

A More Stable Photon Emitter

A new device that generates single photons with more consistent wavelengths than existing methods could improve quantum communications.

By **Marric Stephens**

A foreign ion in a silicon crystal will usefully emit a single photon on demand when illuminated by light at a certain wavelength. Unfortunately, the need for emission efficiency in devices usually comes at the cost of an unwelcome spread in the wavelengths of emitted photons. Now Johannes Früh at the Technical University of Munich and his colleagues have demonstrated a new setup that generates photons with more consistent wavelengths [1]. Producing indistinguishable photons will be crucial for future quantum-optical applications such as quantum networks.

In a conventional single-photon emitter, a nanophotonic resonator is etched into a doped-silicon chip. The nanophotonic resonator enhances the dopant ions' emission, but to ensure that a single ion lies within the tiny resonant volume, the dopant density must be high. Meeting that density requirement spawns defects that, under laser illumination, can trap electric charges. Over time, the resulting electric fields shift an ion's energy levels, making its emission wavelength fluctuate. Dangling bonds and impurities at the surface also

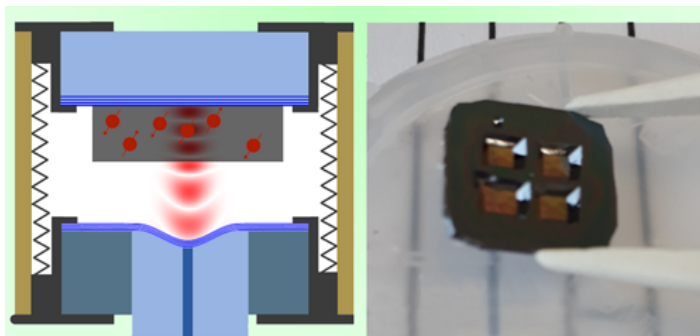
shift the energy levels.

Früh and colleagues replaced the silicon nanocrystal with a 2- μm -thick silicon membrane doped with erbium ions, which emit at near-infrared telecom wavelengths. They placed the membrane in an optical cavity called a Fabry-Perot resonator. Ordinarily, such a cavity is less effective at enhancing emission than a nanophotonic resonator, but by using mirrors of exceptionally high quality, the researchers achieved a practical emission rate. More importantly, they could lower the dopant density thanks to the cavity's larger resonant volume. What's more, the membrane's smaller surface-to-volume ratio weakened the surface effects. These improvements cut the size of the wavelength fluctuations by nearly 90% compared to nanophotonic devices.

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REFERENCES

1. J. Früh *et al.*, "Spectral stability of cavity-enhanced single-photon emitters in silicon," *PRX Quantum* 7, 020363 (2026).



Credit: J. Früh *et al.* [1]