Supplementary information

Room-temperature electric field control of spin filtering efficiency for enhanced modulation of optical spin polarization in a defect-functional 0D-2D hybrid nanostructure

Soyoung Park, Satoshi Hiura*, Hiroto Kise, Junichi Takayama, Kazuhisa Sueoka, and Akihiro Murayama

Faculty of Information Science and Technology, Hokkaido University, 060-0814, Japan
*Correspondence: hiura@ist.hokudai.ac.jp

Note S1. Bias voltage dependence of photocurrent

According to the previous work of QD spin-photodiode,[1] the bias voltage dependence of photocurrent can give information about the band potential. In this study, we investigated the bias voltage dependence of photocurrent to explore the band potential condition. The photocurrent was measured by the transimpedance amplifier and a lock-in amplifier synchronized with the modulated signal of an optical chopper operated at 509 Hz. The incident laser wavelength was set to 850 nm, and the laser power density was set at approximately 15 μW μm^{-2}. Figure S1 shows the bias voltage dependence of the photocurrent. The minimum of the photocurrent appears at around 0.2 V. This result clearly demonstrates that a nearly flat band potential is reached at a bias voltage of 0.2 V.

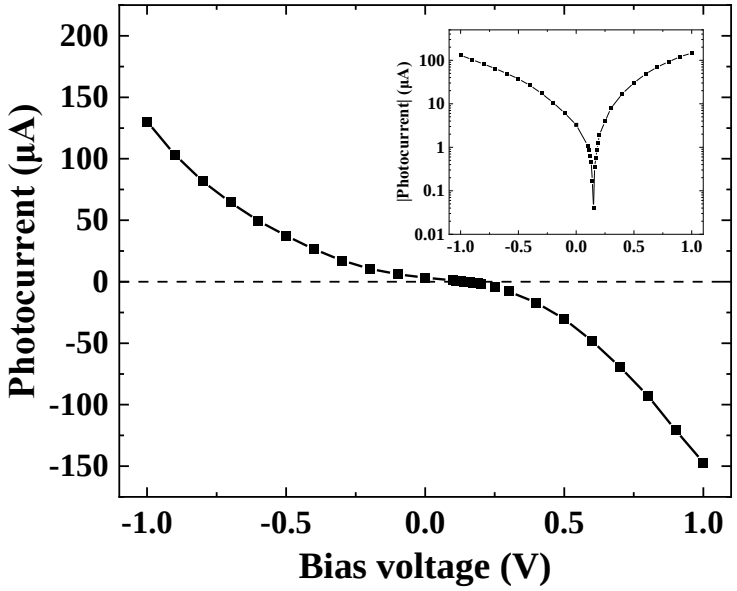

Fig. S1 Bias voltage dependence of photocurrent measured at RT.

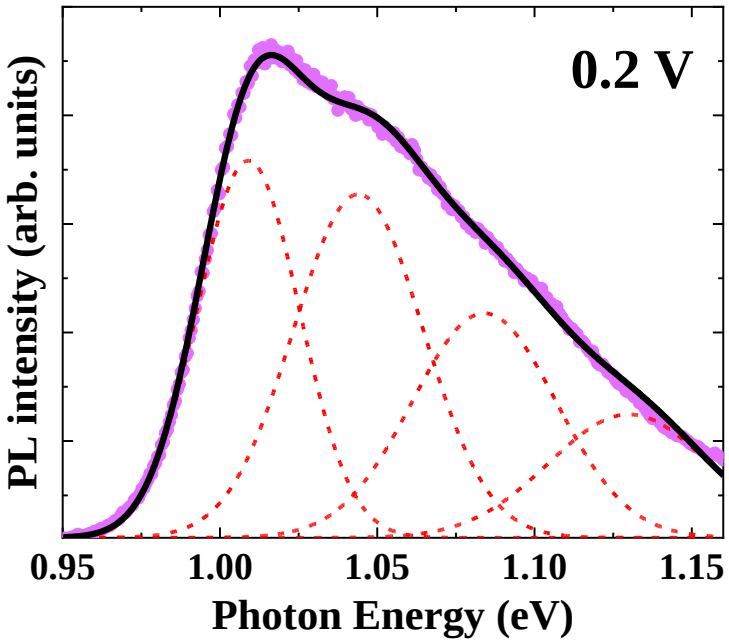

Fig. S2 Peak-fitting analysis of PL spectrum measured at RT with a bias voltage of 0.2 V.

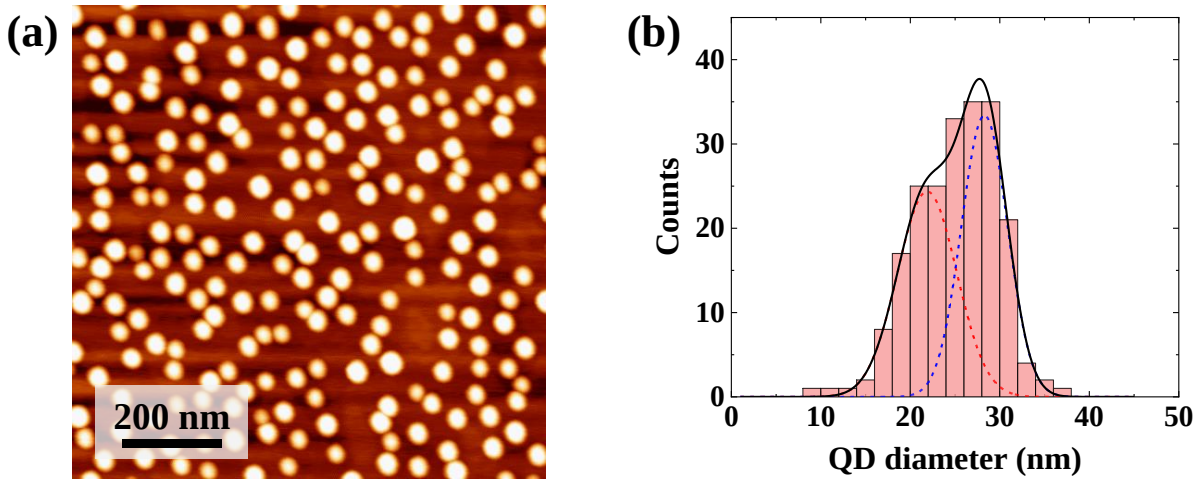

Fig. S3 Structural characterization of QDs by AFM. (a) Typical AFM image of reference InAs QDs grown under the identical conditions as in this study. (b) Size distribution of QDs. The red and blue solid lines indicate the size distributions of smaller- and larger-sized QD ensembles, respectively.

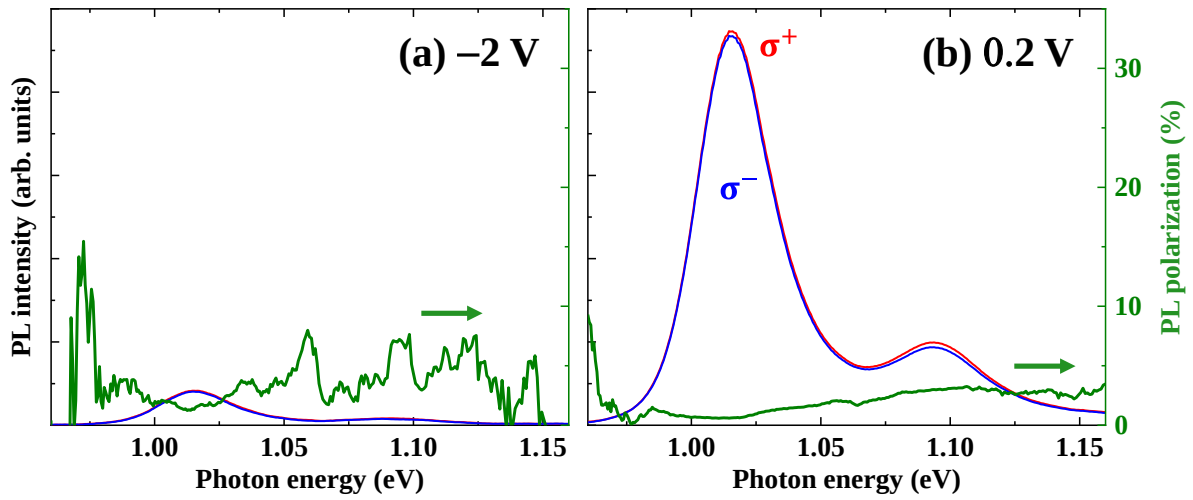

Fig. S4 Circularly-polarized PL spectra and corresponding PL polarization of QDs measured at 295 K with bias voltages of (a) −2 V and (b) 0.2 V, for the InGaAs QW-InAs QD tunnel-coupled structures.

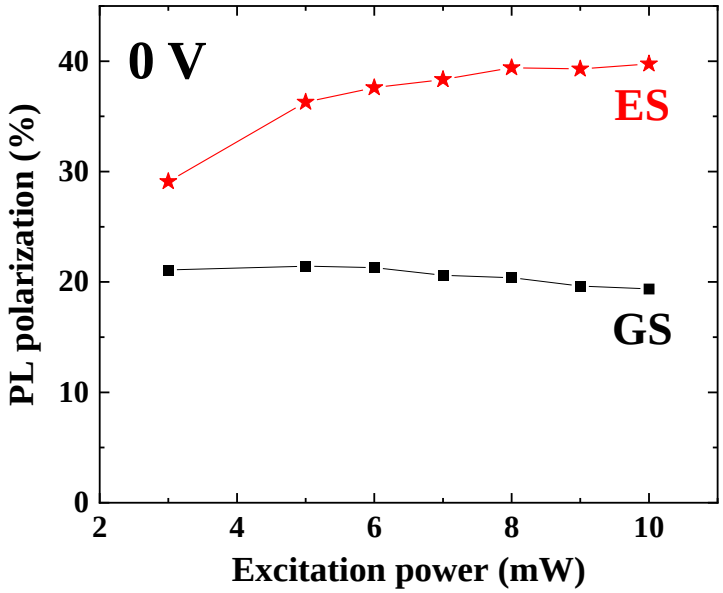

Fig. S5 Excitation power dependence of PL polarization at the QD GS and QD ES, measured at 295 K with a bias voltage of 0 V.

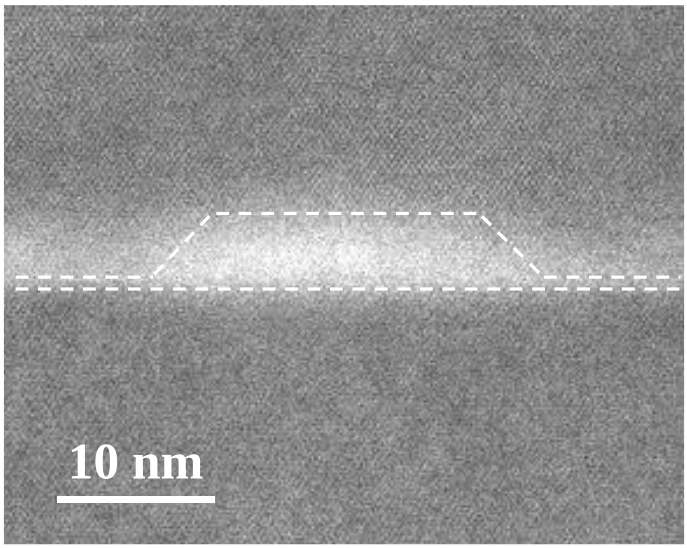

Fig. S6 Typical HAADF-STEM image of the buried InAs QD grown under the identical conditions as in this study.

References

1. F. Cadiz, D. Lagarde, B. Tao, J. Frougier, B. Xu, X. Devaux, S. Migot, Z. G. Wang, X. F. Han, J.-M. George, H. Carrere, A. Balocchi, T. Amand, X. Marie, B. Urbaszek, H. Jaffrès, Y. Lu and P. Renucci, Electrical detection of light helicity using a quantum-dot-based hybrid device at zero magnetic field, *Phys. Rev. Mater.* 2020, **4**, 124603.