Purcell-Enhanced and Tunable Single-Photon Emission from Telecom Quantum Dots in Circular Photonic Crystal Resonators

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The development of scalable quantum light sources operating in the low-loss telecom bands around 1310 nm and 1550 nm is a critical step towards the implementation of quantum networks over the existing optical fibre infrastructure. Among the promising approaches, semiconductor quantum dots (QDs) embedded in bullseye resonators have shown the ability to deliver pure and indistinguishable single photons at impressive rates [1,2]. Recent research has largely focused on achieving deterministic fabrication of these devices to maximize yield and optimize the emitter-cavity coupling. However, electric field control remains a key requirement for advanced quantum applications, enabling spectral tuning, stabilization of the charge environment, and integration into deployable, laser-free systems. While such control has been demonstrated in alternative devices like micropillars and photonic crystal waveguides, it had yet to be realized in bullseye resonators.

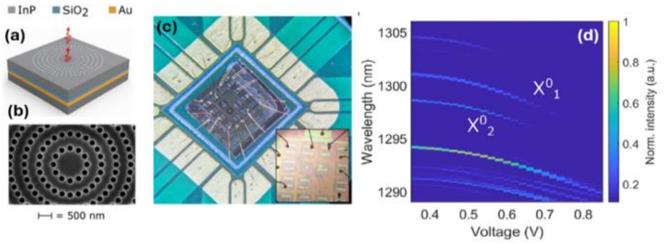

Figure 1 Tunable bulls eye resonator: (a) schematics, (b) SEM image, (c) packaged device, (d) wavelength tuning of the X-XX states.

Our work addresses this gap by demonstrating that electric field control can be implemented in bullseye resonators without compromising the device's symmetry or broadband enhancement, advancing the integration of those photon sources into more scalable and experimentally versatile quantum photonic systems (Fig.1). Our results also address key limitations shown by bullseye resonators in complex quantum optics experiments, which may require precise control of the emission wavelength and unpolarized Purcell enhancement.

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[1] Wang, H.; et al. Towards optimal single-photon sources from polarized microcavities. *Nat. Photonics* 2019, *13*, 770−775.

[2] Barbiero, A.; et al. High-Performance Single-Photon Sources at Telecom Wavelength Based on Broadband Hybrid Circular Bragg Gratings. *ACS Photonics* 2022, *9*, 3060−3066.