Quantum Dot intersubband Photodetectors for LWIR photons

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Abstract: Intersubband photodetector for LWIR photons based on resonant state absorption in quantum dots shows absorption up to room temperature thanks to the enhanced extraction efficiency without sacrificing the absorption probability.

The development of quantum nanostructures is of primary importance for the advancement of photodetector technologies in the long wavelength infrared (LWIR) window, and particularly the successful implementation of quantum dots (QDs) has the potential to result in a generational leap in the field [1]. Despite the promises, the performance of QD-based photodetector is still lacking compared to the state-of-the art technology. We present an innovative solution to surpass the current generation of QD-based detectors by exploiting the absorption from quantum dot localized states to resonant states in the continuum, that is states in the semiconductor conduction band with an enhanced probability density in the quantum dot region [2]. This approach takes advantage of the unique properties of such states to massively enhance carrier extraction, allowing to overcome one of the most crucial drawbacks of quantum dot-based infrared detectors.

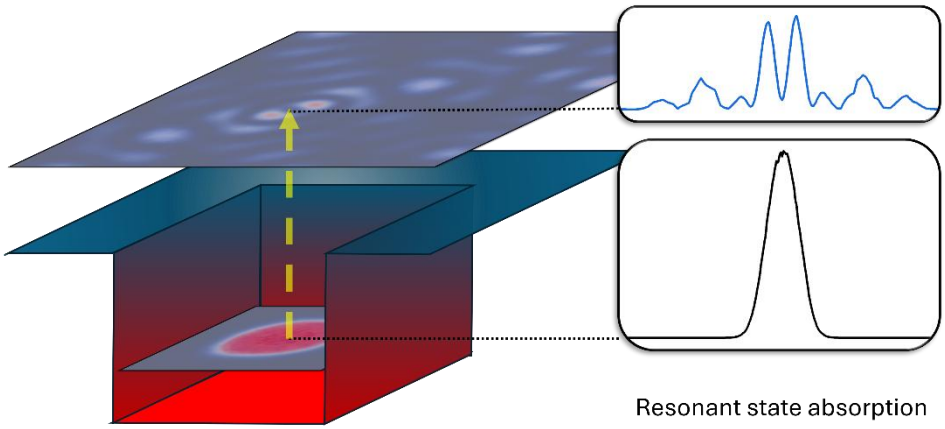

Fig. 1 Visual representation of the resonant state involved in the LWIR photon absorption.

We present the experimental results obtained for a quantum dot intersubband photodetector for LWIR photons operating at room temperature and the theoretical perspectives, demonstrating the effectiveness of exploiting resonant state absorption in quantum dots.

References

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[2] S. Vichi, S. Asahi, S. Bietti, A. Tuktamyshev, A. Fedorov, T. Kita, S. Sanguinetti, "Conduction band resonant states absorption for quantum dot infrared detectors operating at room temperature", ACS Photonics (2024) https://doi.org/10.1021/acsphotonics.4c01856