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Ultra-low power all-optical switch using a single quantum dot embedded in a photonic wire

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We present experimental results on two-mode optical giant non-linearity of a single InAs quantum dot (QD) embedded in a GaAs tapered photonic wire (fig. 1a). This system, in which the QD is efficiently coupled to a single guided mode, has been exploited to realize ultrabright single-photon sources [1,2]. We exploit here its broad operation bandwidth (>100 nm around 950 nm) to efficiently address two different transitions of the QD with two different laser beams (fig. 1b) to implement a two-color giant non-linearity: a weak probe laser coupled to the upper transition has its reflectivity controlled by a few photons of the control laser.

By performing a reflectivity experiment, we show that a control laser of 10 nW (50 photons per emitter lifetime) can modify the transmission of the probe laser, realizing an ultra-low power all-optical switch (fig. 1c).

[1] J. Claudon et al, "A highly efficient single-photon source based on a quantum dot in a photonic nanowire", Nat. Phot. 4, 174 (2010)

[2] M. Munsch et al, "Dielectric GaAs Antenna Ensuring an Efficient Broadband Coupling between an InAs Quantum Dot and a Gaussian Optical Beam", Phys. Rev. Lett. 110, 177402 (2013).

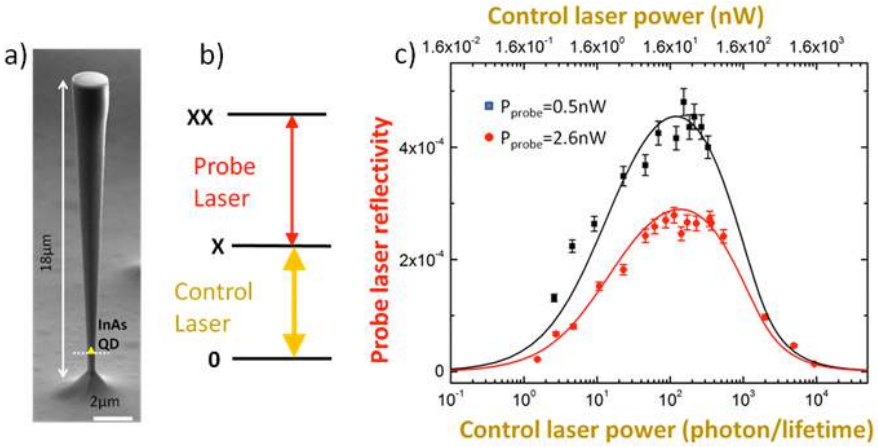

Figure 1. *(a) Scanning electron microscope image of a trumpet like photonic wire. (b) Energy scheme for a quantum dot three-level system with the control and probe laser respectively on resonance with the excitonic (0-X) and biexcitonic (X-XX) transitions. (c) The reflectivity of the probe laser depends on the control laser power. The probe reflectivity can be turned on by an ultra-low control laser power (10 photons/lifetime~2nW).*

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