Silicon Quantum Photonics

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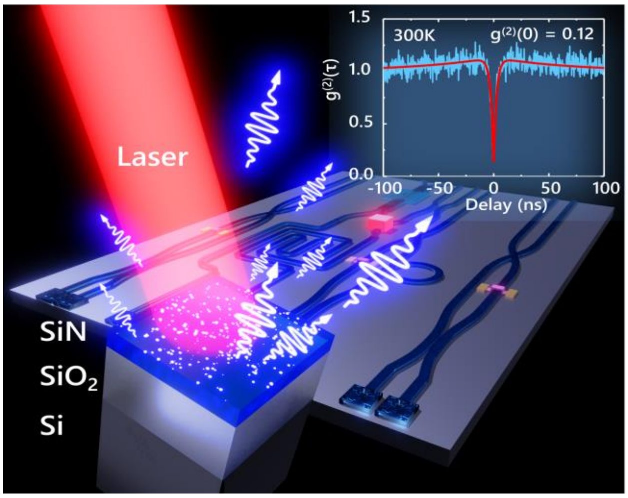
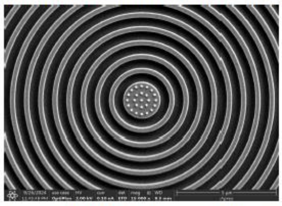
Abstract

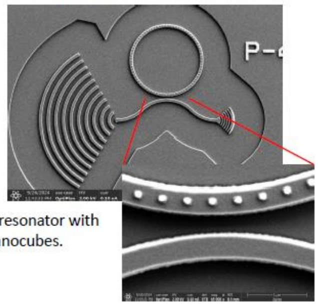
We discuss scalable quantum photonics circuitry based on room-temperature single-photon emitters in silicon nitride that we recently discovered in this technologically important material platform [1-3]. We also consider integration of SiN single-photon emitters with waveguides as well as the quantum emission enhancement through integration with resonant cavities and plasmonic nanostructures. This hybrid dielectric-plasmonic design paves the way for advanced quantum photonic systems by leveraging the benefits of both cavity confinement and plasmonic enhancement. Furthermore, we discuss a new approach for all-optical modulation using silicon avalanche photodiode, where the avalanche multiplication produces significant refractive index changes at ultra-low, single-photon intensities [4], enabling record-high nonlinearity in a telecom-compatible platform with a potential for integrated silicon quantum photonics.



By combining photonic and plasmonic components, hybrid cavities can maintain the benefits of high-Q modes from the photonic side while utilizing the extreme field enhancement offered by plasmonic modes. The expected result is a system that can achieve Purcell enhancement, increasing the emission rate of quantum emitters, such as single-photon emitters (SPEs), through improved spontaneous emission coupling.

Concept of CBG and Microring resonator with distributed plasmonic nanocubes matching phase of propagating mode. Courtesy: Kryvobok, A.





Fabricated Hybrid Bullseye and Microring resonator with symmetrical arrangement of plasmonic nanocubes. Courtesy: Kryvobok, A.

References

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