Hybrid quantum photonic integrated circuits

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Quantum communication applications require a scalable approach to integrate bright on-demand sources of entangled photon-pairs in complex on-chip quantum photonic circuits. Currently, the most promising sources are based on III/V semiconductor quantum dots. However, complex photonic circuitry is mainly achieved in silicon photonics due to the tremendous technological challenges in circuit fabrication.

We take the best of both worlds by developing a new hybrid on-chip nanofabrication approach [1]. We demonstrate for the first time on-chip generation, spectral filtering, and routing of single-photons from selected single and multiple III/V semiconductor nanowire quantum emitters all deterministically integrated in a CMOS compatible silicon nitride photonic circuit [2]. Our method paves the way for large-scale integration and excitation of multiple quantum emitters in the same photonic circuit as shown in the schematic illustration Fig.1 a. The circuit design (shown in the inset) allows for in-plane excitation of the nanowire quantum dots using a two foci setup. Fig.1 b to g show the emission spectrum of 6 independently and deterministically integrated nanowire quantum emitters operating on the same photonic chip.

Our new approach eliminates the need for off-chip components, opening up new possibilities for quantum photonic circuits with multiple on-chip single- and entangled photon sources.

**Figure 1:** a) Schematic of multiple nanowire quantum dots integrated on the same photonic circuit chip. Inset shows the actual circuit design. (b-g) Spectra of the six nanowire quantum dots.


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