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Electrically detected exciton photo-absorption in semiconductor double quantum dot

K. Takahashi[1], K. Kono[1], S. Tarucha[2], H. Kosaka[2, 3], and K. Ono[1, 4, *]

[1] *Low temperature physics laboratory, RIKEN, 2-1 Hirosawa Wako, Saitama 351-0198, Japan*

[2] *Department of Applied Physics, University of Tokyo, Bunkyo-ku, Tokyo 113-8656, Japan.*

[3] *Research Institute of Electrical Communication, Tohoku University, Sendai 980-8577, Japan*

[4] *CREST-JST, 4-1-8 Honcho, Kawaguchi, Saitama 332-0012, Japan*

** Tel: +48-467-4764, Fax: +48-462-4652, E-mail: k-takahashi@riken.jp*

Quantum transports of semiconductor quantum dots so far are mostly treat the conduction band electrons. Trapping an electron from conduction electron reservoir into the dot, and electrically detect their current or charge, enables us to control a single charge, a single spin, as well as tiny numbers of nuclear spins around it. [1] Semiconductor devices on the other hands are well known to be excellent photo-detectors/emitters, and the interaction of photons, conduction band and valence band electrons in such devices are well understood. In this paper, motivated by recent quantum media conversion proposals from a single photon to a single photo-created electron spin [2,3], we report a quantum transport measurement of semiconductor double quantum dots under monochromatic light irradiation which can cause an interband photo-absorption in quantum dots.

We measured a dc transport current I_D of the vertical double dot composed of AlGaAs barrier, InGaAs wells and n-GaAs electrodes at temperature ~ 0.23K with monochromatic light illuminations of wavelength 850nm -1100nm. Under large source drain bias voltage V_S near pinch-off gate voltage V_G, Photo-absorption with minimum photon energy occurs as an indirect exciton, *i.e.* creation of an electron on one quantum well and a hole on the other. (Fig.1) [4] Photon energy needed to create such an indirect exciton depends linearly on the electric field applied to the triple barrier structure and thus can be tuned by V_S (Fig. 2.). This onset V_S is consistent with the amount of the photon energy decrease estimated from V_S deference of two quantum wells (dotted line).

Reference

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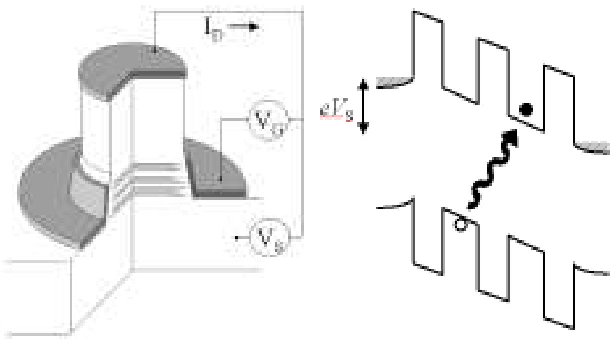

Fig. 1 Schematics of the device and the indirect exciton.

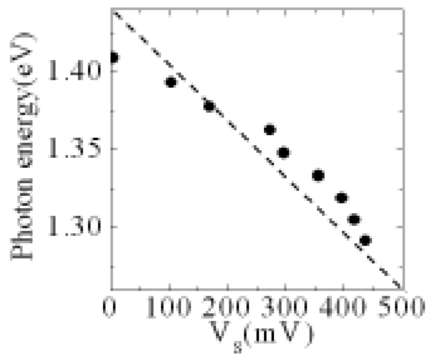

Fig. 2 Onset V_S of photo absorption vs. photon energy.