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Focused ion beam writing of scalable quantum emitters in silicon

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Single-photon sources are one of the elementary building blocks for photonic quantum information and optical quantum computing [1]. One of the upcoming challenges is the monolithic photonic integration and coupling of single-photon emission, reconfigurable photonic elements and single-photon detection on a silicon chip in a controllable manner. Particularly, fully integrated single-photon emitters on-demand are required for enabling a smart integration of advanced functionalities in on-chip quantum photonic circuits [2].

This work presents a mask-free nanofabrication method involving a quasi-deterministic creation of scalable extrinsic color centers in silicon emitting in the optical telecom O-band [3] on a commercial silicon-on-insulator platform using focused ion beam writing. We also show the local writing of an intrinsic color center in silicon, which is linked to a tri-interstitial complex and reveals quantum emission close to the telecom band [4]. The successful integration of these telecom quantum emitters into photonic structures such as micro-resonators, nanopillars [5] and photonic crystals with sub-micrometer precision paves the way toward a monolithic, all-silicon-based semiconductor-superconductor quantum circuit.

[1]D. D. Awschalom et al.,Nature Photonics 12,516 (2018)
[2]J. C. Adcock et al.,IEEE, 27, 2, (2021)
[3]M. Hollenbach et al.,Optics Express 28,26111 (2020)
[4]Y. Baron et al.,arXiv:2108.04283 (2021)
[5]M. Hollenbach et al.,arXiv:2112.02680 (2021)

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