Centre de Nanosciences et de Nanotechnologies

Soutenance de thèse

Vendredi 12 juin 2020

14h00

Institut Photovoltaïque d'Île-de-France (IPVF)
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Lien public: https://eu.bbcollab.com/guest/051689dee3ba4ebca8833bdfb5a99fe4

Romaric DE LÉPINAU

"Cellules solaires en GaAs sur Si à base de réseaux de nanofils épitaxiés par jets moléculaires"

Jury members :

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Abstract :

Nanowires (NW) epitaxially grown on Si substrate are efficient light absorbers and allow to integrate high-quality III-V materials on Si by preventing defects induced by the lattice-mismatch between both materials. They provide a way to fabricate tandem III-V/Si solar cells above 30% efficiency. The goal of this thesis is to develop III-V NW solar cells grown on Si substrates. First, the control of the selective NW growth in ordered arrays on Si was addressed, and vertical yields consistently above 90% and up to 100% were demonstrated. Using transmission electron microscope characterization, the growth conditions were optimized to improve the crystal quality by reducing the number of stacking faults, to investigate GaAsP NWs with the optimal bandgap for tandem, and to study core-shell heterostructures.
Using cathodoluminescence to determine the carrier concentrations in NWs, it was shown that the core and the shell can be doped with Be up to p=8E18 cm-3, while Si is an amphoteric dopant, resulting in shell doping limited to n=5E17 cm-3. A solar cell fabrication process was developed to contact NW core-shell junctions. A first-generation GaAs homojunction device shows efficiencies up to 2.1%, limited by carrier collection issues, whereas the quasi-Fermi level splitting, estimated from PL measurements, reaches a promising value of 0.98 V at 82 sun, extrapolated to 0.86 V at 1 sun. A new core-shell p-i-GaAs/n-GaInP heterojunction exhibits efficiencies up to 3.7%, with a record Voc=0.65 V. These GaAs-based NW top-cells directly grown on Si pave the way toward high-efficiency tandem solar cells.

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