Quantum emitters in hexagonal boron nitride

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The wide bandgap van der Waals material hexagonal boron nitride (hBN) has emerged as a promising host of ultra-bright, room-temperature quantum emitters [1]. Here, I will review progress that has been made in understanding the photophysical and chemical properties of these emitters, as well as functional properties that make the system appealing for a broad range of technologies [2-6]. I will also present recent demonstrations of coupling of the emitters to waveguides and resonators [7-9], a new super-resolution imaging method based on unique photodynamic properties of emitters in hBN [2], and fabrication techniques for engineering of both emitters in hBN and dielectric optical cavities made from hBN [10-12]. Quantum emitters in hBN are deep-trap defects that are photostable and maintain their photon purity even at temperatures as high as 800 K [4]. The defects are chemically stable, and can withstand prolonged, iterative annealing treatments in harsh chemical environments such as NH3, O2, and H2 atmospheres [5], and exhibit sufficient spectral stability to enable resonant excitation of the centers [3]. Moreover, the population dynamics of metastable states associated with the defects, and their blinking behavior can be manipulated using optical re-pumping techniques [2]. These properties, combined with the fact that boron nitride is a non-toxic material that can be chemically functionalized, make hBN monolayers, flakes and nanoparticles attractive for integrated on-chip nanophotonics and quantum information processing, as well as applications in sensing, drug delivery and super-resolution bioimaging.

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