	Name of the PhD candidate: **VAUTHELIN Alexandre** Title of the PhD thesis: **Fabrication and study of antimonide-based solar cells for high solar concentration applications** Dates (start/end): 01/10/15 – 30/09/18
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Context and objectives

High concentrating photovoltaics (HCPV) is currently the mean to achieve solar conversion efficiency records. Although the current record is of 46% at 508 suns with a 4 junction solar cell by Fraunhofer/Soitec/CEA, the potential of multijunction solar cells has not yet been reached and remains very promising. Current studies are mainly focused on multijunction solar cells made with III-V materials that are lattice-matched to Ge or InP. In this field, one of the main difficulties is to get materials with appropriate band gaps (well adjusted to an optimal solar conversion) and that are compatible with the deposition method (lattice-matched). Particularly, the bandgap energy around 1 eV is not easily reachable with a material lattice-matched to Ge.

The main goal of this work is to fabricate and characterize an antimony-based tandem solar cell, but in order to do so, each subcell has to be individually studied beforehand.

Approach

By taking into account the optimal solar conversion and lattice-match conditions, we suggest the antimony-based materials (GaSb, AlGaAsSb) that offer a large band gap coverage (from 0.726 up to 1.64 eV), and that are lattice-matched to GaSb, therefore it is possible to grow monolithic multijunction solar cells. The main difficulty when it comes to high solar concentrations is to have a small enough series resistance in order to reach high efficiencies at high solar concentrations. After having identified each contribution to the series resistance, two were isolated as the main ones: the contact resistance and the sheet resistance. The contact resistance is characterized by circular TLM with its specific contact resistance, and the sheet resistance, also characterized by CTLM, its impact varies with the shape and size of the contact grid. As of today, each series resistance contribution has been reduced enough to reach our solar concentration objective of 1000 suns.

Main results

We have fabricated and characterized GaSb solar cells under 1 sun and low solar concentrations under a solar simulator. As shown in figure 1, we are able to reach an efficiency of 8,35% at 68 suns, which is a very promising result compared to current state of the art results on GaSb for this range of solar concentration (Andreev 2008). In order to fully characterize our GaSb subcells, and to confirm that we are not series resistance dependent, it is necessary to characterize our solar cells in real conditions at higher solar concentrations. Quaternary AlGaAsSb solar cells, which will be used as supplementary subcells in multi-junction antimonide-based solar cells, are also currently being fabricated.

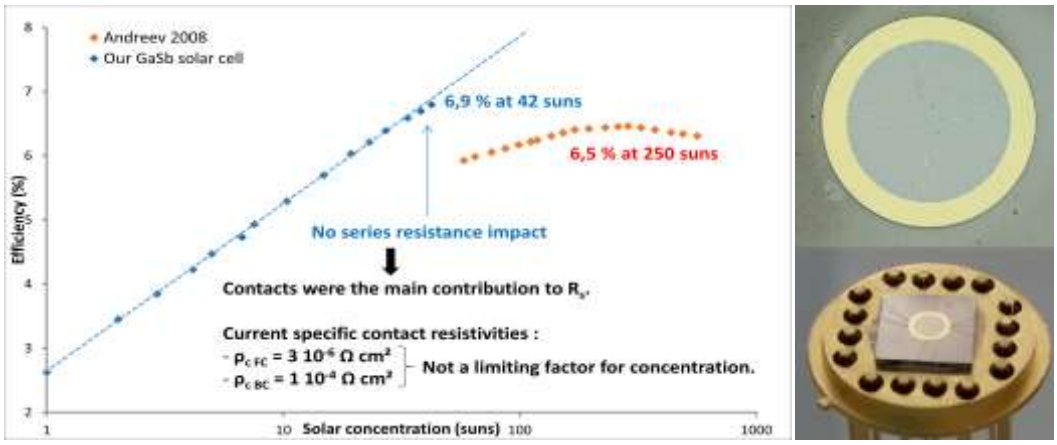

Figure 1: (Left) Efficiency versus solar concentration for the current GaSb concentration record and our own GaSb solar cell.
(Right) Fabricated GaSb solar cell.

International conference proceedings

Parola S, Vauthelin A., Martinez F, Tournet J, Roillard Y, Tournié E and Cuminal Y, "Investigation of antomonide based semiconductors for high efficiency multi junction solar cells under high solar concentrations", World conference on photovoltaic Energy conversion (WCPEC-7), Waikoloa (Hawaï), 10-15 june 2018. IEEE proceeding.

Communication in international conference

Parola S, Vauthelin A., Giudicelli E., Martinez F and Cuminal Y, "Interest of antimonide compounds based multijunction cells for high concentrating photovoltaics", 20th Sede Boqer Symposium on Solar Electricity Production, Sede Boqer (Israël), 26-28 Sept. 2016.