Single photon sources based on quantum dot semiconductor nanowires

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Stage pouvant se poursuivre en thèse : Oui

Résumé :

Single-photon sources are key devices for emerging quantum technologies. They are a necessary building block for quantum-secure communication networks and for photonic quantum computing. In addition, a bright single-photon emitter has also potential applications in light flux metrology, as a new standard of luminous intensity (the so-called "quantum candela"). Despite an intense research effort, the community still lacks an efficient and reliable single-photon emitter operating in the telecom windows (centered between 1.3µm and 1.5µm). Most promising candidates are based on artificial atoms such as fluorescent atomic defects or quantum dots. In particular, semiconductor quantum dots are stable emitters that can be integrated on chip. Defining a quantum dot in a nanowire is very promising, as the light extraction efficiency reaches 90% and the quantum dot morphology can be controlled to the nanometer scale by fine tuning the growth parameters [1]. In our team, we focus on the fabrication and optical characterization of InGaAs quantum dots integrated in GaAs nanowires using the vapour liquid solid mechanism. We lately demonstrated that we can grow axial GaAs/InGaAs heterostructures in a nanowire without creating any crystalline defects [2].

[1] J Claudon et al 2010 Nature Photonics 4(3) 174
[2] D V Beznasyuk et al 2017 Nanotechnology 28 365602

Sujet détaillé :

In this project, the student will (1) grow quantum dot nanowires based on III-V compound semiconductors by molecular beam epitaxy reactor in CEA. The nanowires will be fabricated from Au nanoparticles ordered within a pattern designed by electron beam lithography in the cleanroom facility of Institut Néel. The nanowires will be studied by electron microscopy at the Advanced Nanocharacterization Platform in CEA. She/he will also (2) study the optical properties of these nanowires using micro photoluminescence at cryogenic temperatures.

Possible collaboration and networking:
CEA-INAC Grenoble (J. Claudon, J. Bleuze)
ILM Lyon (P. Verlot)
Philips Eindhoven (M. Verheijen)

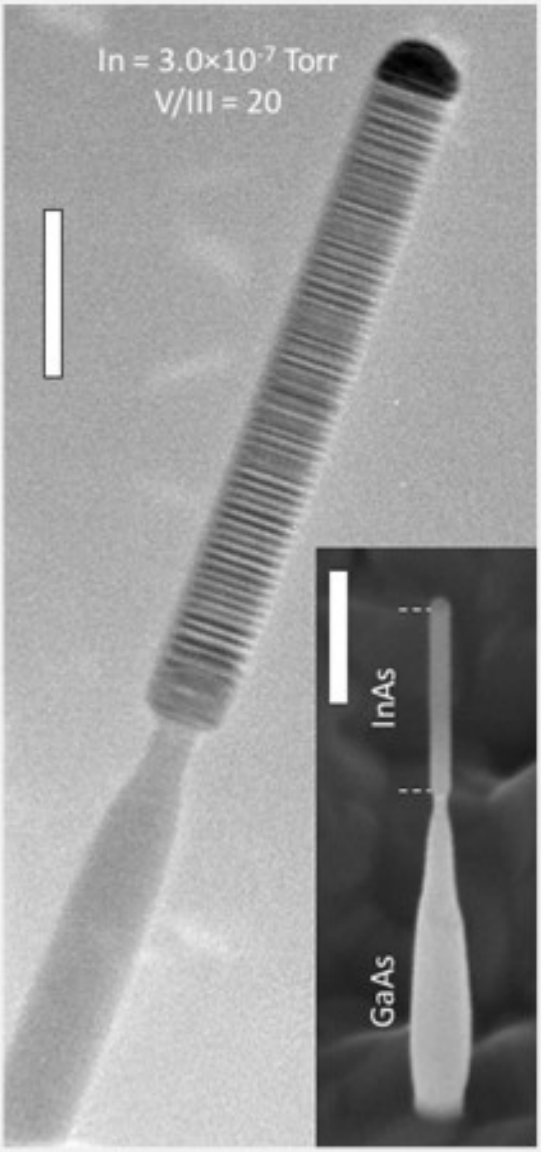

Image of an InAs-on-GaAs nanowire taken by transmission electron microscope (scale bar 100 nm). The dark droplet at the top is the gold catalyst. Inset: image of a standing nanowire from the same sample taken by scanning electron micrograph (scale bar 200 nm, 30° tilt).

Compétences requises :

Motivated experimentalist

Programming