Centre de Nanosciences et de Nanotechnologies

Soutenance de thèse

Jeudi 13 décembre

14h00
Amphithéatre IPVF (Institut Photovoltaïque d'Ile-de-France)

Valerio PIAZZA

" Nanoscale analyses of semiconductor nanowire properties for optimization of third generation photovoltaic converters"

Jury members :

Maria TCHERNYCHEVA	Directeur de Recherche	Université Paris-Sud	Directeur de thèse
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Abstract :

Although III-V nanowires (NWs) are recognized as promising candidates for the development of new generation solar cells thanks to their very attractive optical properties, the expected performance improvement over their 2D counterparts has not yet been demonstrated. To understand the origin of the existing gap between the theoretical predictions and the experimental demonstrations, investigation of the material properties down to the nanometric scale is fundamental. Nanoscale analyses are expected to elucidate the limiting factors (e.g. the electrical properties of internal p-n junctions, the wire-to-wire homogeneity and eventual failures) and to propose solutions for enhancing the performance of NW photovoltaic (PV) devices.
This PhD thesis applies the electron beam probe techniques to get access to the key parameters governing the PV conversion at a single NW level in order to further optimize the properties of III-V NWs grown on Si.
First, GaAs and AlGaAs NWs containing a radial junction are investigated at the nanoscale and their internal structure is optimized accounting for the feedback from the experimental findings. The characterization of mm-sized devices confirms the improvement of the device performance at the macroscopic level.
Then InGaP NWs grown by a novel Template Assisted Selective Epitaxy (TASE) method containing an axial junction are studied. The doping level in the ternary alloy is estimated by the electron beam induced current microscopy and the photovoltaic response of these structures is demonstrated for the first time. The electrical properties of GaAs NWs grown with the same technique are also characterized.
Finally, InP/InGaP dual junction NWs are characterized to demonstrate the first fully nanostructured tandem solar cell. Although an electrical activity is observed under excitation in both top and bottom junctions, the tandem performance is limited by the electrical properties of the tunnel junction which connects them.

Mots clés en anglais : Nanowire,solar cell,third generation

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