Deterministic generation of single B centers in hBN by one-to-one conversion from UV centers

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The control of the position and wavelength of high-quality quantum emitters is crucial for the implementation of a top-down approach in solid-state quantum technologies. In this context, 2D materials such as hexagonal boron nitride (hBN) offer new opportunities in the field, with specific integration techniques at the ultimate scale of single atomic layers.
We have recently demonstrated the local generation of quantum emitters ("B-centers") with reproducible wavelength and high quality photophysics in the visible range [1], which are generated by local irradiation in a scanning electron microscope (fig. 1a). However, in the absence of a real-time monitoring technique, the activation process is stochastic regarding the number of emitters.
To overcome this limitation, we exploit the fact that B-centers exhibit cathodoluminescence (CL) under irradiation conditions compatible with their generation [2]. We implement an in-situ monitoring setup, sensitive to the CL of individual emitters, which allows us to observe the generation of B-centers in real time at the individual scale (fig. 1b) [3]. We show that their creation is spatially and temporally correlated with the deactivation of individual UV centers emitting at 4.1 eV, providing important information about their atomic structure.
We then use the CL signal to herald the successful creation of individual emitters, allowing deterministic generation of single emitter arrays (fig. 1c). The controlled generation of quantum emitters in a 2D material opens exciting prospects in quantum photonics with applications to optical quantum technologies.

References

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Figures

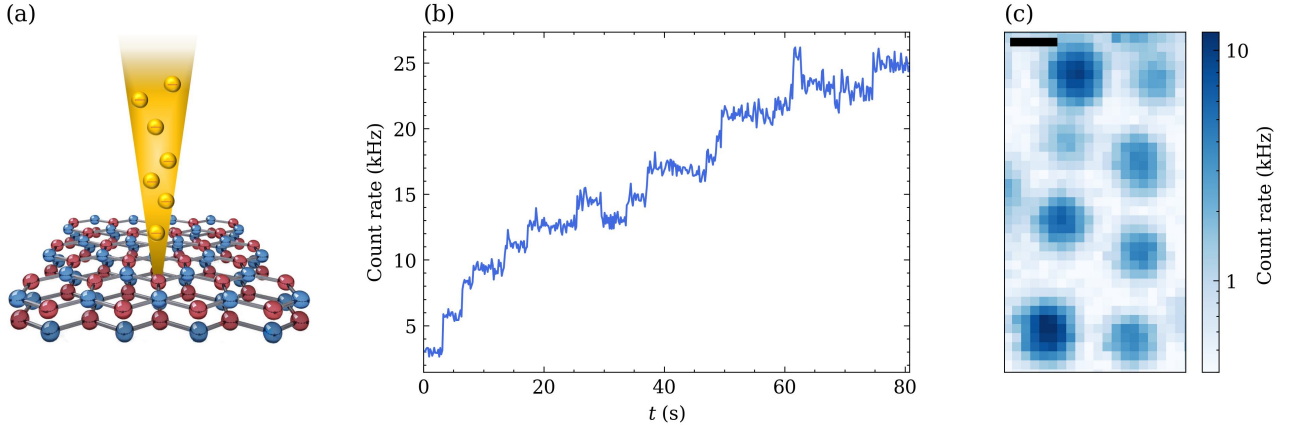

Figure 1: (a) Representation of electron irradiation in a hBN flake (b) Representative CL timetrace measured during a continuous irradiation of a fixed location on a 130 nm flake with I = 0.021 nA (c) PL map of a 4 x 2 array of B centers activated in a 50 nm thick flake. The scale bar indicates 500 nm.