are two regions: (i) T ~ 150 K, (ii) 150 ~ 300 K. In the region of (i), photo-excited carriers by below-pump are redistributed between InAs dots. Generally, for dots embedded in a GaAs matrix, the temperature dependent-line width of the dot photoluminescence (PL) goes to a minimum value while PL intensity moves into a maximum value at T ~150 K in agreement with earlier work on similar samples [2]. Hence, carrier confinement effect is a dominant process resulting in enhanced photovoltaic (PV) effect from 100 K to 0 K and correspondingly, in diminished PV effect from 150 to 100 K. In the region of (ii), the temperature behavior has a general dynamics caused by PV effect [3]. For above-pump, the number of photo-excited carriers in GaAs region is much larger than that in InAs QD region. Therefore, the overall temperature behavior of above-pump leads to that of GaAs bulk.

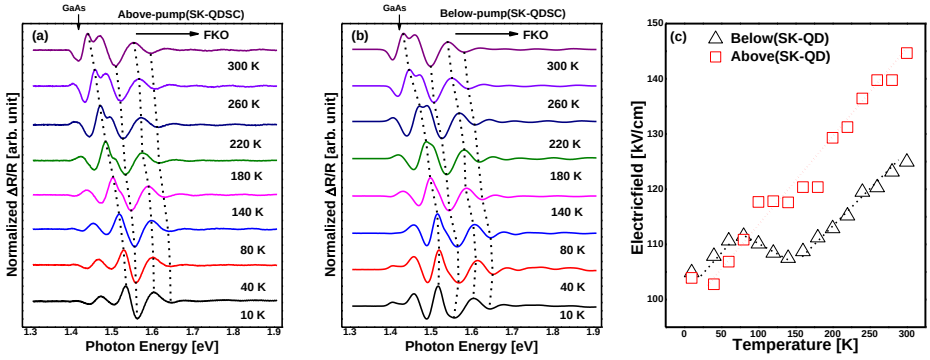

Figure 1. TDPR spectra of InAs/GaAs QD with (a) above- and (b) below-pump source, and (c) junction electric fields evaluated from PR spectra as function of temperature.

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