Polar semiconductors nanowires: collective and individual properties

The wide band-gap GaN semiconductor has attracted much attention as a promising material for the development of optoelectronic devices operating in the blue and ultraviolet range. Self-assembled GaN nanowires (NWs) currently are a subject of sustained interest in the scientific community motivated by both their potential applications for new LEDs, which should take benefit of the improved cristalline quality of those nano-objects, due to a strongly reduced defects density. In addition, the strong interest of the scientific community for these 1D nano-systems, is also related to the new fundamental questions opened by their strongly anisotropic geometry, and to their potential as possible building blocks for future nano-electronic devices.

In this context, vibrational spectroscopy has been increasingly used to study nitride NWs and several new phenomena have been reported to date with respect to these one-dimensional structures. In this work, both GaN and AlGaN Nanowires (NWs) grown by Plasma Assisted Molecular Beam Epitaxy will be investigated experimentally by different techniques, mostly micro-Raman spectroscopy, and theoretically by different models, including both elastic and dielectric models.

On one hand, we will be interested in NWs ensemble for the study of their statistic and/or collective properties by using non resonant visible laser excitation. In particular, surface effects in the optical phonon physics related to both structural anisotropy of the material and 1D geometry of the NWs will be analyzed by modifying exterior dielectric environment and/or NWs surface by metallic shell deposition.

On the other hand, in order to circumvent any averaging effect by a measure of a statistical population of NWs, resonant and non-resonant micro-Raman analysis of a single GaN and AlGaN NW will be performed. We expect to report the demonstration of an ultra-sensitive Raman probing of single AlGaN NWs as recently demonstrated for single GaN Nanowire. Structural fluctuations, as specific phase separation phenomena related to 1D geometry, will be probed by our UV Resonant Raman probe at the scale of a single AlGaN NW.

References :

[1] V. Laneuville, F. Demangeot, R. Pechou et al., Phys. Rev. B. 83, 115417 (2011)

[2] J. Wang, F. Demangeot, R. Pechou et al. Phys. Rev. B. 85, 155432 (2012)

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This work will be realized in the context of the recently labeled GANEX program, a French national network, including most of academic laboratories and industries, focused on growth of III-V nitrides materials, on the study of their fundamentals properties, and on their devices.

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