PERCspective: perspective for PERC in tandems with perovskite

Publieke samenvatting / Public summary

Aanleiding

With silicon module prices steeply decreasing, enhancement in efficiency is a key element towards further reduction in the LCOE. In this perspective, 2-terminal (2T) monolithic Si-perovskite tandem technology, which has demonstrated a staggering increase in efficiency up to 28%, has triggered a strong industrial interest. In terms of commercialization, the use of PERC bottom cells appears to be most appealing: The installed PERC capacity eclipses that of SHJ, which has mostly been used so far for 2T tandems. Being able to upgrade existing PERC lines for tandems thus has a huge market potential. Moreover, it does not require an overhaul to SHJ by the conservative and low-margin PV industry. These considerations, in addition to optional bifaciality and being a low-cost technology, make PERC a highly suited candidate for tandem applications. However, heterojunction Si cells interface quite readily with perovskites due to their full-area conductive front side passivating layer and transparent conductive oxide (TCO) front contact layer. Standard PERC cells lack these two important aspects for monolithic integration, calling for front side innovation, as addressed in this project.

Doelstelling

This project is dedicated to innovation at the front side of a PERC cell to enable monolithic interfacing with a perovskite cell. The consortium will tackle the challenge of implementing full area conductive passivation on the front of PERC, introducing a TCO layer and a hole transport material (HTM) for the

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perovskite, with a low-loss recombination junction. We see a unique opportunity to leverage recently-developed nanolayers to provide the building blocks for this interface: TU/e has shown in the RADAR project that atomic layer deposited (ALD) ZnO can yield excellent Si surface passivation (728 mV iVoc) and contact resistivity <125 mOcm2 on n+ Si. Moreover, TU/e has shown that ALD NiO is a good HTM and leads to a good recombination junction with ZnO. Finally, poly-Si(n) contacts have been established at TNO and Tempress as industrial building blocks which can replace the n+ Si front of PERC. The goal of this project is to bring these building blocks together on PERC cells, demonstrate their operation and compatibility with PERC and perovskite cells and processing, work towards industrial tools and processes, and validate with a 2T tandem cell demonstrator.

Korte omschrijving

This project will be based on the industrial PERC cell of Hanwha Q-Cells (HQC) – without front SiNx and metallization – and implement nanolayers at the front for a proper interface with the perovskite. In the first phase of the project, TU/e will focus on the tunnel oxide/ZnO layers and hydrogenation thereof, and the NiO HTM. Tempress will provide the poly-Si contacts and TNO and HQC will work on the integration of poly-Si with the PERC process and ALD layers. SoLayTec will perform the industrial scale-up by spatial ALD of ZnO and NiO. HQC provides PERC half-fabricates. Finally, TNO (Solliance) will validate the interface layers on a planar silicon surface, employing their established perovskite baseline. A 2nd project phase will be started if the bottom cell performance meets milestones at M18. In this phase, a tandem demonstrator will be made, including an aim for high optical performance. The most promising perovskite top cell approach will be identified, drawing from experience of Solliance and the latest developments worldwide. If necessary, a subcontractor capable of perovskite evaporation will be involved, to enable processing on textured Si.

Resultaat

The bottom cell platform from this project will enable PERC-perovskite tandems with efficiencies around 27%. The project will result in process know-how, industrial tools, and scientific understanding, enabling this bottom cell platform. Enabling the installed PERC capacity to be upgraded to tandem technology will benefit the scale and speed of deployment of Si-perovskite tandems. Importantly, for the Dutch energy transition, moving to tandems the energy yield/m2 from PERC modules can increase by >20%, at equal or lower cost, and the carbon footprint per kWh will decrease by almost the same amount.