Multi-terminals triple junction solar cells fabrication for subcells advanced characterization

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Triple junction (3J) InGaP/(In)GaAs/Ge have reached 31% efficiency (AM1.5G). However, 3J III-V/Ge solar cells are far below their theoretical efficiencies of 50.7% (AM1.5G) [1]. 3J III-V/Ge suffer from low current densities produced by the top and the middle junction compared to the Ge bottom cell. This is why the continuous improvement of these stacks rely on the optimization of external quantum efficiency (EQE) and bandgap of each subcells. Multi-terminal solar cells (MTSC) present a promising architecture to characterize independently sub-cells of multi-junction solar cells. Here, we study monolithic triple-junction InGaP/(In)GaAs/Ge solar cells interconnected by tunnel junctions. We demonstrate a fabrication process, based on wet etching processes, for the obtention of three electrically independent sub-cells (MTMJSC).

I-V measurements under dark and 1-sun illumination highlight that the process flow did not impact the electrical behavior of the complete cell, when compared to a reference 2T solar cell fabricated on the very same wafer. Subcells I-V curves have then been measured and fitted with an ideal-diode model to determine the sub-cells electrical parameters. Finally, EQE and electroluminescence measurements have been performed to demonstrate the use-fullness of such an architecture for the determination of relative absorption, or the optical and electrical coupling between subcells. We conclude on the impact of the electrical and optical coupling between subcells on the MPP of each subcell.

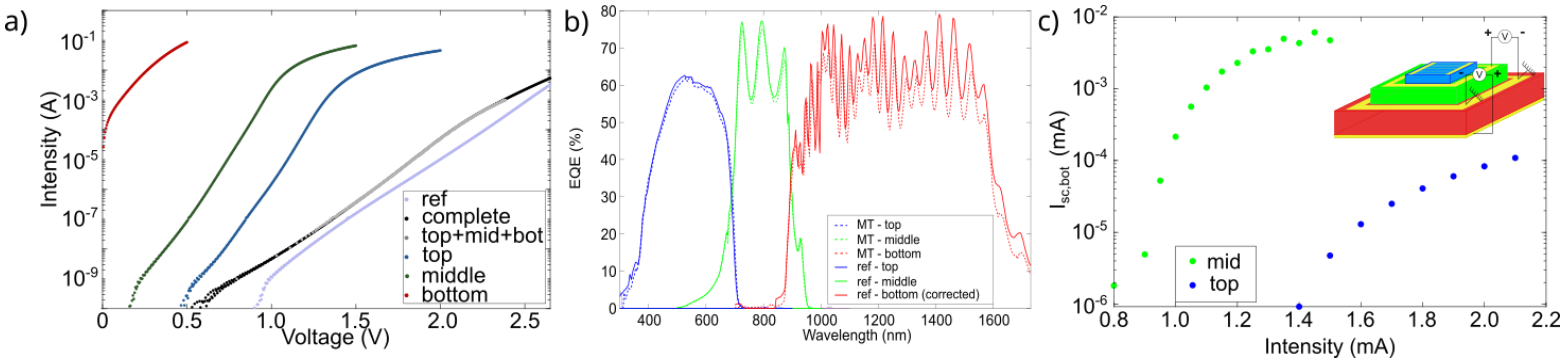

Figure : a) dark I V curve of ref (purple), complete (dark), top (blue), middle (green), bottom (red) and top+middle+bottom serially interconnected (gray). b) EQE measurements performed on a reference cell based on the light bias methods and a MTMJSC c) Evolution of the Isc bottom cell as a function of the applied voltage on the top (blue dots) and the middle cell (green dots). Inset presents a scheme of the experimental setup for the optical coupling measurements between the middle (green) and the bottom (red) solar subcells.

[1] Almansouri et al., *«Supercharging Silicon Solar Cell Performance by Means of Multijunction Concept»*. IEEE J. phot. 2015