Resonance fluorescence from a single quantum dot in a nanopost optical cavity

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On-demand single photon sources are key devices for photonic quantum technologies. Among various approaches, semiconductor quantum dots embedded in a tailored photonic environment offer remarkable performance. However, photonic structures that combine Purcell acceleration with broadband operation are relatively scarce.

In this talk, I will present the nanopost optical cavity: a photonic nanostructure that provides a significant Purcell enhancement of QDs spontaneous emission (up to 7 at resonance) over a broad range of wavelengths (30 nm FWHM) [1,2]. We studied a single QD under CW resonant excitation. Even though the nanost introduces a significant optical roughness at the scale of the focused laser spot, a cross-polarisation scheme leads to an excellent rejection of the reflected laser (up to 10^6). We characterized the QD emission characteristics via linescans and intensity autocorrelation measurements. The emission statistics features an excellent antibunching ($g^{(2)}(0) < 0.02$), and we demonstrate that the homogeneous linewidth of our QD (650 MHz) is only 1.4 times broader than the Fourier-transform limit [3]. I will finally talk about the characterization of residual charge noise present in the device, both in terms of amplitude and of timescales, relying on these experimental data and on an analytical model.

Together with future device improvements, these results pave the way towards the realization of a broadly tunable source of highly coherent single photons.

References

[1] S. Kotal et al., "A nanowire optical nanocavity for broadband enhancement of spontaneous emission", APL 0003-6951 (2021), 194002.

[2] M. A; Jacobsen et al., "Performance of the nanopost single-photon source: beyond the single-mode model", Nanoscale 15 (2023), 6156-6169.

[3] M. Gaignard et al., "Resonance fluorescence from a single quantum dot in a nanopost optical cavity" (to be submitted).

Figure

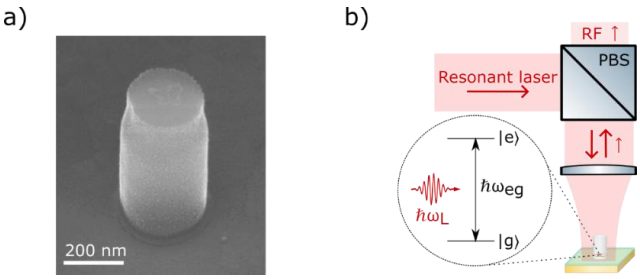

Figure 1: a) Scanning electron micrograph (tilted view) of a representative device. **b)** Schematics of the resonant excitation of a single quantum dot embedded in a nanopost cavity, with the simplified cross-polarisation setup.