Single photon emitters in hexagonal boron nitride for scalable quantum photonics

C. Fournier[1], A. Plaud[1,2], S. Roux[1,2], A. Pierret[3], M. Rosticher[3], S. Buil[1], X. Quélin[1], J. Barjon[1], J.-P. Hermier[1], A. Delteil[1]

[1] Université Paris-Saclay, UVSQ, CNRS, GEMaC, 78000, Versailles, France
[2] Laboratoire d'étude des microstructures - LEM, UMR 104, CNRS-ONERA, Université Paris-Saclay
[3] LPENS - Laboratoire de physique de l'ENS - ENS Paris

In the context of photonic quantum information science, hexagonal boron nitride (hBN) has recently emerged as a very promising material. The bidimensional character of hBN renders it attractive for the realisation of compact heterostructures and integrated photonic devices. Moreover, this wide-gap material has been recently shown to host single photon emitters (SPEs) with appealing optical properties in the red and near infrared regions [1]. However, these deep defects suffer from the wide distribution of their emission wavelength and, in most cases, a random spatial location [2,3]. These limitations hinder the scalability of the system for applications.

Here we demonstrate a new approach towards deterministic positioning of SPEs with similar emission wavelengths, based on irradiation with an electron beam [4]. The SPEs are locally activated in exfoliated hBN flakes using a focused electron beam and subsequently characterised using microphotoluminescence (fig. 1). They exhibit narrow linewidth at low temperature (below the ~ 100 µeV resolution of the spectrometer) and a drastically reduced ensemble distribution of their emission wavelength ($\Delta\lambda < 1$ nm). Individual emitters display low $g^{(2)}(0)$ as well as high and stable count rates. Moreover, emission is observed up to room temperature.

Our results suggest new avenues towards top-down realisation of integrated quantum optical devices based on indistinguishable single photon sources in hBN.

References

[1] T. Tran *et al*., Nature Nanotech. **11**, 37 (2015).
[2] N.R. Jungwirth *et al*., Nano Lett. **16**, 6052 (2016).
[3] N. Chejanovsky *et al*., Nano Lett. **16**, 7037 (2016).
[4] C. Fournier *et al*., Nature Commun. **12**, 3779 (2021).

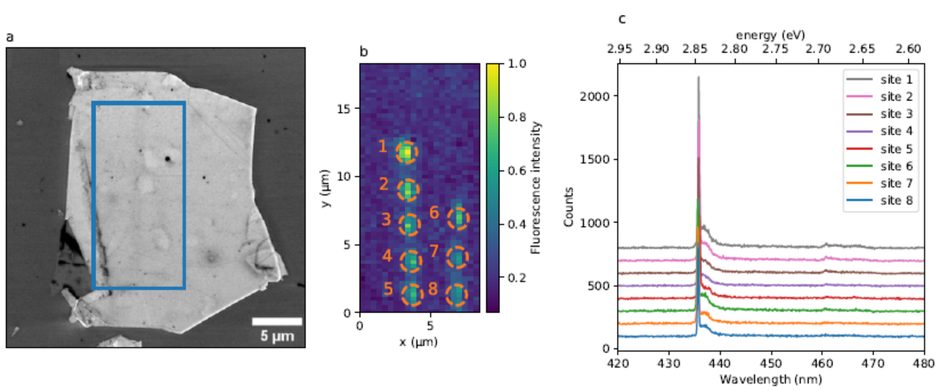

Fig. 1: hBN flake with eight irradiation sites and corresponding confocal map and spectra, displaying reduced statistical dispersion of the emission wavelength.

corresponding author: aymeric.delteil@uvsq.fr