On-chip coupling of single photon emission from InAs/InP quantum dots at telecom range

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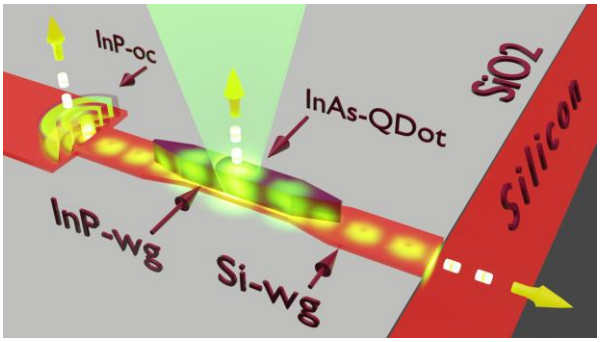
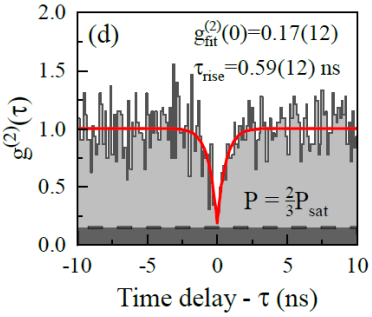
Integrated Quantum Photonic Circuits (IQPC) in which semiconductor-based components, like emitters, waveguides (WGs), detectors, can all be integrated on a compact photonic chip, could provide a better performance in complex tasks such as computing, energy conversion, biomedical sensing, and cryptography. In this work we present modelling, fabrication, and experimental studies related to a hybridized InP/Si WG system with InAs/InP quantum dots (QDs) heterogeneously integrated with the silicon-on-insulator platform. Numerical studies of such WGs demonstrate efficient QD coupling with multimode propagation in a hybrid InP/Si part of the system, as well as efficient transfer of light to Si WG via a linear taper structure [1]. The optimized system promises of approx. 30 % of on-chip directional copuling which might be further enhanced via Bragg grating system. Single-photon source is based on low density $3.1\text{x}10^{8}$ cm^{-2} epitaxially grown InAs/InP QDs with high single photon emission purity, high extraction efficiency when coupled with photonic microstructures [2]. The quantum emitter is integrated with SOI wafer by wafer bonding technique and via subsequent photo and e-beam lithography to process the WGs.

We investigated experimentally both the on-chip coupling efficiency and the quantum nature of emission by orthogonal microphotoluminescence configuration allowing for collection of outcoupled light from the cleaved facet. In this way, we obtain a high-quality quantum device with broadband on-chip coupling to Si WG of 10.2% preserving a good suppression of multiphoton emission events with background corrected $g^2(0) < 0.05$ [3]. The outcomes of our study underscore the potential benefits of this approach for advancing the development of quantum on-chip photonics using single-photon sources which are also easily combined with external fiber optics network.





[1] P. Mrowiński, et al., *Opt. Express* **31**, 1541-1556 (2023) [2] P. Holewa, et al., *ACS Photonics* ***9****, 2273 (2022)* [3] M. Burakowski, et al., *Opt. Express* **32**, 10874-10886 (2024)

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