Inverted wide band gap heterojunction solar cells for III-V/Si tandem

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Silicon single-junction solar cell is a mature technology that is fundamentally limited to a 29.4 % conversion efficiency under AM1.5G illumination. This limit can be overcome by stacking a wide band gap solar cell on top of the Si cell in a tandem architecture, which improves light harvesting and reduces thermalization losses.

Wide band gap solar cells based on *III-V* semiconductors such as AlGaAs and GaInP can offer high efficiency and stability. Especially, AlGaAs/GaInP heterojunction solar cells with a 1.73 eV band gap and a 18.7 % efficiency have been demonstrated [1] and further improved up to 19.05 % efficiency [2]. These heterojunctions are thin semi-transparent devices (≈2 µm) that can be coupled with Si solar cells in a 2-terminals or 4-terminals configuration.

In this work, samples relying on the same architecture as mentioned above were grown by molecular beam epitaxy in an inverted way. A technological process was then developed to obtain 5×5 mm² solar cells. After a full frontside metallization, the samples were either transferred (pasted) on glass or on silicon holders, before their GaAs substrate was chemically removed. Photolithography was then used to define the metal grid and the mesa of the cells. The processed samples were characterized by *I-V* and EQE measurement techniques, showing performances close to upright grown heterojunctions (Figure 2). Further process optimization and characterization results will be presented at the conference.

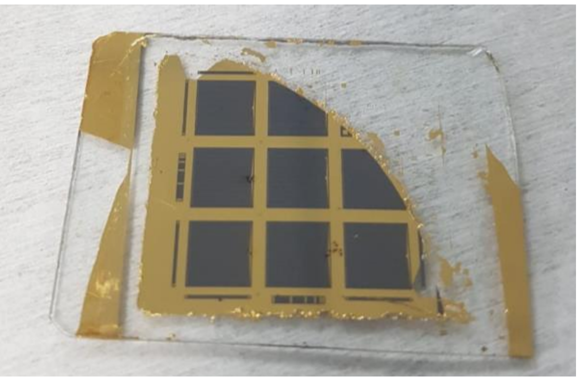

Figure 1: Picture of inverted solar cells reported on glass

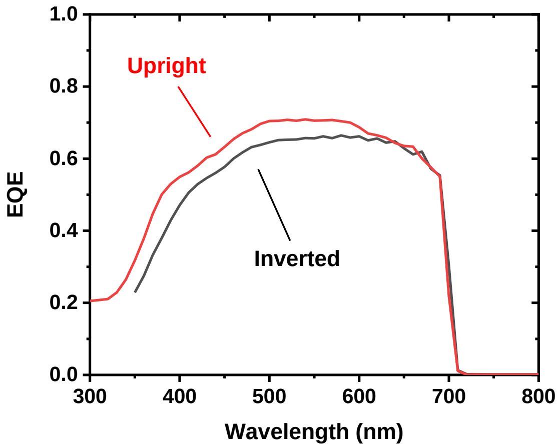

Figure 2: External quantum efficiency of upright and inverted solar cells

References:

[1] A. Ben Slimane et al., 1.73 eV AlGaAs/InGaP heterojunction solar cell grown by MBE with 18.7% efficiency. Prog Photovolt Res Appl. 28: 393– 402. (2020)

[2] O. V. Bilousov et al. Large band gap AlGaAs/InGaP Heterojunction Solar Cells: towards 20% efficiency and beyond. JNPV 2021