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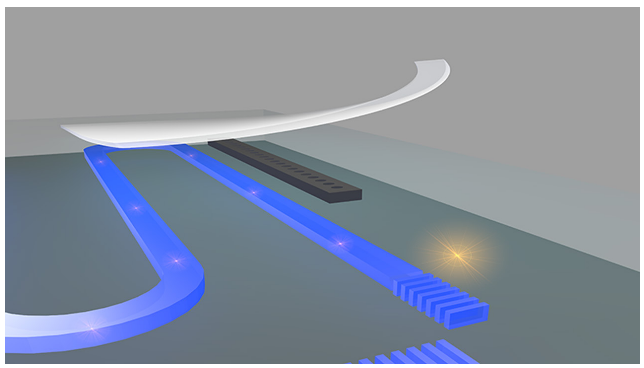
Using a transfer printing method, researchers developed a CMOS-friendly silicon photonic chip that could pave the way for large-scale quantum technology.



The road to large-scale quantum applications may be paved with silicon photonic integrated circuits. Given their compatibility with complementary-metal-oxide-semiconductor technology (CMOS), silicon photonics may be used to develop quantum technology that can be integrated with existing electronics. However, a major challenge to their widespread use remains—creating photonic devices that can deterministically emit single photons efficiently.

The new paper proposed a solution using a transfer printing technique with quantum dots to create the photon sources. Previously, researchers had created single photon sources from silicon, but with probabilistic single-photon generation. Other research had created such sources in materials like as diamonds with InAs/GaAs quantum dots. Katsumi et al. combined these previous methods to print InAs/GaAs quantum dot emitters onto a silicon base.

The method uses quantum dots first embedded in a PhC nanobeam cavity that helps funnel the emitted photons to a waveguide. For producing the chip itself, the quantum-dots single-photon source are transferred onto the waveguide using a rubber stamp that picks up then deposits the quantum-dot-based single-photon source. This method resulted in a successful deposition nearly 100 percent of the time.

In characterizing the resulting chip, the researchers found a near perfect cavity-waveguide coupling efficiency of 90 percent and a similarly high emitter-cavity coupling efficiency of 70 percent.

The new transfer printing method is expected to also work for other nanophotonic components such as nanolasers and cavity quantum electrodynamics systems. This technique is therefore also applicable in other areas of silicon photonics beyond CMOS.

Source: “Quantum-dot single-photon source on a CMOS silicon photonic chip integrated using transfer printing,” by Ryota Katsumi, Yasutomo Ota, Alto Osada, Takuto Yamaguchi, Takeyoshi Tajiri, Masahiro Kakuda, Satoshi Iwamoto, Hidefumi Akiyama, and Yasuhiko Arakawa, *APL Photonics* (2019). The article can be accessed at https://doi.org/10.1063/1.5087263.