- Axe de GANEX : 2
- Titre du sujet : GaN/AlGaN nanowires for quantum devices
- Nature de la thèse : *Partagée académique : GANEX 100%, laboratoires bénéficiaires et taux de partage : INAC (Eva MONROY) / NEEL (Martien DEN HERTOG)* (Financement 60% GANEX / 40% CEA)
- Date souhaitée de démarrage : 01/09/2015
- Lien avec un projet ANR ou H2020 : Partial link with an H2020 proposal. Partial link with ANR JCJC project COSMOS
- Lien avec un autre partenaire de GANEX : *IEF (Sébastien SAUVAGE)*
- Sujet développé :

Context: GaN nanowire (NW) heterostructures are model materials for the study of quantum phenomena (single photon emission, intersubband (ISB) transitions, resonant tunneling transport), since the presence of stacking faults or extended defects can be limited to the first hundred nanometers close to the substrate.[1] The feasibility of electron transport via quantized levels in the conduction band of GaN/AlN heterostructured NWs was demonstrated by the fabrication of resonant tunneling diodes.[2] Furthermore, the capability of externally tuning the internal electric field in a quantum dot in a NW has been recently demonstrated,[3] and the observation of ISB transitions in GaN/AlN NW heterostructures has been recently reported.[4]

Objectives and available means: The student will work on the fabrication and characterization of GaN/AlGaN NW heterostructures (single nanodisk insertions, nanodisk superlattices) for the study of quantum phenomena, including ISB transitions and resonant tunneling. The capability of these nanostructures for the fabrication of quantum optoelectronic devices will be assessed.

The tasks of the student will be:

- The student will grow the NW heterostructures by plasma-assisted MBE, profiting from the know-how at NEEL (Rudeesun Songmuang). Note that the aim of this thesis is not the research on growth, but the application of previously established growth knowledge to the synthesis of structures for opto/electrical studies.
- He/she will process and contact the NWs at the NEEL/CEA cleanroom facilities (Nanofab, PTA) using established protocols (M.I. den Hertog) allowing opto-electronic characterization as well as TEM characterization on the same single NW[1].
- He/she will be in charge of the electro-optical characterization of the wires in terms of luminescence, photodetection and electronic transport at the NEEL/INAC laboratories, particularly using the new cryogenic probe station (GaNEX investment INV7.31).
- The TEM facilities present at the nano-characterization platform (PFNC) in CEA will be used for the TEM characterization –TEM studies will be performed by Martien den Hertog (NEEL).
- He/she will work on the interpretation of the results by correlation of structural/optical studies with 3D simulations using nextnano3.

Possible collaboration and networking: Collaboration with Sébastien Sauvage for the study of intraband transitions in a dot-in-a-wire by measuring the infrared photo-induced deformation field locally detected with an AFM tip.[5] The topic sets ground for collaboration with other groups involved in NW growth. Furthermore, the PhD student would be a main developer and user of investment INV7.31, so that he would be able to assist other PhD students from the GaNEX community coming to Grenoble to perform measurements in this system.

[1] M. I. den Hertog, et al., Nano Lett. 12, pp. 5691-5696 (2012).
[2] R. Songmuang, et al., Nano Lett. 10, 3545 (2010). L. Rigutti, et al., Nanotechnology 21, 425206 (2010).
[3] J. Müßener, et al., Nano Lett. 14, 5118 (2014).
[4] M. Beeler, E. Monroy, et al., Nano Lett. 14, 1665 (2014).
[5] S. Sauvage et al. Phys. Rev. B 83, 035302 (2011).