HORIZON EUROPE PROGRAMME

TOPIC HORIZON-CL5-2021-D3-03

Demonstration pilot lines for alternative and innovative PV technologies (Novel c-Si tandem, thin film tandem, bifacial, CPV, etc.)

GA No. 101084046

Digitalised pilot lines for silicon heterojunction tunnel interdigitated back contact solar cells and modules

PILATUS

PILATUS - Deliverable report

D4.2 Draft with first results from Inline Cell and Module Metrology

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Deliverable Background:

Based on task T4.1 (Definition of indoor and outdoor measurement and testing protocol), the task T4.2 aims at the investigation of possibilities and requirements for an inline metrology in the cell pilot line (WP2) and module pilot line (WP3). The focus is on the development of novel inline metrology tools and procedures for the IBC tunnel SHJ technology. Several project partners contribute to this deliverable. ISRA develops inline metrology systems suitable for inspection of SHJ tunnel-IBC cells. FhG implements new measurement applications in automated test platforms to evaluate inline applicability, e.g. for LED sun simulators in combination with imaging techniques. FZU is investigating advanced inspection techniques for structured contacts using Raman or PL-imaging. PASAN develops an inline I-V-measurement unit with special focus on a reliable contacting unit. MBCH focusses on the implementation and data analysis of inline metrology in the module pilot line.

Publishable summary

The aim of PILATUS's work package 4 is to ensure and assess the quality of the solar PV modules. Therefore, the silicon heterojunction (SHJ) tunnel-interdigitated back contact (IBC) solar cells and modules are to be tested extensively, and the results are thoroughly evaluated. This deliverable represents a draft with first results from Inline Cell and Module Metrology. By collecting these data along the pilot line processes, a continuous evaluation of cells, cell processes and module components will provide ongoing feedback in the development of the components. Given the high throughputs of the cell and module pilot lines, and the correspondingly large dataflows generated from inline metrology equipment, smart approaches are needed to collect and store only the relevant data.

Within the tasks on metrology and reliability of SHJ tunnel-IBC technology, requirements and technological solutions for an inline characterization of cells and modules are investigated and developed. For the cell metrology, it focusses on reliable I-V-measurements, spectral luminescence imaging, and optical inspection. A reliable contacting solution, applicable to the IBC metallization layout, is crucial for inline metrology. Within the project, several configurations are developed, tested and scaled to recent cell sizes by PASAN. This contacting solution is integrated into an automated measurement unit and evaluated by FhG-CSP regarding measurement errors and its usage for more advanced characterization such as thermography or light beam induced current measurement. FZU, FhG-CSP and ISRA furthermore develop imaging solution with inline applicability. ISRA reports on advances in the implementation of a new image analysis algorithm to identify print and alignment defects. FZU has developed photoluminescence-based imaging for visualization of non-uniformities in the deposited passivation and/or back-contact layers. FhG-CSP has performed tests to integrated spectral PL imaging into its automated lab-to-fab platform. Besides the metrology techniques themselves, adapted data collection and data analysis is developed, for example innovative algorithms for the image analysis during optical inspection.

The module pilot line contains several camera-based inspection systems for process control in open and closed loops. The highest precision of component alignment is essential for faultless IBC string and module production. Key components like the foil-wire-assembly (FWA) production on the Roll-to-Roll Unit (RRU) and the string production on the Cell-Connecting-Station (CCS) are monitored carefully. Crack inspection systems developed by Meyer Burger are combined with predictive maintenance concepts programmed by CSEM. The back-end focusses on standard inline metrology including visual imagery, electroluminescence imaging, and current voltage characteristics with respect to tunnel-IBC specific characteristics. All metrology data of the module pilot line can be stored in the MES for future analysis and module performance tracing.

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Project partners:

#	Partner short name	Partner Full Name
1	UNR	Uniresearch BV
2	MBG	Meyer Burger (Germany) GmbH
3	MBI	Meyer Burger (Industries) GmbH
4	FhG	Fraunhofer Gesellschaft zur Forderung der Angewandten Forschung EV
5	FZU	Fyzikalni Ustav AV CR V.V.I
6	EURAC	Accademia Europea di Bolzano
7	EXATEQ	Exateq GmbH
8	TNO	Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek TNO
9	NCR	Norwegian Crystals AS (terminated)
10	ULIEGE	Universite de Liege
11	PADA	Finproject SpA
12	ISRA	ISRA VISION GmbH
13	CSEM	CSEM Centre Suisse d'Eletronique et de Microtechnique SA – Recherche et Developpement
14	MBCH	Meyer Burger AG
15	MBR	Meyer Burger Research AG
16	PASAN	PASAN SA
17	WCH	Wacker Chemie AG
18	EPFL	École Polytechnique Fédérale de Lausanne
19	CPT	Cambridge Photon Technology Limited
20	NOR	Norsun AS

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