

# Tailoring of the luminescence of hexagonal boron nitride (h-BN) using focused Helium ion beams

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Hexagonal boron nitride (h-BN) is a van der Waals crystal with a honeycomb structure similar to graphene has emerged as a prominent candidate for quantum nanophotonics. The quantum emitters in h-BN have been associated with mid-gap states in ultra-wide bandgap (6 eV) that originate from atomistic defects in the hBN lattice. It is challenging to tailor the point-of-care defects in h-BN without changing the atomic structure. The samples were prepared by micromechanical exfoliation and we observed a robust photoluminescence (PL) emission at 1.55 eV from 10 K to room temperature on thick flakes of h-BN under focused He<sup>+</sup> ion irradiation. The above PL emission activate an additional Raman mode at 1295 cm<sup>-1</sup>. The effect of -ion beam energy (8-30 keV) and the substrate indicate that end of range defects are responsible for the PL emission. We also demonstrate that similar results can be obtained by Ne, and Ga ion irradiation, confirming the PL emission to be related to intrinsic structural defects in h-BN. Raman spectroscopy and high-resolution scanning transmission electron microscopy imaging further confirm that the emerging PL response is correlated with point-defect states in h-BN. Our work presents a platform to precisely create and control defect-related color centers in hBN that can serve as a building blocks for next-generation nanophotonic and possible quantum devices.