Quantum optics in photonic wires: Basics and application to "ultrabright" single-photon sources

J.M. Gérard

Institute for Nanosciences and Cryogeny CEA Grenoble, FRANCE

e-mail: jean-michel.gerard@cea.fr

Over the last 20 years, major efforts have been devoted to the tailoring of the optical properties of semiconductor emitters using optical microcavities and photonic crystals.

We have recently introduced photonic wires as a novel resource for solid-state CQED. I will review recent studies which demonstrate an excellent control over the spontaneous emission of InAs quantum dots (QDs) embedded in single-mode GaAs photonic wires.

On the basic side, we have demonstrated a strong inhibition (x 1/16 [1]) of QD SpE in thin wires ($d<\lambda/2n$) and a nearly perfect coupling of the SpE to the guided mode ($\beta>0.95$ for $d\sim\lambda/n$) in circular photonic wires [2]. The polarization of QD SpE can also be tailored by playing with the shape of the cross section of the photonic wire. For elliptical cross sections, a strong (>90%) linear polarization oriented along the long axis of the ellipse is observed [3].

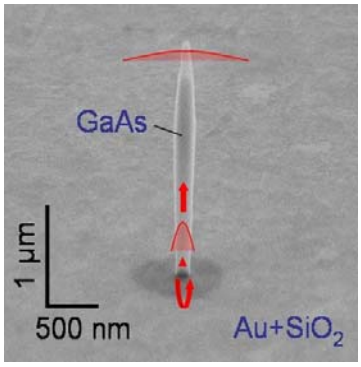

Fig.1. Electron micrograph of a photonic nanowire QD single-photon source

A single QD in a photonic wire is thus an attractive system to explore the physics of the "one-dimensional atom" and build novel quantum optoelectronic devices. Quite amazingly, this approach has for instance permitted (*unlike* microcavity-based approaches) to demonstrate jointly for the first time in a QD single photon source a record-high efficiency (72%) and a high purity of the single photon emission process ($g^{(2)}(0) < 0.01$) [4].

This work has been done in collaboration with J Claudon, J Bleuse, M Munsch, NS Malik, P Jaffrennou (CEA Grenoble), N Gregersen, Y Chen and J Moerk (DTU Fotonik, Copenhagen), P Lalanne (Institut d'Optique, Palaiseau).

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