Next-generation quantum photonics at the National Advanced Photonics Facility

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Abstract
Despite its maturity as a photonics platform, Silicon-on-Insulator (SOI) is not suitable for many quantum photonics applications, given silicon's limited transparency window (1.2–7 μm, 50–100 μm) and high optical loss (typically dB per cm). Given this, there is increasing focus on the next-generation of materials for quantum photonics, such as silicon carbide (SiC) and lithium niobate. In particular SiC has: a large transparency window (370 nm–5.6 μm, 16.6–1000 μm), allowing its use in applications such as nonlinear interferometry [1]; high refractive index (2.55–2.6) ensuring strong optical confinement; wide bandgap (2.9 eV), ensuring low optical losses in the visible to near-IR and suppressing two-photon absorption in the near-IR; both second-order and third-order nonlinearities, enabling efficient downconversion for photon production; CMOS-fab compatibility; and very high thermal conductivity and mechanical stability [2]. Uniquely among next generation materials, SiC enables combination of CMOS logic directly with integrated photonics in the one substrate, avoiding heterogenous or hybrid structures and associated and manufacturing complexity. However, until now there have been no readily available sources of Silicon Carbide-on-Insulator (SiCOI), slowing its adoption for quantum photonics in both academia and industry.

To meet this need we have established the National Advanced Photonics Facility (NAPF), which will produce thin film Silicon Carbide-on-Insulator (SiCOI) wafers by the end of 2026, and manufacturing and processing of nanophotonics and optomechanics for both academic and commercial users. Here we discuss some of our quantum-photonic use cases, and the capacity our facility adds to the worldwide quantum photonics community.

References

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