**Integrated nanophotonics with hexagonal boron nitride**

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**Abstract**

Hexagonal boron nitride (hBN) has emerged as a promising platform, following reports of hyperbolic phonon-polaritons and optically stable, ultra-bright quantum emitters. In this report, we fabricate hBN into high-quality photonic devices such as photonic crystals and microrings to increase light-matter interaction. This is the first direct fabrication of van der Waals crystals into photonic devices with nano-sized features. This can open up promising avenues in many applications in nanophotonics including quantum photonics and optomechanics.

**Introduction**

Single photon emitters (SPEs) are key resources for many quantum technologies including quantum computation and quantum communications. To date, the most investigated solid state SPE systems are epitaxial quantum dots that operate primarily at cryogenic temperatures, and colour centres in solids. Despite years of research, the existing systems remain inadequate for practical applications, and the search is on for high-performance quantum emitters. In 2015, the SPE platform expanded to 2D materials. In 2016, hexagonal boron nitride (hBN) emerged as a compelling 2D host of SPEs [1].

SPEs in hBN are promising because they are bright, with more than a million counts per second at room temperature, optically stable at ambient conditions, fully polarized and with a narrow zero photon line (ZPL). Furthermore, hBN is a wide bandgap material, which guarantees optical transparency in the visible and infrared spectral regions. These factors make this material an outstanding candidate for quantum nanophotonics with diverse promising applications.

Here, we present our research on integrated nanophotonics using hexagonal boron nitride. First, photonic crystal cavities that are entirely consisted of hBN is demonstrated, which is the first of its kind among van der Waals materials [2]. High-Q photonic cavities made of 2D materials enable increased in light-matter interaction which is promising for many nanophotonics applications including quantum photonics, optomechanics [3] and nonlinear optics. Next, we demonstrate room-temperature coupling of quantum emitters embedded in layered hexagonal boron nitride to an on-chip aluminum nitride waveguide. Our results serve as foundation for integrating layered materials to on-chip components and realizing integrated quantum photonic circuitry.

**References**

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