

SYNTHESIS OF ROOM-TEMPERATURE SINGLE PHOTONEMITTERS IN HEXAGONAL BORON NITRIDE

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Quantum key distribution requires reliable on-demand, room-temperature single-photon emitters (SPEs) hosted in wide-bandgap materials. Hexagonal boron nitride (hBN) has emerged as a promising platform due to its excellent optical performance and compatibility with integrated photonic devices [1]. hBN is a two-dimensional material that hosts a diverse range of fluorescent quantum defects that may form intrinsically during material growth or can be deterministically engineered [2] [3]. Here, we synthesized defect-based SPEs in high-quality hBN flakes using controlled defect-engineering approaches combining ion implantation, focused laser irradiation, and high-temperature annealing. Spatially localized single-photon emitters with favorable optical properties, including high brightness and photostability are obtained. Under optimized fabrication and annealing conditions emission in visible to near-infrared spectral range is observed, demonstrating that precise control of annealing parameters is critical for reproducible emitter formation. The resulting SPEs are characterized using scanning confocal photoluminescence microscopy, time-resolved lifetime measurements, and second-order correlation (Hanbury Brown and Twiss) experiments to confirm single-photon emission. These results address key requirements for practical quantum key distribution sources and paving the way towards scalable and integrated quantum photonic devices.

[1] H. Z. J. Zeng et al., "Integrated room temperature single-photon source for quantum key distribution," vol. 47, no. 7, pp. 1673-1676, 2022.

[2] G. L. Liu et al., "Single photon emitters in hexagonal boron nitride fabricated by focused helium ion beam," vol. 12, no. 9, p. 2302083, 2024

[3] L. Gan et al., "Large-scale, high-yield laser fabrication of bright and pure single-photon emitters at room temperature in hexagonal boron nitride," vol. 16, no. 9, pp. 14254-14261, 2022.