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EFFICIENT AND BROADBAND CONTROL OF THE SPONTANEOUS EMISSION IN PHOTONIC NANOWIRES

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Photonic nanowires (PWs) are simple dielectric structures for which a very efficient and broadband spontaneous emission (SE) control has been predicted [1]. Recently, a single photon source featuring a record high efficiency was demonstrated using this geometry [2]. Using time-resolved micro-photoluminescence, we investigate directly the SE of single InAs QDs embedded in GaAs PWs and demonstrate performances that fully confirm the theoretical predictions [3]. In addition, we discuss very recent results obtained on elliptical wires that ensure an efficient control of the photon polarization [4].

We first consider cylindrical PWs, defined within a top-down fabrication process. For diameters leading to the optimal confinement of the fundamental guided mode HE_{11} ($d/\lambda \sim 0.25$, $\lambda \sim 950$nm), the coupling to HE_{11} (2-time polarization degenerated) dominates the SE process and a maximum enhancement of the SE rate by a factor of 1.5 is reached (see Fig 1(a)). When the diameter is decreased by 100nm, the guided mode is completely deconfined. The coupling to this mode vanishes, thus allowing the coupling to the other radiation modes to be probed [3]. In these conditions, a SE inhibition factor of 16, equivalent to the one obtained in state-of-the-art 2D photonic crystals, is measured.

Moreover, a PW featuring an elliptical section (Fig. 1(b)) provides a very efficient control over the polarization of the emitted photon. In that case, only one guided mode, with a linear polarization oriented along the major axis, is confined in the semiconductor. Polarization-resolved experiments show that the coupling to this single mode can exceed 95% for optimum structures (Fig. 1(c)) [4]. These results confirm the high potential of PWs for the realization of efficient sources of quantum light.

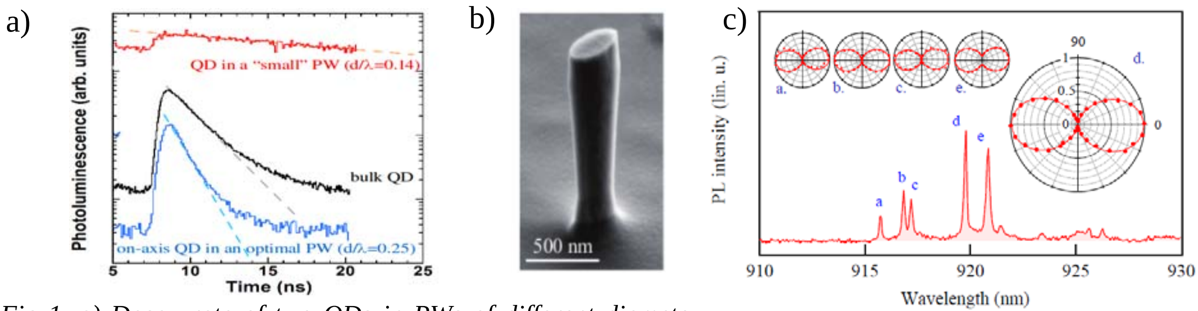

Fig 1. a) Decay rate of two QDs in PWs of different diameters, compared with the bulk situation. b) SEM picture of an elliptical PW with a major to minor-axis diameter ratio of 2. c) Normalized intensity of single QD as a function of the polarization angle for five different transitions in a single PW oriented along the 0° axis.

References

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