iemn
Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Master and Engineer Internship: 2021-2022

Proposed by : Ludovic Desplanque, Pierre Capiod, B.Grandidier Phone number : 0320197861

E-mail : Ludovic.desplanque@univ-lille.fr Research group : EPIPHY/PHYSICS

Title : Selective area epitaxy and near-field characterization of III-V nanostructures for quantum simulators

Abstract :

Quantum simulators are physical systems that can map complex physics problems like correlated systems, ferromagnetism or topological phases. Operating III-V semiconductor with low electron effective mass at the nanoscale to form coupled quantum dots could be of prime interest for the fabrication of quantum simulators based on the coupling of artificial atoms. Up to now, this kind of system essentially relies on cold atoms with focused lasers [1], trapped ions [2], superconducting qubits [3] or quantum dots [4]. By carefully selecting the position of the artificial atoms (and therefore the geometry), band engineering can be realized and could lead to exotic band structures and systems such as topological insulators (TIs). TIs are good candidate for quantum computation applications as their electronic properties are robust against disorder.

Since a few years, selective area molecular beam epitaxy has been developed at IEMN to fabricate lithographically designed in-plane nanowires of low electron effective mass III-V semiconductors (InGaAs, InAs, InSb) [6-7]. This method consists in growing the semiconductor inside the nanoscale openings of a dielectric mask deposited on a substrate. Thanks to electron beam lithography, dimensions as low as a few tens of nanometers can be reached contemplating the fabrication of coupled quantum dot systems.

In the frame of the Master internship, the student will participate to the nanostructure fabrication and to the investigation of their electronic properties using near field microscopy under the supervision of L.Desplanque, B.Grandidier and Pierre Capiod.

In case of mutual satisfaction, this work could be extended to a PhD thesis for which the financial support is already ensured within an accepted ANR project.

[1] I. Bloch et al. Nat. Phys.,8(4):267–276, 2012.
[2] R. Blatt et al. Nat. Phys., 8(4):277–284, 2012.
[3] A. A. Houck et al. Nat. Phys.,8(4):292–299, 2012.
[4] P. Barthelemy et al. An. der Phys., 525(10-11):808–826, 2013
[5] M. Fahed et al. Nanotechnology 27, 505301 (2016)
[6] Bucamp et al. Nano Res. 13, 61–66 (2020)
[7] L.Desplanque et al. Nanotechnology 29, 305705 (2018).