Supporting Information

Site-specific fabrication of blue quantum emitters in hexagonal boron nitride

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The supplementary information includes:

Figure S1: Spectral calibration of spectrometers.
Figure S2: CL autocorrelation data of an SPE ensemble measured versus electron beam current.
Figure S3: SPE array and emitter saturation behaviour.
Figure S4: Autocorrelation characterization of the emitter array.

Three spectrometers were used in the work: one for CL (Andor Kymera 193i) measurement, denoted as “spectrometer A”. One for room temperature PL (Princeton Instruments) measurement, denoted as “spectrometer B”. And one for cryogenic PL (SR303I, Andor) measurement, denoted as “spectrometer C”. For calibration, a diode laser source (peak centred on 532.3 nm) was used. The laser peak profile measured using each spectrometer was fitted with a Voigt function. As is shown in Figure S1, the variance is within 3 nm. All spectra in this work were collected using a 300 l/mm grating. “Spectrometer A” was therefore used as the standard, and the other spectra were shifted accordingly. Specifically, the wavelength values were adjusted by +0.89 nm in room temperature PL spectra and by -2.2 nm in cryogenic PL spectra.
Figure S1. A diode laser source measured using spectrometers used in this work. All spectrometers employed a 300 lines/mm grating.

To demonstrate the expected CL bunching behaviour, we scanned a 5 keV electron beam over an area of 150 x 130 nm containing an ensemble of blue emitters as a function of electron beam current (Figure S2). The CL bunching shows a clear (expected) dependence on electron beam current – namely, the value of $g^{(2)}(0)$ decreases with increasing current.

Figure S2. Second-order CL autocorrelation data of an SPE ensemble measured using electron beam currents of 8.0 pA, 30 pA and 75 pA. A 5 keV electron beam was scanned over an area of 150 x 130 nm containing an SPE ensemble. The emission was filtered using a 460±30 nm band-pass filter.

Low electron beam dose irradiations were performed to create individual single photon emitters. An array of 4 x 3 spots was patterned. The irradiation time for each spot was 2 seconds, which corresponds to a dose of $1.2 \times 10^{10}$ electrons. Figure S3 shows a PL map of the 12 spot array. We note the presence of several other random bright spots in the map, which were also observed to be single photon emitters (which were either present in the flake prior to electron exposure, or generated unintentionally during SEM imaging). Hanbury Brown-Twiss measurements were carried out for each patterned emitter. The coincidence data were fitted with a three-level model:

$$g^{(2)}(\tau) = 1 - (1 + a)e^{\frac{-\tau}{\tau_1}} + ae^{\frac{-\tau}{\tau_2}}$$
where, \( a \) is amplitude, and \( \tau_1 \) and \( \tau_2 \) are lifetimes of the excited and metastable state, respectively. Without any background correction, all 12 spots show antibunching with \( g^{(2)}(0) \) values in the range of 0.2 to 0.8. Four of the 12 spots are confirmed as single photon emitters (\( g^{(2)}(0) < 0.5 \)). The corresponding experimental data and fits are shown in Figure S4.

The saturation behaviour of a representative SPE is shown in Figure S3c. The power dependent emission rate (APD counts per second) has been fitted to the equation \( I = I_{\text{inf}} \frac{P}{P_{\text{sat}} + P} \), where \( I_{\text{inf}} \) and \( P_{\text{sat}} \) are the saturation rate and power, extracted to be 424,200 cps and 2.6 mW, respectively.

**Figure S3.** Single photon emitters fabricated using a low electron dose of \( 1.2 \times 10^{10} \) electrons. (a) PL map of a 4 x 3 emitter array. The spot locations are marked with circles for clarity. Intensities are plotted as photon counts per second. (b) Histogram of \( g^{(2)}(0) \) values of the 12 spots in (a). Note that background correction was not employed. The autocorrelation curves are shown in Figure S4. (c) Saturation curve of a representative single photon emitter.

**Figure S4.** Second-order autocorrelation function of the 12 spots shown in Figure S3.