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| SOLSTICE | Name of the PhD: **Lucas GAVOTTO**<br>Title of the PhD thesis: **Fabrication, characterization and modeling of III-Sb multijunction solar cells**<br>Dates (start/end): 10.2020 – 09.2023 |
| Supervisors | Yvan Cuminal, Stéphanie Parola, Frédéric Martinez (IES) |

The best efficiencies recorded to date in photovoltaic conversion have been obtained with concentrator systems using III-V multijunction solar cells. Indeed, the NREL recently demonstrated a 6-junctions solar cell with 47.1% efficiency under 143 suns. The recent raise in efficiency for these devices is due to an increase of the number of junctions within the solar cell, allowing a better solar spectrum harvesting. For multijunction solar cells with more than 4 junctions, the ideal bandgap values are included in the 0.5-2eV range. Consequently, the interest for III-V materials able to reach these values of bandgap increased very recently. In this context, antimonide alloys (III-Sb) are particularly suitable candidates because of their ability to reach a broad bandgaps range (0.27-1.64eV), including the low bandgap values requested for an optimal harvesting of the solar spectrum, while remaining lattice-matched to GaSb. The studies carried in the IES Montpellier aim at designing, fabricating and characterizing solar cells based on III-Sb materials.

During this first year of my PhD thesis, a tandem AlGaAsSb/GaSb solar cell has been fabricated in clean room and characterized. The detail of its structure is given in Fig. 1. Electrical and light bias have been added to our measuring bench in order to measure the Quantum Efficiency (QE) of multijunction solar cells. An alternative method to extract the intrinsic QE of each junction despite low shunt resistance value has been proposed. This procedure is based on a small-signal analysis of the solar cell. The parameters of the model are determined using a set of I-V measurements under various light conditions. The experimental and corrected QE are presented on Fig. 2. The studied solar cell has also been modeled using 1D TCAD modeling, which highlighted low SRH lifetimes for the minority carriers in the AlGaAsSb junction. We are currently writing a paper to report this work, which will be submitted to IEEE Journal of Photovoltaics by the end of 2021.

The following steps will be directed towards increasing the performances of AlGaAsSb and GaSb junctions. A p-i-n structure will be studied for the AlGaAsSb solar cell in order to compensate for the low SRH lifetimes in this quaternary alloy. A heterojunction structure will also be investigated to increase the open-circuit voltage of the low bandgap GaSb junction, with AlGaAsSb as emitter. The clean room process for the realization of $MgF_2$/ZnS bi-layer will also be implemented for the improvement of the optical management. Finally, a characterization method based on the impedance spectroscopy approach will be investigated for a deeper characterization of multijunction solar cells.

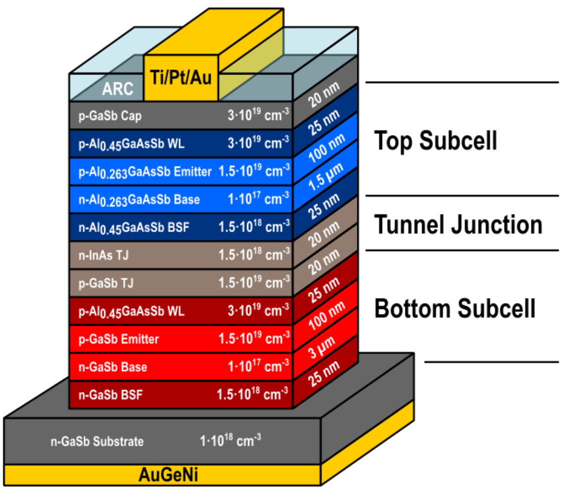


**Figure 1**: Architecture de la cellule tandem AlGaAsSb/GaSb

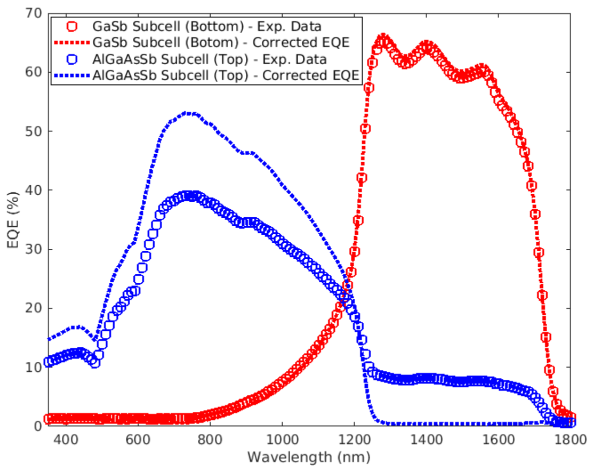


**Figure 2**: EQE de la cellule tandem AlGaAsSb/GaSb (Exp. Data et EQE corrigées)