Control of the emission of semiconducting nanowires using plasmonic nanoantennas

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PHD GRANT

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Semiconducting nanowires (NWs) offer the possibility to fabricate extremely high quality light-emitting structures for a wide range of applications, ranging from photovoltaics and optoelectronic displays to solid-state based sources of quantum light. However, because of their small size, studying and engineering their optical properties is a challenging task. Metallic nanostructures, on the other hand, provide the ability to control electromagnetic fields at length scales well below the wavelength. The main goal of this project is the control and enhancement of the emission properties of semiconductor quantum dots (QDs) inserted in NWs by modifying their dielectric environment using nano-antennas. For this purpose, we first developed a set of nanocharacterization techniques to correlate various measurements on the one and same NW, allowing a full characterization of its optical and electronic properties. We then implemented a novel nanofabrication technique to couple single QDs embedded in semiconducting NWs to metallic nanostructures. The resulting coupled systems show up to a twofold enhancement of their light emission properties.

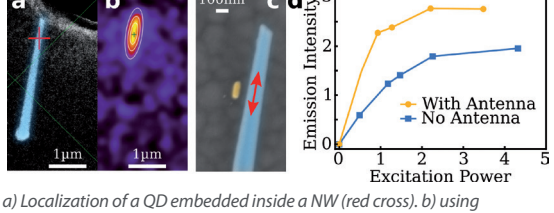

Fig. 1: a) Localization of a QD embedded inside a NW (red cross). b) using cathodoluminescence. (c) Hybrid system with antenna. (d) Enhanced luminescence.

OUTCOMES

[1] Deterministic radiative coupling between nanowire quantum dots and plasmonic nanoantennas, Nanotechnology 27, 185201 (2016).

[2] Optimized Wave-mixing in single and compact aluminium nanoantennas, ACS Photonics 3, 1840 (2016).

[3] Light-hole exciton in semiconducting nanowire quantum dot, Phys. Rev. B 95, 035305 (2017), editor's choice.

[4] Cathodoluminescence spectroscopy of patch plasmonic antennas: towards lower order and higher energies, Opt. Express 25, 5488 (2017).

[5] Enhanced photon extraction from a nanowire quantum dot using a bottom-up photonic shell, Phys. Rev. Appl. 8, 054022 (2017).

Oral presentation: JMC14MCD25, Paris, France, 2014

Collaborations: Alberto Artioli, Joël Cibert, David Ferrand, Guillaume Bachelier, NEEL. Yanxia Hou-Broutin, INAC.

Awards: Best poster award, Nanowires2015, Barcelona, Spain, 2015
Best poster Award, QCD2016, Jeju, South Korea, 2016
PhD award from the Nanoscience Foundation
Leverage: CEA DRF-Impulsion project Hybridimer.