SCIENCES SORBONNE UNIVERSITÉ

2024-2025

Master thesis proposal

INSP INSTITUT DES NANOSCIENCES DE PARIS

Campus Pierre et Marie Curie
Tower 23 – 3rd floor – 23-22
Director: Massimiliano Marangolo

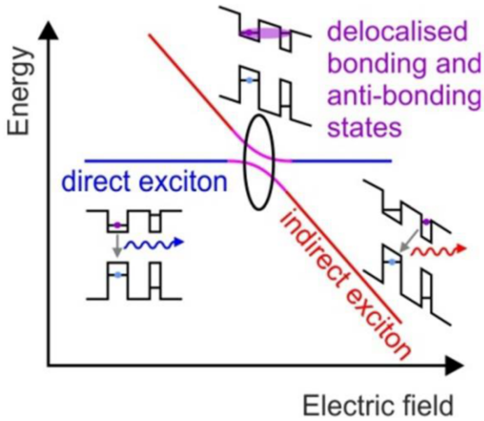
Title: Developing charge-tunable coupled quantum dot devices for quantum computation

Keywords: Epitaxy, QDs, Photoluminescence.

Scientific description:

Self-assembled quantum dots – clusters of hundreds of atoms that form spontaneously under certain thin film growth conditions – are ideal for quantum information applications due to their discrete, atom-like density of states and ease of integration into conventional semiconductor devices. Coupled quantum dots, or so-called quantum dot molecules, where two dots are close enough that carriers can tunnel coherently between them have even greater potential: as the quantum gate needed for quantum computation.

For this to be possible, the size of each dot in the molecule needs to be precisely controlled and embedded in a suitable designed diode structure. When an electric field is applied across the dots, the energy levels of the two dots can be brought into resonance, thereby creating new electron states which are delocalised across the two dots. In addition, the field can also be used to control the number of electrons in this delocalised state – which is needed to create molecular spin states with long coherence time.



In this project we will study the effect of growth conditions and surface morphology on the kinetics of atom migration and incorporation during growth to optimise the coupled quantum-dot device structure. The charge state and the coupling between the two dots, which can be visualised as an energetic anticrossing of the excitonic emission lines, will be studied using photoluminescence measurements.

The student will have the opportunity to participate in all the stages of development of a new quantum device: from device design, thin film growth and device fabrication, to the final low temperature photoluminescence measurements of quantum confinement effects.

Techniques/methods in use: molecular beam epitaxy, atomic force microscopy, device lithography, low-temperature photoluminescence microscopy

Applicant skills: interest in crystal growth and device fabrication, basic knowledge of semiconductor devices and quantum mechanics, some experience in optical measurements

Industrial partnership: N

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Internship location: Institut des NanoSciences de Paris, tour 22, campus Jussieu

Possibility for a Doctoral thesis: Y