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Silicon solar cells with Low Environmental footprint and Advanced interfaces

SiLEAN - Deliverable report

D2.1 – EpiWafers production

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Project Scientific Abstract

The SiLEAN project deals with the development of advanced innovations to tackle the major drawbacks of silicon heterojunction solar cell technology, namely the high energy and material demand for Si wafer manufacturing, limited current generation, and the consumption of scarce materials like silver, bismuth and indium. Within the scope of the project, we will directly grow the wafers from the gas phase, optimize the light trapping during texturing, apply alternative passivation concepts that show higher optical transparency, develop indium-free contact layers and apply silver and bismuth-free metallization with all-in-one cell interconnection and encapsulation. The project aims to achieve >25.5% solar cell efficiency and >23.5% module efficiency with 50% lower costs for Si wafers and contacting, as well as up to 75% lower carbon footprint. All processes applied allow upscaling to larger sizes as well as high manufacturing throughput. Eventually, the developments of SiLEAN will pave the way for a new, lean, generation of heterojunction solar cell technology that will both increment the energy conversion efficiency and unlock production at terawatt-scale.

Public summary

The SiLEAN project aims to advance silicon heterojunction (SHJ) solar cell technology by addressing key challenges such as the high energy and materials demands, as well as the use of scarce materials like silver, bismuth and indium. The project focuses on developing lean sustainable manufacturing processes for ultra-thin silicon wafers, with enhanced light trapping and hence improved overall solar cell efficiency.

Deliverable D2.1 specifically reports 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.

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.

These advancements 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.

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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.
9	GUNAM	ODTU GUNES ENERJISI UYGULAMA VE ARASTIRMA MERKEZI

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