Local probing the effects of mechanical stress on electronic properties of single III-Nitride nanowires for energy conversion devices

Scope: **Harvesting energies** from the ambient of our daily lives and converting them into electricity has received an increasing interest nowadays, driven by the problems of energy crises and global warming. Faced by these challenges, **nano-piezotronics** has recently emerged. In this field, piezoelectric **semiconductor nanowires (NWs)** are used to generate electrical energy by scavenging the mechanical energy from very tiny vibrations in our environments, for examples, a simple air movement, muscle movement or even a bloodstream. However, the **fundamental mechanism** responsible for the device's operation remains unclear and must be thouroughly explored.

PhD topic: The main goals of this PhD topic are technical developments and physical understanding of nano-piezotronics devices based on **III-nitrides semiconductor NWs** for energy conversion. **The optical, electrical and mechanical properties of single NWs under mechanical stress will be studied by using local probing technique.**

The first part focuses on **designing and fabricating the contacted suspending III-N NWs**. For this purpose, the PhD student will be trained on **cleanroom facilities**. She/He will also use cathodoluminescence (CL) and scanning electron microscopy to characterize the optical and structural properties of the devices. In the second part, in order to understand intrinsic properties of the NWs, she/he will measure on the devices the **electrical transport** and **local piezoelectricity** by dual tracking piezoresponse force measurement (PFM). Then, **controlled mechanical stress using atomic force microscopy (AFM)** will be used to induce changes of these properties. In the last part, the influence of the **optical excitation** combined with the external forces on electrical transport on the NWs will be investigated, focusing on photocurrent dynamics as a function of applied forces. At the end of his/her thesis, the investigations could be extended to III-Nitride NWs with **quantum structures** i.e. quantum dots or quantum wells which is entirely unexplored.

This PhD work will provide an in-depth understanding of the charge generation associated with material deformation and the charge transfer at the interface between the NW and the electrical contact. The results achieved will offer the pathway to determine the effect of the piezopotential profile on the performance of NW devices, and how to manipulate device characteristic by applying the external force. The overall study should yield to improve energy conversion by mastering the effect of the piezopotential induced by mechanical force on the electrical characteristic of the devices.

Interactions and collaborations: This PhD research is founded by ARC-4 Energies Rhone-Alpes. and is based on a collaboration between Dr. R. Songmuang from the Néel Institute (CNRS, Grenoble), Dr. E. Monroy (CEA, Grenoble) and Dr. F. Dahlem from LTDS laboratory (Ecole Centrale de Lyon). Research will be done at Grenoble.

Candidate profile: She/he should have a background study in physics/material science/semiconductors. She/he should be highly motivated for research work and developments nanofabrication process. Good handskills and fluent in english are recommended. Skill on computer simulation will also be appreciated.

Calendar: 15th of July, deadline for application. Final answer at the end of july. Starting of the PhD: end of September, beginning of October.

Contact: Please send your CV to both email addresses:
Dr. R. Songmuang: rudeesun.songmuang@cea.fr (04.38.78.54.16)
Dr. F. Dahlem: franck.dahlem@ec-lyon.fr (04.72.18.64.30)