Efficient light collection from single-photon emitters in 2D materials

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Single-photon sources are crucial components for quantum networks and communications. Recently, single-photon sources in 2D materials have emerged as robust solid-state light emitters. For collecting and making use of single photons emitted from 2D materials, different strategies can be envisioned, whether the photons are needed on-chip or in free space.

We present waveguide-coupled single-photon emitters in the layered semiconductor GaSe as promising on-chip sources [1]. GaSe crystals are placed on Si_3N_4 waveguides, resulting in a modified mode structure, which is efficient for light coupling. Using optical excitation from within the waveguide, we find nonclassicality of the generated photons routed on a photonic chip. Thus, our work provides an easy-to-implement and robust platform for integrated photonic quantum technology.

For far-field collection, we present polymer microlenses, which are 3D-printed directly on single-photon emitters in commercially available hBN nanocrystals. First, a regular array of hBN nanocrystals is created using capillary assembly [2]. Subsequently, we 3D-print elliptical polymer microlenses onto the nanocrystals. The light emission is efficiently collimated to angles below 5° [3]. The small angle of emission of the new single-photon source allows for using collection lenses with very low numerical apertures including optical fibers.

In summary, we have demonstrated two methods to efficiently harvest single photons from 2D materials, rendering these single-photon sources highly promising for quantum optics and photonic quantum technologies

[1] P. Tonndorf et al., Nano Lett. **17**, 5446 (2017).
[2] J. Preuß et al., 2D Mat. **8**, 035005 (2021).
[3] J. Preuß et al., Nano Lett. **23**, 407 (2023).