

Terahertz intersublevel transitions in single self-assembled InAs quantum dots with variable electron numbers

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We have investigated intersublevel transitions in single self-assembled InAs quantum dots (QDs) by using a single electron transistor geometry that consists of a QD and nanogap metal electrodes as a terahertz detector. Fig. 1 shows Coulomb stability diagram and measured photocurrent for two QD samples. Photocurrent distribution with respect to the Coulomb diamonds indicates that there are two mechanisms for the photocurrent generation: $N \leftrightarrow N-1$ photoexcitation process and $N \leftrightarrow N+1$ photoexcitation process. Fig. 2 shows the photocurrent spectra measured at various V_G . When the p shell is fully occupied ($N = 6$), we observed rather simple photocurrent spectra induced by the $p \rightarrow d-2s$ shell intersublevel transitions. The intensity change of the photocurrent peaks with V_G qualitatively agrees with the numerical calculation that takes into account the electron-electron Coulomb repulsion. When the p shell is half filled ($N = 4$), however, the photocurrent spectra exhibited rather complicated behavior as a function the gate voltage, most likely due to the fluctuation in the electron configuration when the empty p state is filled back from the electrode.

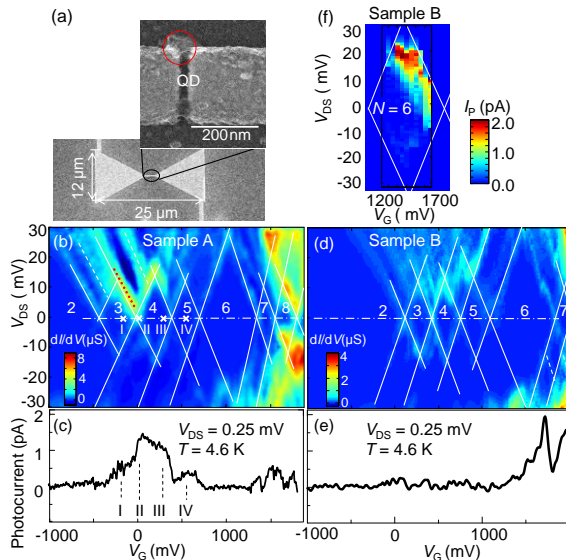


Fig.1 (a) SEM images of a QD SET with a bowtie antenna structure. (b) Coulomb stability diagram of sample A. (c) THz-induced photocurrent as a function of V_G measured on sample A. (d) Coulomb stability diagram of sample B. (e) THz-induced photocurrent as a function of V_G measured on sample B. (f) Photocurrent mapping measured in the $N=6$ Coulomb diamond for sample B.

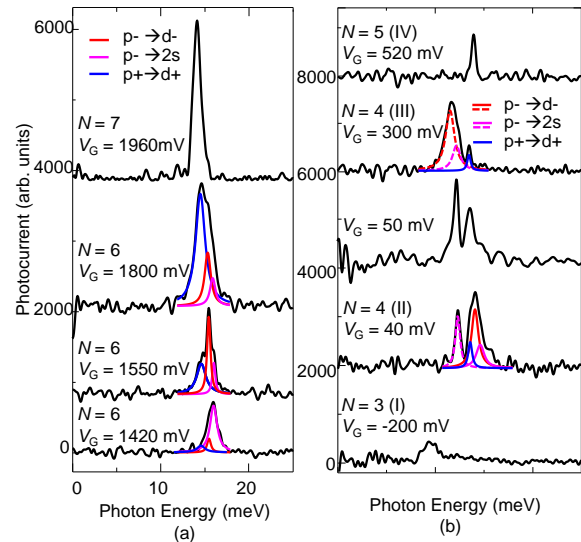


Fig.2 (a) Photocurrent spectra measured at various V_G on sample B for $N=6$. Three possible transitions, *i.e.*, $p \rightarrow d$, $p \rightarrow 2s$, and $p \rightarrow d+$, are indicated by red, pink, and blue arrows, respectively. (b) Photocurrent spectra measured at various V_G on sample B for $N=3,4,5$.