Centre DE Nanosciences & DE Nanotechnologies

Surface texturing process for the lateral epitaxial growth of AlGaAs/Si photovoltaic tandem cell

CV and motivation letter to : Charles Renard (charles.renard@c2n.upsaclay.fr)
Phone / e-mail : 01 70 27 03 46 / charles.renard@c2n.upsaclay.fr

Context of the research project and motivations

SEEDs team of C2N have developed an innovative strategy for the integration of III-V materials on silicon. The latter is based on lateral epitaxial growth from nano-seeds formed in an ultra-thin silica layer (less than 2 nm thick) covering the silicon substrate. With this process we have demonstrated: i) the perfect integration of GaAs crystals of micrometric sizes dispersed on Si without any structural or electrical detrimental defect [1,2], ii) the very good electrical connection not only between the GaAs microcrystals and the Si substrate, but also through the GaAs/SiO2 /Si stack by tunnel effect [2].
The next step is now the realization of an AlGaAs/Si tandem photovoltaic (PV) cell demonstrator. For this, we need to develop a low-cost technological process of ordered nanostructuring of silica from lithography by nanospheres which can be easily extended to a large surface. Such process will ensure very low III-V material requirement and no use of III-V or Ge substrate helping thus maintain low-cost.

Objectives and description of the internship (3-6 months)

We propose to develop a process to minimize the cost of the localization process of nanometric growth seeds, namely nanosphere lithography (NSL). The NSL technique is based on the self-organization [3] of cheap, commercially available polystyrene (or silica) beads. Thanks to the use of simple synthesis processes, one can thus easily produce by spin-coating single or double layers of beads on Si substrates. By using different diameters of beads, one can easily adjust the distance between the apertures (in the range 20-1000 nm), and obtain small apertures between the beads (up to 20 nm). These openings will then be used as a mask to obtain the nanometric Si seeds necessary for the localized epitaxy of the AlGaAs µ-crystals. With this technique, we therefore propose to produce hexagonal patterns of nanometric seeds through a very thin layer of SiO2 . Once this method of nanostructuring by NSL has been mastered, we will continue to set up the basic bricks for the realization of the PN junction in the crystals of AlGaAs for the realization of a tandem photovoltaic cell on Si.

Profile

M2 or 3rd year of the engineering cycle, with a solid knowledge in materials science, condensed-matter physics and/or physical chemistry. The candidate must show ability to work in a clean room and strong taste for experimentation and microstructural analysis Materials. The candidate is expected to be able to work independently, suggest innovative solutions, and to collaborate with other international members of the SEEDs team. English communication skills are required for regular presentation of work progress in internal meetings. Possibility to continue with a PhD grant with ANR (Agence Nationale de la Recherche) funding

Laboratory and hosting team

This internship is part of an ANR project (HELLO_PV) dedicated to photovoltaic bringing together C2N, IPVF and GEEPs laboratory, and is hosted by the SEEDs team (C2N, CNRS / Université Paris Saclay) of materials department (http://seeds.c2n.universite-paris-saclay.fr/en/research/)

Références :

[1] Renard C., et al., Dislocation and antiphase domain free microscale GaAs crystals grown on SiO2 from (001) Si
nano-areas Applied Physics Letters, vol. 102, p. 191915, 2013
[2] Renard C., et al., High current density GaAs/Si rectifying heterojunction by defect free Epitaxial Lateral
overgrowth on Tunnel Oxide from nano-seed, Scientific Reports, vol. 6, p. 25328, 2016
www.nature.com/articles/srep25328
[3] D. Gogel et al., Plasma modification of nanosphere lithography masks made of polystyrene beads, J.
Optoelectronics and Advanced Materials, Vol. 12, No. 3, March 2010, p. 740 – 744