



## InAs(P)/InP QDs as sources of single indistinguishable photons at 1.55 $\mu\text{m}$

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# InAs(P)/InP QDs as sources of single indistinguishable photons at 1.55 $\mu\text{m}$

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Epitaxial quantum dots (QDs) exhibit substantial promise as non-classical light sources in quantum technologies [1]. In particular, the generation of single, indistinguishable photons on demand is pivotal for advanced quantum cryptographic key exchange algorithms [2]. This study investigates the quantum optical characteristics of single photons emitted by InAs(P)/InP QDs heterogeneously integrated with silicon.

The investigated QDs, grown via metalorganic vapor-phase epitaxy in the Stranski-Krastanow mode, showcase the emission at  $\sim 1.55 \mu\text{m}$  [3], indispensable for long-haul, low-loss optical transmission through standard silica fibers. The photon extraction efficiency is enhanced to  $\sim 10\%$  by employing a metallic mirror beneath the QDs in combination with a top mesa structure [4]. Our study confirms the single-photon emission from the QDs through measurements of the second-order autocorrelation function, revealing  $g^{(2)}(0) = 0.005(4)$  for biexciton under two-photon resonant excitation of the biexciton-exciton radiative cascade.

To investigate the degree of indistinguishability of emitted photons, we conducted also Hong-Ou-Mandel-type two-photon interference (TPI) experiment. The TPI visibility, quantifying the degree of indistinguishability of emitted photons, is crucial in examining the coherence of carriers within the QD [5]. Exciton-phonon interactions and carrier-carrier scattering significantly contribute to the degradation of coherence within the QDs. Using direct integration of the raw experimental data or fitting to a model, we evaluated the raw (i.e., ‘as measured’) and the post-selected TPI visibility up to 35% and 73%, respectively [6], which represents a state-of-the-art achievement for InAs/InP QDs emitting at  $1.55 \mu\text{m}$ . The significant progress in the generation of single indistinguishable photons in the telecom C-band offers crucial insights into their potential integration within quantum information technologies.

## References

- [1] P. Michler, *Quantum Dots for Quantum Information Technologies* Vol. 237, Springer (2017).
- [2] D. A. Vajner *et al.*, *Quantum Communication Using Semiconductor Quantum Dots*, *Adv. Quantum Technol.* **5**, 2100116 (2022)
- [3] P. Holewa *et al.*, *Optical and electronic properties of low-density InAs/InP quantum-dot-like structures designed for single-photon emitters at telecom wavelengths*, *Phys. Rev. B* **101**, 195304 (2020).
- [4] P. Holewa *et al.*, *Bright Quantum Dot Single-Photon Emitters at Telecom Bands Heterogeneously Integrated on Si*, *ACS Photonics* **9**, 7, 2273–2279 (2022).
- [5] L. Wells *et al.*, *Coherent light scattering from a telecom C-band quantum dots*, arXiv:2205.07997v2
- [6] D. Vajner *et al.*, *On-demand Generation of Indistinguishable Photons in the Telecom C-Band using Quantum Dot Devices*, arXiv:2306.08668v1