



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

Nguyen, H.A.; Grange, T.; Malik, N.S.; Dupuy, E.; Tumanov, D.; de Assis, P. L.; Yeo, I. ; Fratini, F. ; Gregersen, Niels; Auffeves, A.; Gerard, J.M.; Claudon, J.

*Publication date:*  
2016

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*  
Nguyen, H. A., Grange, T., Malik, N. S., Dupuy, E., Tumanov, D., de Assis, P. L., ... Claudon, J. (2016). Ultra-low power all-optical switch using a single quantum dot embedded in a photonic wire. Abstract from Wilhelm und Else Heraeus-Seminar, Bad Honnef , Germany.

## DTU Library

Technical Information Center of Denmark

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

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

H.A. Nguyen<sup>1</sup>, T. Grange<sup>1</sup>, N.S. Malik<sup>2</sup>, E. Dupuy<sup>2</sup>, D. Tumanov<sup>1</sup>, P.L. de Assis<sup>1</sup>, I. Yeo<sup>1,2</sup>,  
F. Fratini<sup>3</sup>, N. Gregersen<sup>4</sup>, A. Auffèves<sup>1</sup>, J.M. Gérard<sup>2</sup>, J. Claudon<sup>2</sup>, J.P. Poizat<sup>1</sup>

<sup>1</sup> Equipe « Nanophysique et semi-conducteurs », Institut Néel, CNRS, Université Grenoble Alpes,

<sup>2</sup> Equipe « Nanophysique et semi-conducteurs », INAC, CEA Grenoble,

<sup>3</sup> Atominstytut, Technische Universität Wien, Austria

<sup>4</sup> Department of Photonics Engineering, DTU Fotonik, Kongens Lyngby, Denmark

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 cw laser beams (fig. 1b). The laser coupled to the upper transition leads to a Rabi splitting of the intermediate state (Autler-Townes effect), affecting the resonant reflectivity of the laser coupled to the lower transition (see fig. 1c).

By performing reflectivity experiment, we show that a coupling 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.

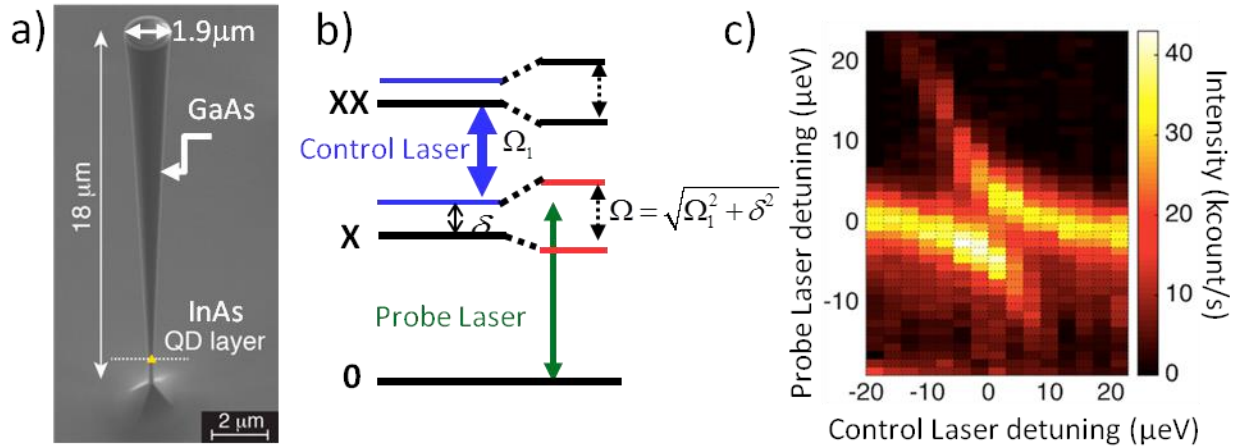


Figure 1. (a) Scanning electron microscope image of a trumpet like photonic wire. (b) Energy scheme for a quantum dot three-level system with two lasers on resonance with two transitions. Here, on the exciton level, we observed the fine structure splitting (FSS). When the coupling laser is on resonance with the state  $X_v$ , two new dressed states are formed. The FSS is large so that we can neglect the influence of the coupling laser on the state  $X_H$ . (c) Color plot of the reflection intensity as a function of the probe laser detuning  $\Delta_p$  (horizontal axis) and coupling laser detuning  $\Delta_c$  (vertical axis). For  $\Delta_c=0$ , the splitting experienced by the probe laser is equal to the Rabi frequency of the coupling laser.

[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).