Cu(In,Ga)Se_2 mini-modules : alternative architecture yielding 82% fill factor

J. Lorthioir[1], L. Arzel[1], N. Barreau[1]

[1] Institut des matériaux Jean Rouxel, Université de Nantes, CNRS-UMR 6502, France
Justine.lorthioir@cnrs-imn.fr

Cu(In,Ga)$(S,Se)_2$ (CIGSSe) based thin-film solar cells have recently achieved the outstanding performance of 22.9%[1] efficiency at the laboratory scale. In contrast, the best performance of CIGSSe commercial modules does not exceed 17.5%[2]. Such a difference is inherent to the actual architecture of the modules (P1, P2, P3 patterning), leading to a decreased active area, an increased series resistance as well as optical losses due to the increased thickness of the transparent conductive oxide (e.g. AZO).

To overcome these limitations, we propose a modified architecture of modules (see **Fig. 1**) where the cells are interconnected via the metallic grids.[3],[4] Our approach consists in using Ni/Al/Ni buses (e-gun evaporated throughout a shading mask) to electrically connect the rear contact of the cell N to the top window layer of the cell N+1. Independently of the absorber's bandgap energy, this architecture allows to (i) increase the width of the cells and (ii) decrease the thickness of the AZO layer without resistive losses.

Fig. 2 compares the *IV* curves of a cell of 0.5cm² and our alternative module composed by 3 cells. The V_{OC} of the alternative module is 2.07 V (i.e. 690 mV per cell), which is very close to the V_{OC} value of the cell (706 mV). The most impressive result concerns the *FF* achieved with the alternative module, which reaches the outstanding value of 82 %, yielding a total area efficiency of 16.5%.

The details concerning our alternative modules fabrication will be presented during the JNPVs and the device performance will be further discussed.

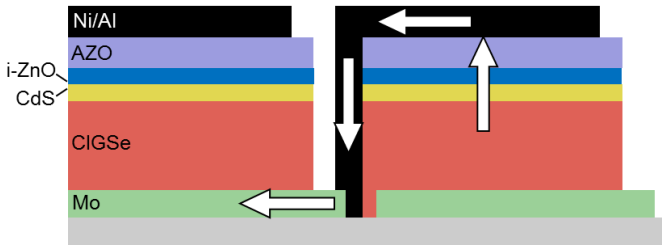

Fig. 1. Schematic representation (not to scale) of the alternative module with a cross section view. It presents interconnection layout between two adjacent cells and the flow of current is shown by the white arrows.

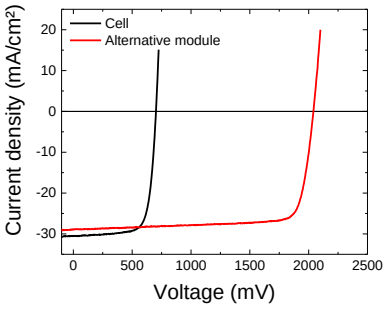

Fig. 2. IV-curves for two devices based on CIGSe: cell and alternative module, considering the active area.

Acknowledgement

This work was supported by the ADEME and Région Pays de la Loire.

References

[1] Solar Frontier Achieves World Record Thin-Film Solar Cell Efficiency of 22.9%. <http://www.solar-frontier.com/eng/news/2017/1220_press.html> (2018.1.2)

[2] Solibro, "17.52 % EFFICIENCY – NEW WORLD RECORD FOR SOLIBRO´S CIGS THIN-FILM PANELS," 2018 http://solibro-solar.com/en/news-downloads/news/?platform=hootsuite&cHash=9b81c8f171044bbada56cc06d43db4d0

[3] J. Kessler *et al* "Highly efficient Cu(In,Ga)Se_2 mini-modules," Solar Energy Materials and Solar Cells, 2003

[4] J. Wennerberg *et al* "Design of grided Cu(In,Ga)Se_2 thin-film PV modules," Solar Energy Materials and Solar Cells, 2001