HORIZON EUROPE PROGRAMME
HORIZON-CL5-2023-D3-02-11

GA No. 101147275

Silicon solar cells with Low Environmental footprint and Advanced interfaces

SiLEAN – Milestone report

MS1 – Epiwafer successful production

Funded by
the European Union

Public summary

One of SiLEAN's goal is achieving ultra-thin wafers with the desired properties for high-efficiency solar cells with lower environmental footprint.
To reach this target, during the first project year, partners (in particular Nexwafe) have been working on the development activities for the production of EpiWafers using the EpiNex™ process developed by Nexwafe. This process involves growing silicon wafers directly from the gas phase in an Atmospheric Pressure Chemical Vapor Deposition (APCVD) reactor on porosified re-usable silicon wafers, that serve as templates for mono-crystalline growth. The key steps of production include seed wafer preparation, porosification, epitaxial growth, lift-off, and post-treatment.
During these activities Nexwafe has developed the necessary recipes and process flows for consistent production of wafers in the range between 50µm and 100µm with high minority carrier lifetimes as can be seen in Figure 1.

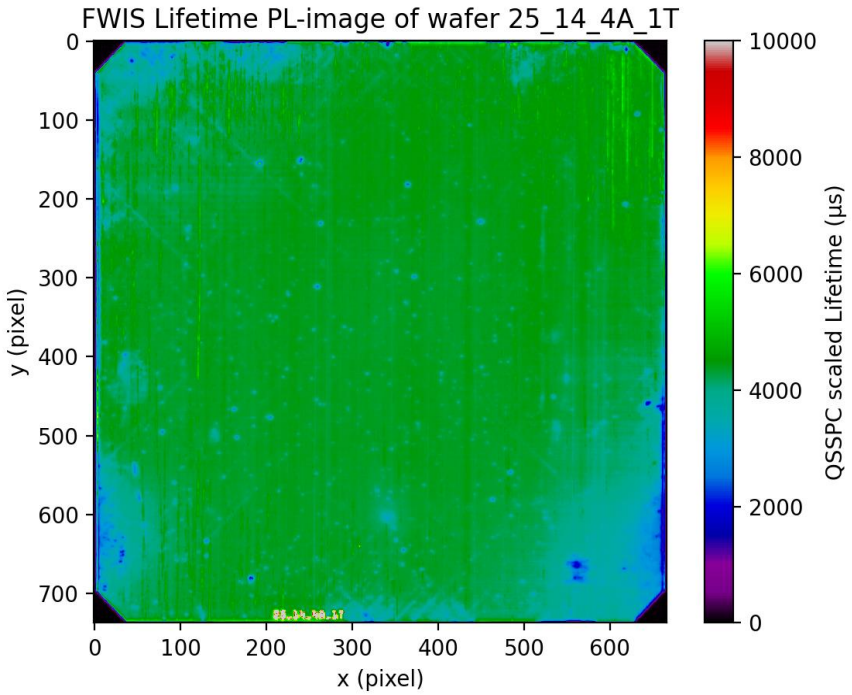

*Figure 1 - QSSPC-scaled PL image of a passivated 1.1 Ωcm n-type EpiWafer measured on an automated wafer inspection system (**wafer thickness <95um**)*

Contents

List of Figures

1 Milestone Achievement

1.1 Production of ultra-thin EpiWafers

This document reports the achievement of SiLEAN Milestone MS1 concerning the production of ultra-thin EpiWafers.

1.2 Description of Milestone and means of verification

The advancements made for achieving this Milestone set the groundwork for further activities within the SiLEAN project. The successful production of high-quality, ultra-thin EpiWafers will enable subsequent activities focusing on optimizing light-trapping and surface passivation in Work Package 2, as well as providing material for the development activities in the other work packages. The redefined processes and improved material quality provide a solid foundation for achieving the project's ambitious goals, including high-efficiency solar cells and sustainable manufacturing process.

The Means of verification, as foreseen by the DoA have been met without deviations nor delays:

Wafers production with desired thickness range of 50-100 µm, D2.1 submitted.

For the validation, the EpiWafers from the first production run with the newly developed flow and recipes were internally passivated and measured in an industrial automated wafer inspection system (WIS), where the physical geometry was measured confirming wafers are within the targeted M2 size specifications. The WIS system also measured the thickness, resistivity and minority carrier lifetime (MCLT) at 1E15cm^{-3} minority carrier density (MCD) by quasi steady state photoconductance (QSSPC), confirmin all project targets were achieved.

1.3 Comments on completion

Key achievement reported is the development of a process for manufacturing EpiWafers with thicknesses below 100µm, with demonstrated minority carrier lifetime (MCLT) exceeding 3.5ms at these thicknesses.

The EpiNex™ process significantly reduces material waste and production costs compared to traditional Czochralski (Cz) grown wafers, which will be further investigated in an LCA study during the project.

1.4 Other relevant information

Lead beneficiary	
Delivery date in DoA	30 April 2025
Actual deliverable date	30 April 2025
Interconnection between WPs	Epiwafer will be used by WP4 working on development of ultra-thin SHJ solar cells. Further this work is also linked to WP6 focusing on demonstrating reduced environmental impact
Achieved	Yes
Reference documents	Linked to D2.1 (submitted on time end April 2025)

2 Risk Register

Risk No.	What is the risk	Probability of risk occurrence[1]	Effect of risk[1]	Solutions to overcome the risk
WP2.1	Insufficient material production capacity (due to competing priorities not enough production capacity is allocated to project)	1	2	Supply partners with smaller sized wafers (5x5 cm2) cut from larger M2 or M6 sized EpiWafers for development activities that can be made on smaller size (eg. Nano-pyramid development, MST, passivation).
WP2.2	Nano-random pyramids do not nucleate easily on EpiWafers and reflectance is too high.	3	2	Tests at WP partners showed that EpiWafer morphology does not impact nucleation of nano-pyramids.

[1)] Probability risk will occur: 1 = high, 2 = medium, 3 = Low

3 Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

#	Partner short name	Partner Full Name
1	FZJ	FORSCHUNGSZENTRUM JULICH GMBH
2	IMEC	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM
3	TUD	TECHNISCHE UNIVERSITEIT DELFT
4	UNR	UNIRESEARCH BV
5	NXW	NEXWAFE GMBH
6	PVW	PV Works B.V.
7	GET	GraphEnergyTech
8	3SUN	3SUN S.R.L.

Disclaimer/ Acknowledgment

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101147275. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.