

Electrical and Optical Tuning of Telecom-Band InAs/InP Quantum Dots Using a Non-Local Biasing Scheme

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Electrical control of quantum dot (QD) emission is essential for scalable quantum photonic devices, enabling spectral tuning via the quantum-confined Stark effect and deterministic coupling to photonic resonators. Moreover, control of the QD charge environment and electrostatic potential directly impacts excitonic fine structure, linewidth, and photon indistinguishability, which are key parameters for quantum technologies at telecommunication wavelengths.

Here, we present a micro-device based on single InAs/InP quantum dots grown by droplet epitaxy¹ and embedded in a p-i-n junction. The QDs emit in the telecom C-band around 1550 nm. We apply a non-local bias that induces an effective vertical electric field at the quantum dot location. The measured I-V characteristic exhibits a current-limited, quasi-symmetric behavior (Fig.1A).

Voltage tuning (0 – 5.2 V) induces significant changes in the device emission spectrum, including the emergence of charged excitonic complexes and a Stark shift of ~ 0.5 nm/V, enabling identification of neutral and charged states via polarization-resolved photoluminescence, photoluminescence excitation (PLE), and voltage-dependent evolution (Fig.1B). Furthermore, when a constant external voltage is applied, increasing optical excitation power induces bias-like spectral changes, including Stark shifts and excitonic state switching, consistent with a photovoltage-induced electric field.

These results demonstrate versatile electrical and optical control of telecom-band quantum dots and establish a solid platform for future investigations of single-photon purity and indistinguishability under applied bias.

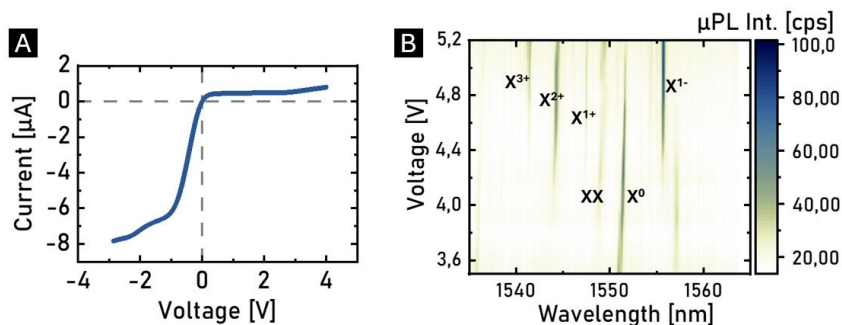


Figure 1 (A) I-V characteristic of the device. (B) Micro-PL of a single QD as a function of applied voltage.