Defect assignment of hexagonal boron nitride quantum emitters in nanoflakes

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In this work, we present the optical characterization of hexagonal boron nitride (hBN) nanoflakes with the aim of advancing their use in quantum radiometry. Quantum-based radiometric applications require stable single-photon sources with a narrow spectral bandwidth and high photon flux. Point defects in hBN are promising candidates in this regard; however, their practical implementation is limited by unpredictable instability. Strong temporal fluctuations in emission intensity ("blinking") as well as irreversible bleaching significantly complicate both reliable characterization and subsequent application.

A detailed understanding of the microscopic origin of the emitting point defects is therefore essential in order to identify the conditions under which such fluctuations occur and to develop strategies to circumvent them. To address this, we performed a systematic optical study of emitters in commercial hBN nanoflakes (1–5 monolayers) drop-cast onto silicon substrates with different post-processing treatments [1].

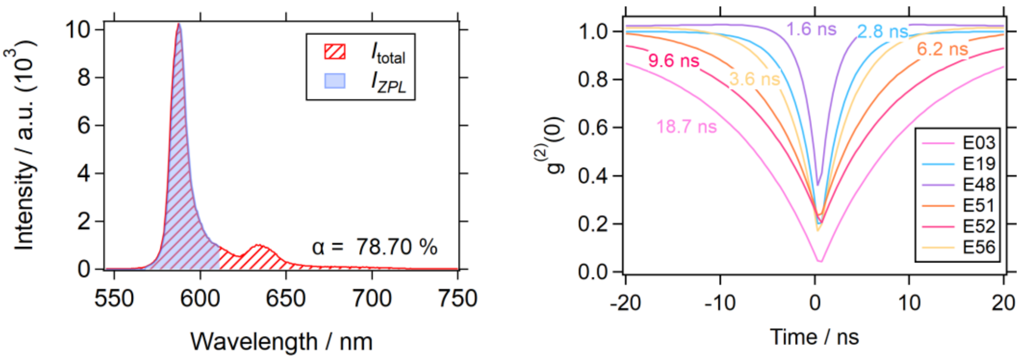

Fig. 1: *(Left) : Spectrum with Debye-Waller calculation for a single-photon emitter in hBN. The blue shaded area (I_{ZPL}) shows the area under the zero-phonon line in contrast to the whole area (I_{Total} , shaded red). (Right) : Fit for the second-order correlation function for different SPEs with their corresponding excited-state lifetimes indicated by color.*

Parameters such as the zero-phonon line (ZPL) position, Debye–Waller factor (DW), excited-state lifetime, photon flux, and single-photon purity are measured and used to determine possible defect configurations (see Fig. 1). We identify three possible defect candidates consistent with our measurements through comparison with the hBN defect database [2]. The defects $C_NV_B^-$, C_2V_B and C_2C_2-3 show values most consistent with the experimentally obtained data (see Table 1).

Table 1 : *Comparison of ZPL position, lifetime and DW factor of the experimental average with three defects.*

Defect	ZPL position	Lifetime	DW factor
$C_NV_B^-$	608 nm	35 ns	0.03
C_2V_B	641 nm	14 ns	0.41
C_2C_2-3	564 nm	17 ns	0.33
Exp. average	580 nm	6 ns	0.64

References

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