	Name of the PhD: **Emmanuel GIUDICELLI** Title of the PhD thesis: **Evaluation of a new multi-junction photovoltaic cell technology based on antimonide materials for Concentrated PhotoVoltaic (CPV) Application.** Dates (start/end): 01/10/12 – 20/06/16
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Context and objectives

The objective of this thesis is to propose an alternative to existing cells for CPV application, easier to implement with monolithic MJ cells grown on a GaSb substrate. This type of cell, due to the good complementary of the material gaps and its favorable band gap alignments, is a realistic and original alternative to existing cells for use under highly concentrated solar flux.

Approach

The work carried out consisted on the manufacturing and characterization of the three sub-cells independently to better understand the optimal multijunction III-Sb cell.
For the first time three AlGaAsSb quaternary alloys cells were fabricated by Molecular Beam Epitaxy (MBE). The three alloys investigated are $Al_{0,9}Ga_{0,1}As_{0,07}Sb_{0,93}$ (*Top* cell), the $Al_{0,35}Ga_{0,65}As_{0,03}Sb_{0,97}$ (*Middle* cell) and GaSb (*Bottom* cell) having as respective gaps 1.6 eV, 1.22 eV and 0.726 eV at 300 K.

Main results

The works done have more particularly carried out on,

- The establishment of all the technological steps required to manufacture the cells (metal deposition, wet and dry plasma etching ...).
- The characterization of metallization by TLM structure (Transmission Line Method) with the best result being a three-layer metallization Cr/Pd/Au (30/30/30 nm) on a GaSb P-type substrate.
- The current-voltage characterization.
- The thermal characterization by measuring the thermal conductivity of the materials and the surface temperature mapping in function of the concentrated solar flux.
- The electro-optical characterization by spectral response: EQE and IQE measurements.
- The characterization under 1 sun illumination (1 000 W/m²).
- The characterization of solar cells under (highly) concentrated solar flux in the PROMES laboratory (Fig. 1).

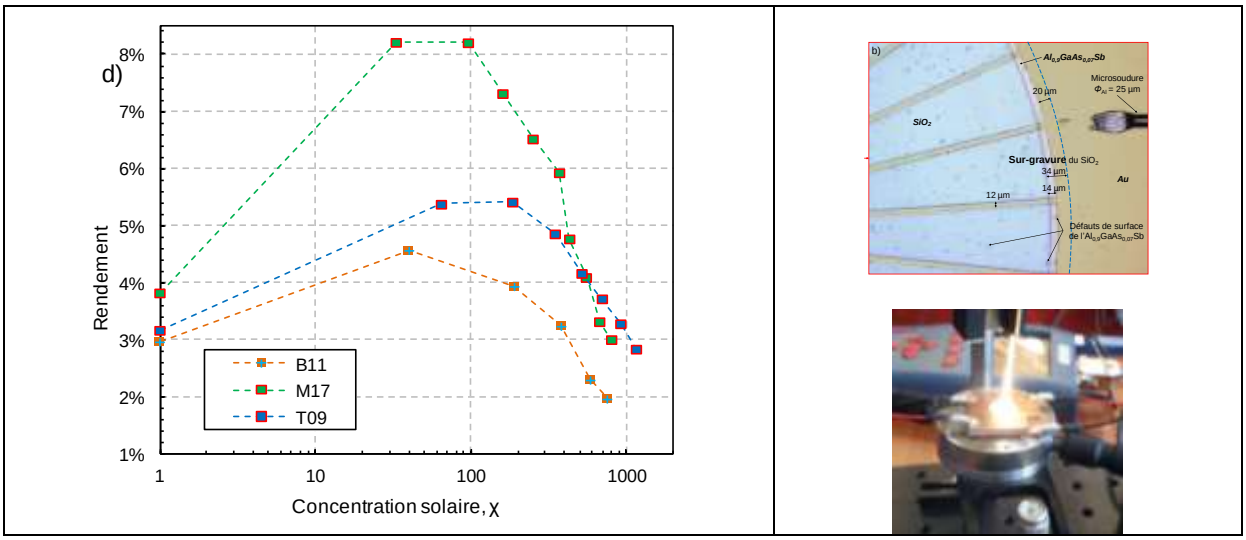

Figure 1. The best efficiencies for Bottom (B11), Middle (M17) and Top (T09) PV cells respectively are 4.6 % for 40 χ (close to the state of the art),8.2 % for 96 χ and 5.4 % for 185 χ (world first for these quaternary materials).

Patent

- Y. Cuminal , F. Martinez, E. Giudicelli « Nouveau concept de cellule solaire à base d'alliages antimoniures (III-Sb) pour fabrication de cellules solaires de nouvelle génération » Brevet déposé le 21 mai 2014, N°EP14305748.

International conference proceedings

- Giudicelli E., Martaj, N., Dollet, A., Perona A., Pincemin S and Cuminal Y. "Solar Cells Based on GaAs: Thermal Behavior Study", 11th Int Conf. on Concentrator Photovoltaic Systems (CPV-11), AIP Conference Proceedings, Vol. 1679, 2015.

International communication

- E. Giudicelli, N. Martaj, Y. Cuminal, A. Perona, and S. Pincemin « Study of the thermal behavior of solar cells based on GaAs » in Comsol conference, Rotterdam, 2013.

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- E. Giudicelli, Y. Cuminal « Technology and fabrication of antimonide based photovoltaic cells at high and very high solar concentration » in Chair Total International Conference 2014 in Montpellier, January 2014.

- E. Giudicelli, N. Martaj, P. Combete and Y. Cuminal "Thermal characterization of multi-junction solar cells by the 3ω method" in CPV11, Aix-les-Bains, 2015.

- Y. Cuminal, E. Giudicelli, El Husseini, A. Perona, F. Martinez, G. Boissier and A. Dollet « Multi-junctions PV concentrator solar cells : state of art, interest of antimonide compouds », in Lille, EMRS, 12-15 Mai 2015.