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Epitaxial films on reusable substrates: towards a sustainable III-V semiconductors based Photovoltaics

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III-V semiconductor based solar cells hold the record efficiencies under the global AM1.5 spectrum for single-junction solar cells (29.1%), multi-junctions (39.2%), multi-junctions with c-Silicon (35.9%) and the absolute record under concentration (47.1% at 143 suns) [1]. Despite these great performances, III-V solar cell are restricted to space applications due to their prohibitive cost, while the terrestrial PV market is dominated by Si-wafer based PV technology (95% in 2017), with a 17% average module efficiency (21% for "Super-mono") [2].
The III-V substrate used for the epitaxial growth accounts for more that 80% of the total cost of III-V solar cells and its cost-effective reuse is key to make III-V based photovoltaics a sustainable option for terrestrial applications.

This internship aims at developing a technique for producing IIII-V semiconductor epitaxial films on reusable substrates. The idea is based on a previously introduced technique called CLEFT (cleavage of lateral epitaxial films for transfer), which demonstrated the possibility to grow single-crystal GaAs(110) films over a GaAs(110) substrate covered with a graphite mask with narrow stripe openings. The epitaxial growth initiates within the openings, and continues by lateral growth over the mask, producing a continuous single-crystal GaAs film that can be successively mechanically exfoliated [3]. The internship aims at developing graphite masks obtained by pyrolysis of organic resists patterned by Nanoimprint lithography. The technology will be implemented on GaAs(100), a more relevant crystalline orientation for the PV industry. The internship student will be strongly involved in the fabrication of the mask, its characterization and the characterization of the epitaxially grown III-V films using different techniques (Raman, Photoluminescence, Van der Pauw method etc). The development of this process and its implementation for the further fabrication of solar cells will strongly benefit from the know-how acquired in our group on the selective growth of III-V semiconductor nanowires [4] and the fabrication of state of art ultra-thin GaAs solar cells [5].
This work will be done in close collaboration between the C2N (SUNLIT Team) and the IPVF both located on the Saclay plateau (one block away). The candidates are invited to send their CV, motivation letter and detailed academic career to andrea.cattoni@c2n.upsaclay.fr.
Paid internship. Possibility to continue with a PhD grant.

[1] Green et al., Solar cell efficiency tables (version 54), **Prog. Photovolt. Res. Appl.** 27, 565 (2019)
[2] Photovoltaic Report, Fraunhofer ISE, 14 November 2019
[3] McClelland et al., **Appl. Phys. Lett.** 37, 560 (1980)
[4] Oehler et al., **Nano Letters** 18, 701 (2018)
[5] Chen et al., **Nature Energy** 4, 761 (2019)