Telecom C-band single photon emission using a scalable platform based on deterministically positioned nanowire quantum dot sources

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The development of photonic-based quantum information technologies depends on the availability of devices that consistently, and with high efficiency, deterministically emit identical single photons. A key requirement for the implementation of fiber-based quantum secured communication protocols demands that such high-performance single photon sources be compatible with pre-existing, long-haul, optical fiber networks operating in the low-loss telecom C-band (λ ~ 1530-1565 nm). Semiconductor quantum dot emitters offer on-demand operation at high rates and can be incorporated into photonic structures that allow for high efficiency collection. By altering their composition and geometry, these artificial atoms can be engineered to emit at desired wavelength ranges. Through composition engineering of $InAs_xP_{1-x}$ dot-in-a-rod (DROD) nanowire quantum dot structures [1] we have previously demonstrated single photon emission from nanowire quantum dots from wavelengths of up to the telecom O-band [2]. In this talk, we show how the DROD structure can be modified to shift the emission wavelength to the telecom C-band. Using sources emitting at λ > 1530 nm, we obtain single-photon purities of $g^{(2)}(0) = 0.062$ [3]. Through further optimization of these structures, we aim to dramatically increase source brightness with the long-term goal of developing scalable and efficient C-band emitting site-selected single-photon sources. This work represents an important milestone towards the development of a scalable platform for the manufacture of high efficiency, high-rate single photon sources operating in the telecom C-band.

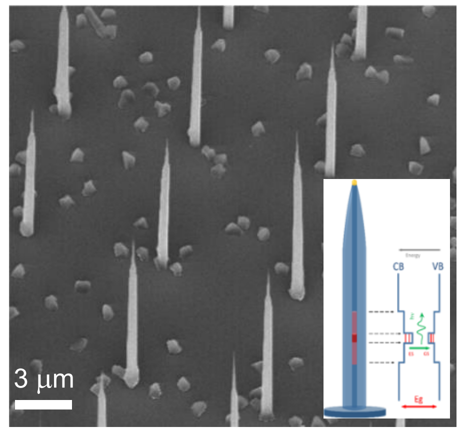

Fig. 1. Scanning electron microscopy image of an array of nanowire quantum dot C-band single photon sources. Inset shows a schematic of the $InAs_xP_{1-x}$ dot (dark red) in a $InAs_yP_{1-y}$ rod (light red) device along with the associated band structure.

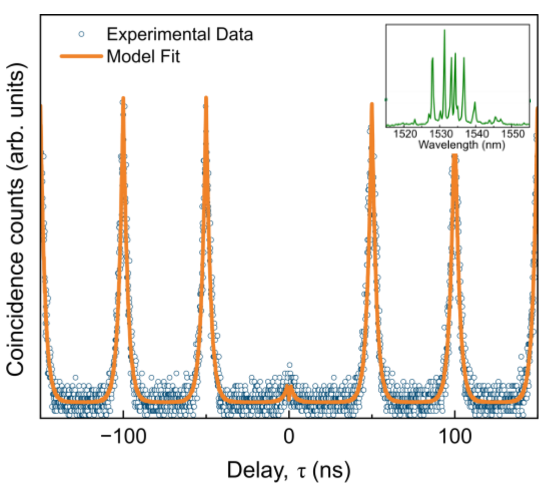

Fig. 2. Second-order auto-correlation measurement, $g^{(2)}(\tau)$, of the peak at λ = 1531 nm (see inset) from a single nanowire quantum dot device. The fit (orange curve) is generated using a stochastic model used to describe the photon emission statistics [3].

References

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