Towards p-PERT c-Si solar cells with tunnel junction for monolithic tandem integration with CIGS

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Abstract :

Tandem solar cell researches are growing rapidly in the recent years. This type of solar cell design can boost the efficiency of solar cells beyond the Shockley-Queisser (SQ) limits by stacking two or more solar cells with different band gaps on top of each other. Due to the ideal substrate quality of c-Si wafers and the lower band gap (1.12 eV), c-Si solar cells can be used as substrate and bottom cell in the monolithic tandem configuration. The pure sulfide CIGSu can be used as the top cell in the tandem configuration due to the low lattice mismatch (tunable) with Si and the demonstrated efficiency (16%) for a gap near 1.6 eV (Barreau et al., 2022). For epitaxial growth of the top CIGSu absorber, the bottom Si cell must be suitable for high-temperature growth of CIGS (~550 °C) and untextured. A tunnel junction with low lattice mismatch is also required to connect in series the two sub-cells and ensure the charges separation.

The presented work shows the different technological steps towards the optimization of a non-textured c-Si solar cell with all Si tunnel junction adapted to the epitaxial growth of the CIGSu top cell. The solar cells were fabricated according to the passivated emitter rear totally diffused (PERT) configuration with implanted Boron as Back Surface Field and standard Phosphorus diffused emitter. On the front surface a tunnel junction is realized using Proximity Rapid Thermal Diffusion method (Li et al., 2021). Some characteristics of the fabricated devices are presented, as well as the simulations performed by SCAPS to guide the future experimental developments.

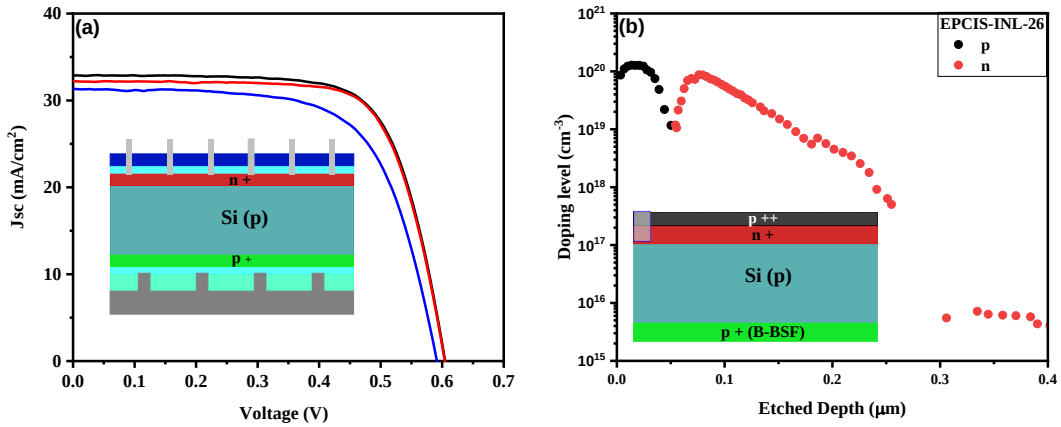

Figure: *(a) I(V) characteristics of the solar cells, (b) ECV doping profile of the tunnel junction.*

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References

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