From Quantum Dots to Quantum Networks: Scalable Photonic Devices Operating in the Telecom C-Band

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In this presentation, we will discuss the methods for the epitaxial growth of InAs quantum dots (QDs) embedded in an InP matrix (see Fig. 1a), tailored to emit single photons in the telecom C-band [1,2]. We further demonstrate the experimental realization of a deterministically fabricated single-photon source based on these QDs, operating in the telecom C-band [3] (see Fig. B). We explore strategies for establishing a scalable quantum photonics platform leveraging silicon photonics. Specifically, we present results on wafer bonding [4] and transfer printing of QD-integrated photonic cavities (Fig. 1c). Lastly, we discuss the direct selective epitaxy of InP-based heterostructures on silicon [5], providing an analysis of the optical and morphological properties of the resulting structures and discussing the challenges and future prospects of this approach.

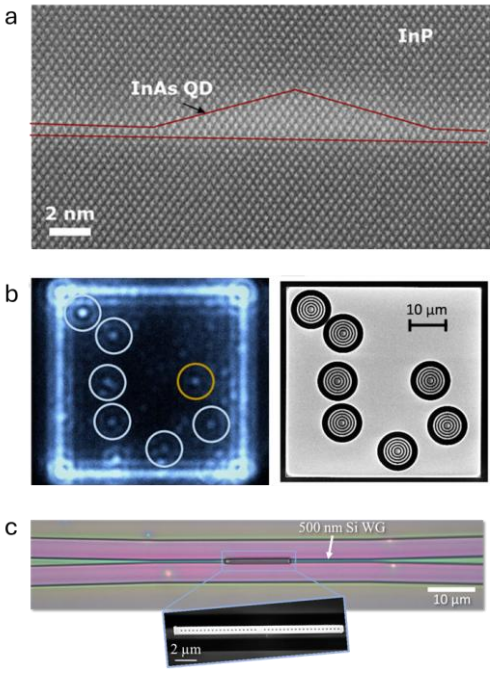

Fig.1. a) Atomic resolution scanning transmission electron micro-scope image of InAs QD in InP in cross-section geometry; b) left panel: a micro-photoluminescence map of an InP field with localized QDs; right panel: scanning electron micro-scope image of the same field with photonic cavities fabricated around preselected QDs; c) optical microscope image of an InP beam resonator with InAs QD heterogeneously integrated to the Si waveguide, inset: scanning electron microscope image of InP beam resonator with InAs QD.

References

[1] Y. Berdnikov et al,, Sci Rep **14**, 23697 (2024)

[2] P. Holewa, et al, Nanophotonics. **11**, 8, p. 1515–1526 (2022)

[3] P. Holewa, et al, Nat Commun **15**, 3358 (2024)

[4] M. Burakowski et al, Opt Express. **32**(7),10874-10886 (2024)

[5] A. Nanwani et al, Adv. Optical Mater. , 13, 2403419 (2025)