EUROPEAN COMMISSION

HORIZON 2020 PROGRAMME
TOPIC H2020-LC-SC3-2019-RES-IA-CSA
Increase the competitiveness of the EU PV manufacturing industry

GA No. 857793

High-performance low-cost modules with excellent environmental profiles for a competitive EU PV manufacturing industry

HighLite- Deliverable report

D3.2- Selection of industrial approaches for high-temperature passivating contacts

Disclaimer/ Acknowledgment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857793. The information and views set out in this publication does not necessarily reflect the official opinion of the European Commission. Neither the European Union institutions and bodies nor any person acting on their behalf, may be held responsible for the use which may be made of the information contained therein.

About HighLite

The HighLite project aims to substantially improve the competitiveness of the EU PV manufacturing industry by developing knowledge-based manufacturing solutions for high-performance low-cost modules with excellent environmental profiles (low CO_2 footprint, enhanced durability, improved recyclability). In HighLite, a unique consortium of experienced industrial actors and leading institutes will work collectively to develop, optimize, and bring to high technology readiness levels (TRL 6-7) innovative solutions at both cell and module levels.

HighLite consortium members

Document information

Deliverable No.	HighLite D3.2
Related WP	WP3
Deliverable Title	Selection of industrial approaches for high-temperature passivating contacts.
Deliverable Date	Day – Month - Year
Deliverable Type[i]	Report
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Document history

Date	Revision	Prepared by	Approved by	Description
24/09/2020	1	Task Leader	WP leader	First draft
29/09/2020	2	WP Leader	Coordinator	Final

Dissemination level[ii]

PU	**Public**	
CO	**Confidential, only for members of the consortium (including the Commission Services)**	X

Publishable summary

High-temperature passivating contacts (hereafter referred to as poly-Si contacts) are an appealing technology for next-generation silicon solar cells. Poly-Si contacts minimize minority charge carrier recombination effectively while maintaining efficient charge carrier transport and thereby have laid the foundations for reaching efficiencies above 26% using lab-type solar cells. A unique feature of poly-Si contacts is their high-temperature stability which renders them compatible with conventional solar cell production processes such as diffusion or contact formation via screen-printing and firing. As of today, most work has been dedicated to integrating these poly-Si contacts in a so-called TOPCon solar cell featuring a boron-diffused emitter at the front and a passivating rear contact and large-area solar cells achieving an efficiency of up to 24.58% have been realized in laboratory. Despite such high efficiency the industrialization of such a cell concept or other cell concepts faces significant challenges. Firstly, screen-printed contacts can fire through the poly-Si layer and thereby deteriorate the passivation. This effect can be mitigated by using a rather thick poly-Si layer on the order of 200 nm which in turn reduces the solar cell's infrared response due to free carrier absorption induced by the heavily-doped poly-Si layer as well as the solar cell's bifaciality. Secondly, the deposition of thick layers can be rather time-consuming, thereby lowering throughput and increasing operational expenditures. Thirdly, the industrial viability of different deposition methods such as low-pressure chemical vapor deposition (LPCVD) or plasma-enhanced chemical vapor deposition (PECVD) as well as a lean integration of poly-Si layers into the solar cell process flow is still to be demonstrated.

This report summarizes the round-robin experiment conducted in task 3.3 to assess passivation and contact quality of various industrial approaches to create poly-Si contacts. To this end, different deposition methods available at the research institutes ISFH, ISC Konstanz, csem, imec, CEA INES, and Fraunhofer ISE were employed to realize test structures featuring poly-Si contacts. These structures were metallized by screen-printing a silver paste and firing. Thereafter, recombination losses both in the passivated region and underneath the metal contacts were determined by photoluminescence imaging. Another important parameter, the contact resistivity, was measured using the transfer length method (TLM).

It was found that the surface passivation quality of poly-Si contacts differed only marginally between the institutes. And more importantly, negligibly low recombination currents (J_0) were obtained for all contact systems. Interestingly, the measured contact resistivity values did not show such a homogeneous distribution but differences from institute to institute were visible. This will be analysed in detail. In summary, a comparison of the currently most important deposition techniques PECVD and LPCVD revealed that both methods form poly-Si contacts of similar performance.