Openbaar eindrapport

BEAST

Back **E**nd **A**dvanced **S**erial interconnection **T**echnology for CIGS

Projectnummer:	TEUE117046
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Deelnemers:	Meyer Burger Netherlands BV AVANCIS GmbH TNO (voorheen ECN) TNO

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1 SAMENVATTING VAN HET PROJECT

In this project we have shown that back-end interconnected modules can be at bar with industrial modules. No electrical losses and minimization of the dead zone to below 300 μm was demonstrated.

Research type samples were made and used to increase insight in the laser ablation of the CIGS stack, leading to two patent applications in preparation.

Inkjet printing and specifically curing of the inks was improved by better control on timing of UV illumination after printing. Removal of the TCO with a reactive ink system was shown, however for industrial application some steps are needed to adjust the processing to be compatible with CIGS. Damp heat experiments to show durability of this type of interconnection showed that first to fail is the P3 laser scribe which is identical to classical in-process created interconnections.

The prototype machine (BEEP) for making back-end interconnections in thin-film PV was used for research on conductive inks. The conductivity of the inks using mild temperatures was not sufficient to compete with the semi back-end or classical interconnections. Final experiments show that this technology has potential in the industrial environment especially because less alignment and vacuum braking can be needed to have higher yields.

2 OVERZICHT BEHAALDE RESULTATEN

Different types of backend interconnected modules were made during this project and were compared to industrial benchmark modules. The following results were obtained:

- Backend interconnected modules with TCO that showed no electrical losses compared to the reference modules
- Backend interconnected modules with TCO with reduced dead zone below 300 μm, which is below the current overall industrial standard of ~350 μm
- Full backend interconnected modules with conductive ink based on Ag nanoparticles that show some additional losses in series resistance

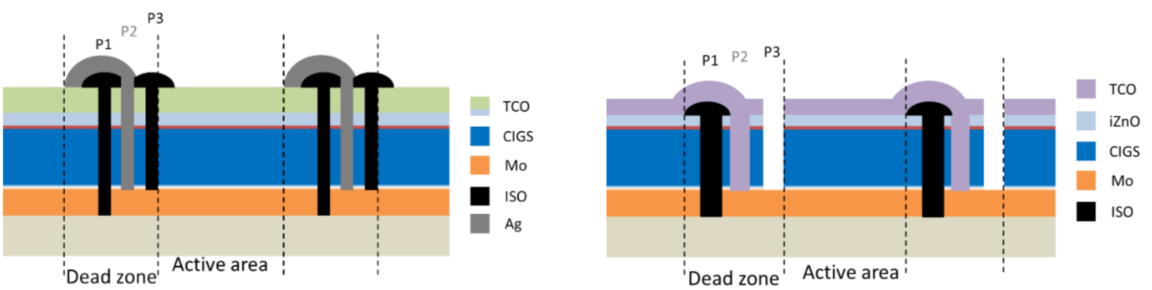

Figure 1: Schematic layout of backend interconnection in CIGS with conductive Ag (left) or TCO (right).

3 CONCLUSIE EN AANBEVELINGEN

In the project we have shown that "semi" backend interconnection technology is at bar with classical interconnection technology from the pilot production at AVANCIS; no electrical losses are observed when a single layer of TCO is used, also the dead zone was reduced to less than 300 µm. A large effort has been made in full backend interconnection technology by testing and combining different dielectric and conductive inks. Though the module results are showing increased series resistance compared to semi-backend interconnected modules and reference patterning, the results are promising and show there is potential for this technology.

Alternative strategies for the application of conductive ink, such as dispense are being considered. With dispensing strategies (part of) the digital form freedom can be retained and more viscous and higher conductive inks can be deposited with this technique. Looking at the market developments and ambitions in the thin-film PV industry to expand the effort on flexible substrates, a logical next step would also be the application of backend interconnection technology on flexible thin-film PV.

4 PUBLICATIES

The results from this project were shared in the following publication:

- *Conference proceedings*: V.S. Gevaerts, A.F.K.V. Biezemans, H.H. 't Mannetje, H. Linden, J. Bosman "*Back End Monolithic Serial Interconnection Technology for CIGS with Shunt-free Laser Scribing and Inkjet Printing* ", Proc. of WCPEC 2018 - A Joint Conference of 45^{th} IEEE PVSC, 28^{th} PVSEC and 34^{th} EU PVSEC, 8548280, pp. 3567-3570 (2018).