ÉCOLE DOCTORALE
Physique et ingénierie : électrons, photons, sciences du vivant (EOBE)

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Propriétés photoniques et électriques de nanofils de nitrures et leurs applications optoélectroniques

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Manuscript summary:

This manuscript is dedicated to the study of optical and electrical properties of nitride nanowires and their optoelectronic applications.

In the first part, the emission properties of GaN nanowires are analyzed, showing that the nanowire geometry can significantly modify the emission polarization. Uniaxial strain in core/shell nanowire heterostructures is demonstrated to induce the inversion of the A and C valence bands. Investigation of the electrical transport through GaN/AlN quantum discs in nanowires allows to observe a reproducible resonant tunneling enabled by the crystalline perfection of nanowires. Demonstration of this effect still represents a major challenge in 2D nitride layers because of the high concentration of defects.

In the second part, nanowire photodetectors and light emitting diodes (LEDs) are analyzed. First, the photoconductive mechanism in nanowires is theoretically described. The difference with respect to thin films related to the modification of the conducting surface in nanowires is pointed out. Realization and analyses of nanowire photoconductors and photodiodes is then presented. In particular, it is shown that because of photoconductive effects in the nanowire extremities and of the leakage of the active region, p-i-n axial diodes present photoconductive gain if biased.

Properties of InGaN/GaN core/shell nanowire LEDs are examined. The impact of the compositional

variations on the current injection and electroluminescence properties is analyzed both for single nanowire LEDs and for array devices. The problem of inhomogeneous injection is identified, its origin is analyzed at the nanoscale using electron beam induced current microscopy and a solution based on a different contact architecture is proposed. Finally, flexible LEDs based on polymer-embedded nitride nanowires are demonstrated with a blue, green and white emission color. Perspectives for other types of organic/inorganic nanowire devices are presented.