Room-temperature single-photon emitter in the blue-green spectral range using a CdSe/ZnSe nanowire quantum dot

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Single-photon sources are key components for communication ultra-secured by quantum physics laws. In this contribution, we present a promising solid-state system able to emit triggered single-photons at room temperature in the blue-green range. This spectral band allows quantum communications both in free space and underwater.
The active element is a CdSe quantum dot (QD) embedded in a bottom-up core-shell ZnSe nanowire (NW) grown by molecular beam epitaxy. The NW shell acts as a waveguide and confines the fundamental optical mode HE11, channelling the photons emitted by the QD along the NW axis. We present a thorough study of a single nanowire using a whole range of characterization thanks to markers made on the growth substrate. The studied NWQD has a base diameter of 140 nm and a length of 5 µm (Fig. a). The conical ending adiabatically expands the guided mode and reduces the divergence angle, thus increasing the collection efficiency [1]. This is confirmed by the far-field diagram (Fig. b) collected along the NWQD axis (Fig. a) where a Gaussian mode profile with small divergence angle is observed. Photo-correlation measurements on the excitonic lines show anti-bunching with $g^{(2)}(0)$ value down to 0.3 (Fig. c) [2]. Complementary measurements done at cryogenic temperature have helped to understand the phenomena that degrade the single-photon purity at room temperature. We found that the single-photon emitter shows a promising brightness with a potential emission rate of 13 MHz with a 76 MHz excitation rate. This work paves the way for development of on-chip single-photon sources operating at non-cryogenic temperatures.

[1] N. Gregersen et al., Optics Letters, 33 1693 (2008)
[2] F. Granger et al., *Brightness and purity of a room-temperature single-photon source in the blue-green range*, 2023, ⟨hal-04034474⟩.

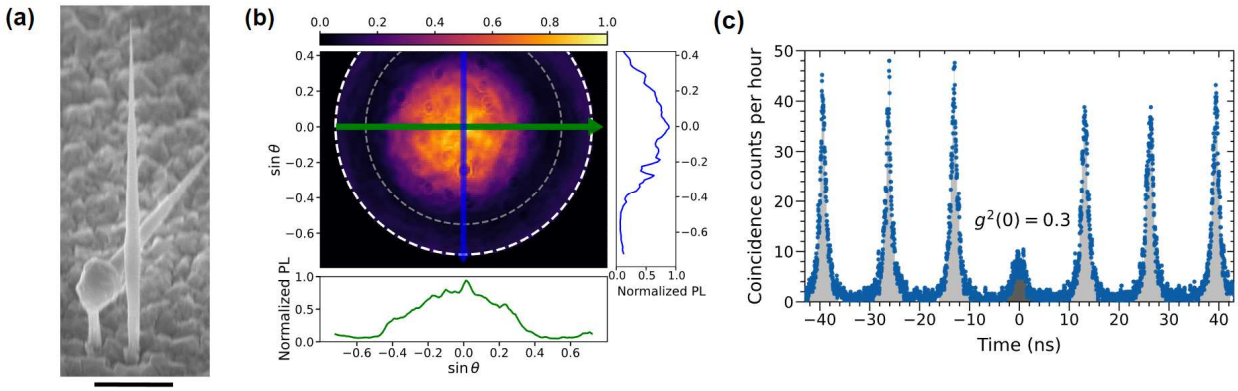

Figure : (a) SEM image of a vertical and tapered ZnSe NW embedding a CdSe QD; (b) Radiation pattern of the QD-NW displayed in (a) through a microscope aperture of NA=0.72; (c) autocorrelation histogram of the NWQD at 300K with a $g^{(2)}(0)$ value of 0.3.