Telecom O-band quantum dots in an open access fiber-based microcavity

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Semiconductor single photon sources are fundamental building blocks for quantum information applications. The current limitations of such quantum dot sources are the emitting wavelength and insufficient collection efficiency in fiber-based implementations. For low optical attenuation in quantum network applications, it is favourable to get single photons at telecom wavelengths. Here, we present a comprehensive study of semiconductor quantum dots (QDs), emitting in the telecom O-band [1], integrated in an open fiber-cavity [2]. We utilize the full tunability in all spatial dimension to investigate the lifetime shortening of spatially and spectrally varying samples. The outstanding emitter performances of semiconductor QDs, in terms of brightness, indistinguishability and single-photon purity, have been shown on the open cavity platform for near infrared wavelengths [3]. However, our cavity's inherent fiber coupling holds promise for enhancing these properties further and allowing an application-oriented use case as fiber-pigtailed single photon source [4]. For a full description of our platform, we did a thorough theoretical description comprising different cavity-emitter regimes and the influence of vibrational noise. We show that the current limitations of our platform are (in descending order of importance) the natural linewidth of the emitter, the surface roughness and surface defects of the advanced MOVPE growth of the QDs and the vibrational noise of the system.

References

[1] Matthias Paul et al., Appl. Phys. Lett. 106 (2015), 122105
[2] David Hunger et al., New J. Phys. 12 (2010) 065038
[3] Natasha Tomm et al., Nature Nanotechnology volume 16 (2021), pages 399–403
[4] Alexander Schlehahn, Scientific Reports volume 8 (2018), Article number: 1340

Figures

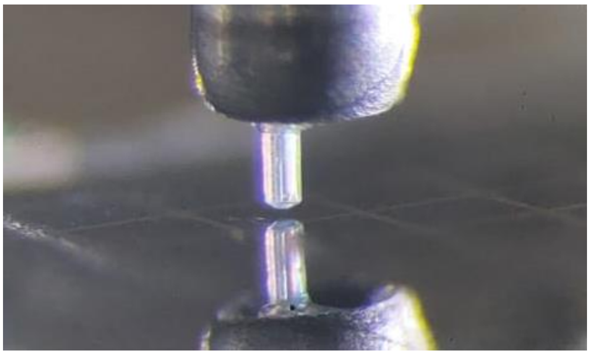

Figure 1: Image of the setup. The fiber (top) is held above the semiconductor sample and mirrored in the surface (bottom). The semiconductor and fiber tip form the cavity.

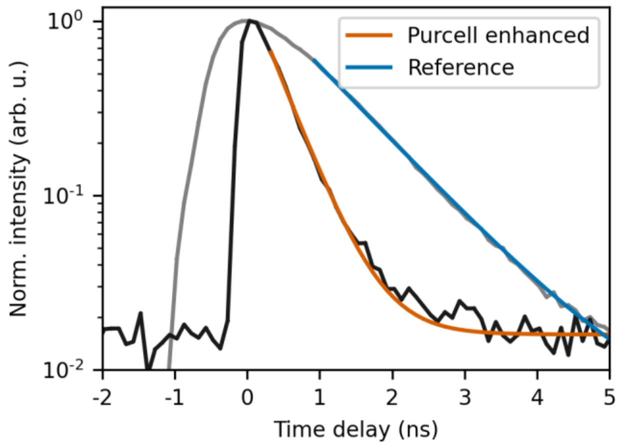

Figure 2: Time-resolved single-photon counting and lifetime shortening inside the fiber-based microcavity. The decay time is shortened by a factor of 2.45.