Ambi PV
Adapted Modules for Bifacial Photovoltaics

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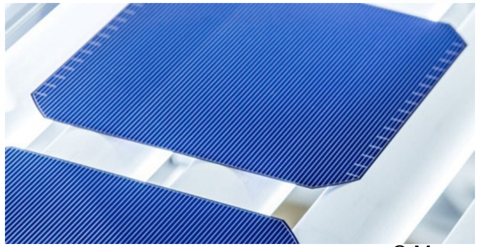
Main Objectives

- The project Ambi PV focused on new interconnection approaches for bifacial solar cells
  - *The higher current in bifacial modules causes increased ohmic power losses*
  - *Potential interconnection approaches: wired interconnection, shingling, 1/2 cells or combined approaches*
- Approaches investigated in Ambi PV:
  - *A new wire-based concept for the interconnection of bifacial IBC (Interdigitated Back Contact) cells*
  - *Two shingling interconnection approaches for PERX cells, based on electrically conductive adhesives (ECA) and seamless soldering.*

Multiwires



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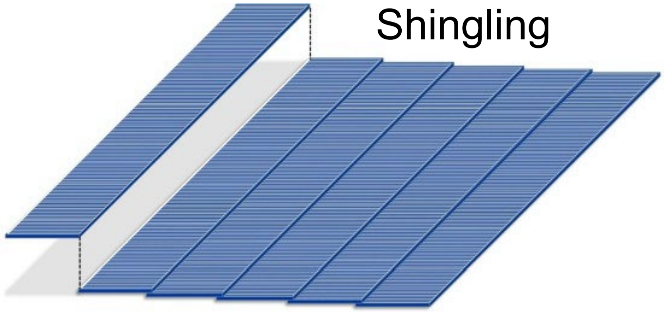

Shingling

https://doi.org/10.1016/j.apsusc.2020.145420

Consortium

- Polymer Competence Center Leoben (Lead, AT)
  - *Simulation of ECA interconnects*
  - *Investigation of transparent backsheets*
  - *Investigation of degradation behavior and material interactions*
- ISC Konstanz (D)
  - *Development and optimization of IBC & PERC cells*
  - *Development and testing of shingling and wire interconnection*
- University of Applied Sciences Gelsenkirchen (D)
  - *Temperature modelling & Outdoor performance*
- ZHAW (CH)
  - *Development and testing of seamless soldering interconnection*
- SolAround (ISR)
  - *Development of PERC cells*
- Meyer Burger (CH)
  - *Development of wire interconnection method and equipment*

Facts & Project progress

- Duration: 10/2019 - 12/2022
- Incident 1: Meyer Burger stepped out of the project in December 2019
- Hiatus until September 2020:
  - ✓ *Efforts to replace Meyer Burger with another swiss company partner without changing the main project goals*
  - ✓ *Replacement partner was found, but due to COVID related economic difficulties stepped out*
  - ✓ *Swiss funding agency agreed on continuation of project without replacement partner*

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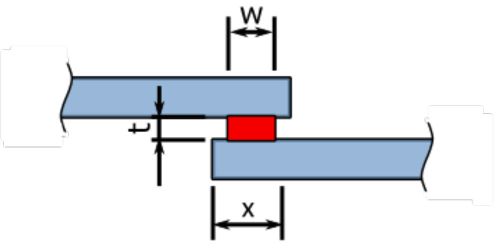
Simulation of shingled ECA bonds

Objective: Reduce stresses in the joint and adjacent silicon cells

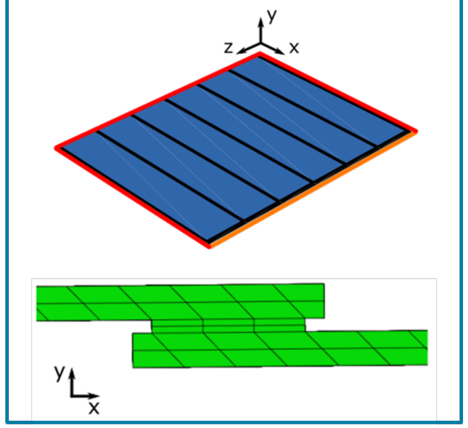
Potentially adaptable design parameters

- Cell width
- Joint thickness (t)
- Joint width (w)
- Overlap (x)



Detailed stress analysis

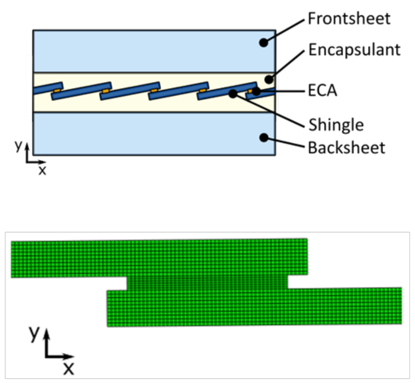
Global model



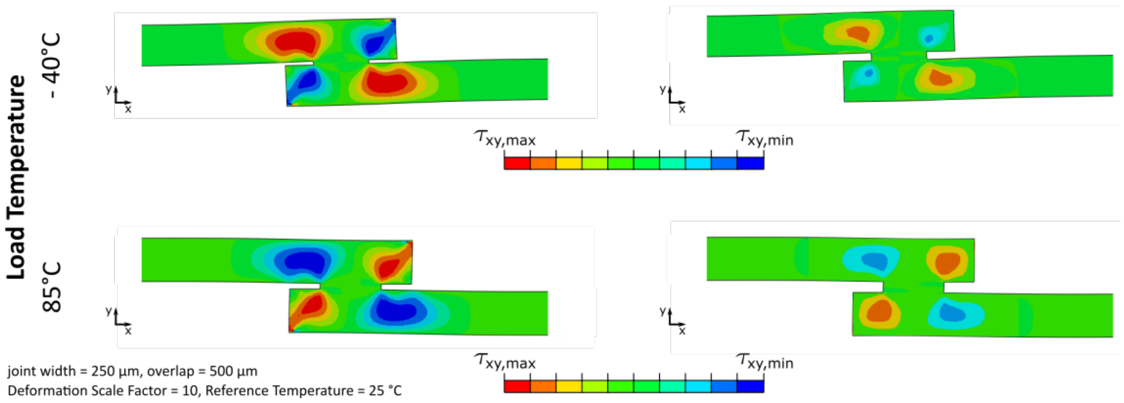
Deformation field

Temperature field

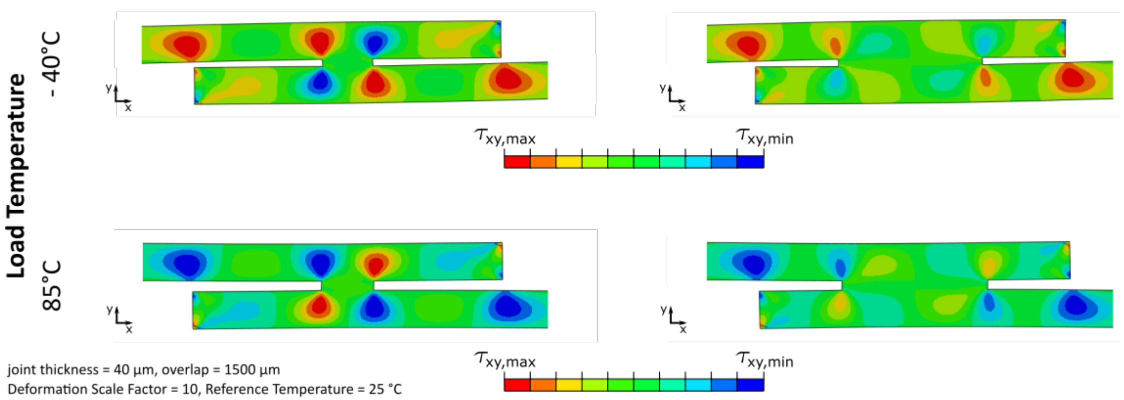
Local model



Variation of geometric parameters



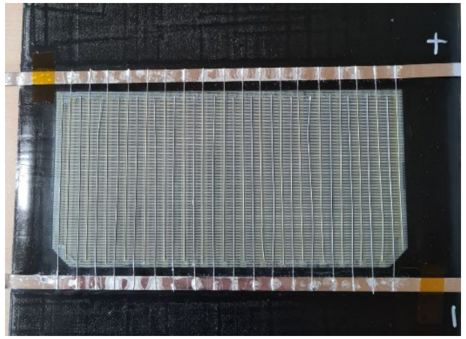
Variation of geometric parameters



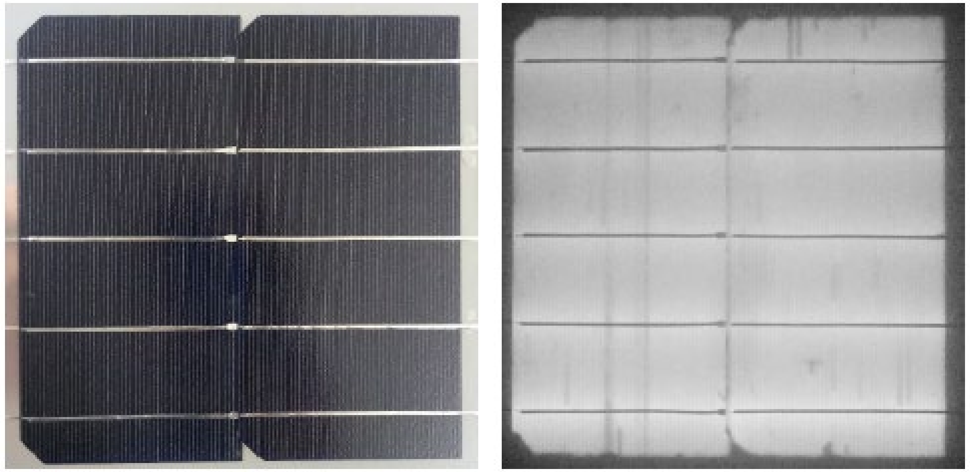
Optimum joint design criteria for shingled solar cells derived

Lang M., Oreski G., Helfer E., Halm A., Klenk M., Fuchs P, FEM simulation of deformations and stresses in strings of shingled solar cells under mechanical and thermal loading(2022) AIP Conference Proceedings, 2709, art. no. 020008, DOI: 10.1063/5.0126221

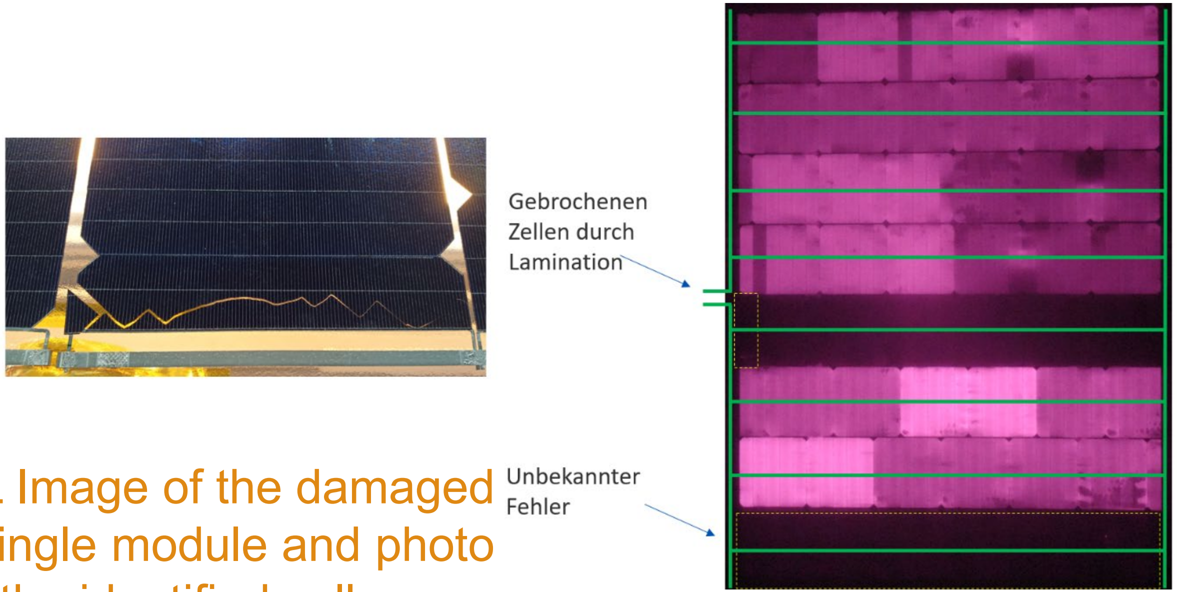
Interconnection approaches



Semi-laminate, made from 18 BB IBC cell

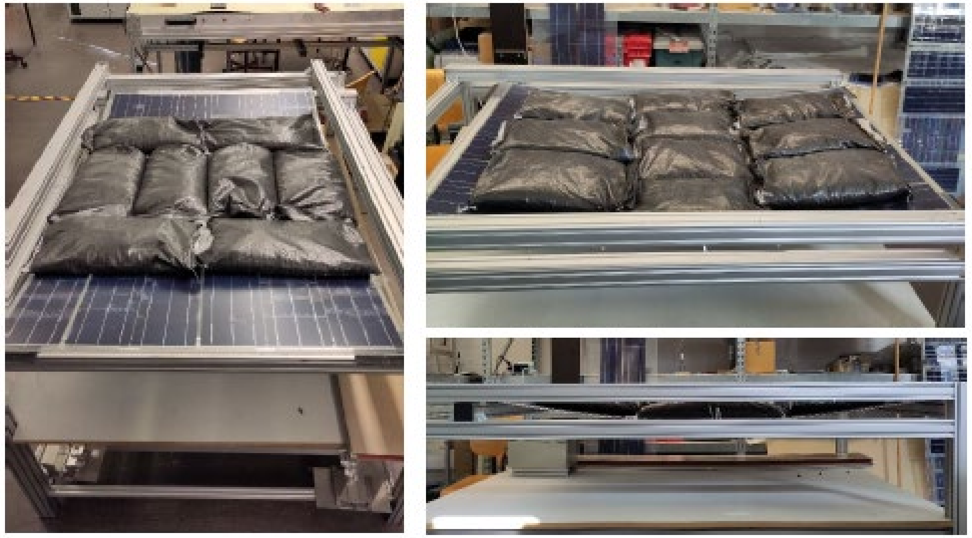


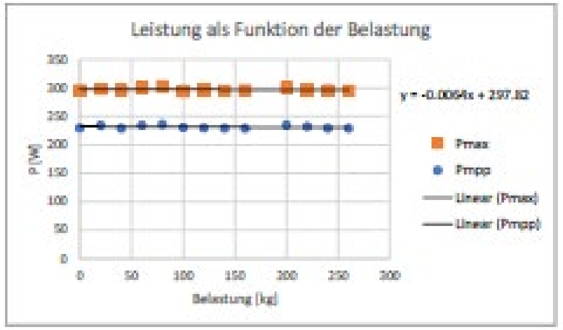
Mini module (glass/transparent backsheet) made with overlapping soldering from bifacial monocrystalline 5 busbar solar cell from SolAround with no detectable breakage even in EL.

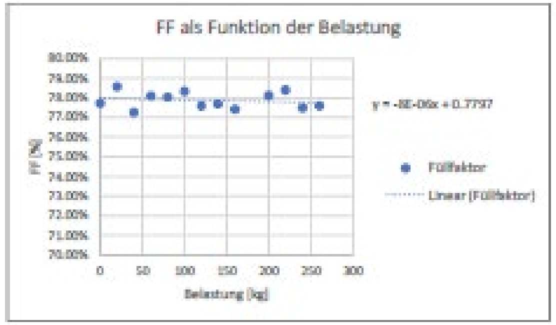


EL Image of the damaged shingle module and photo of the identified cell fracture during lamination

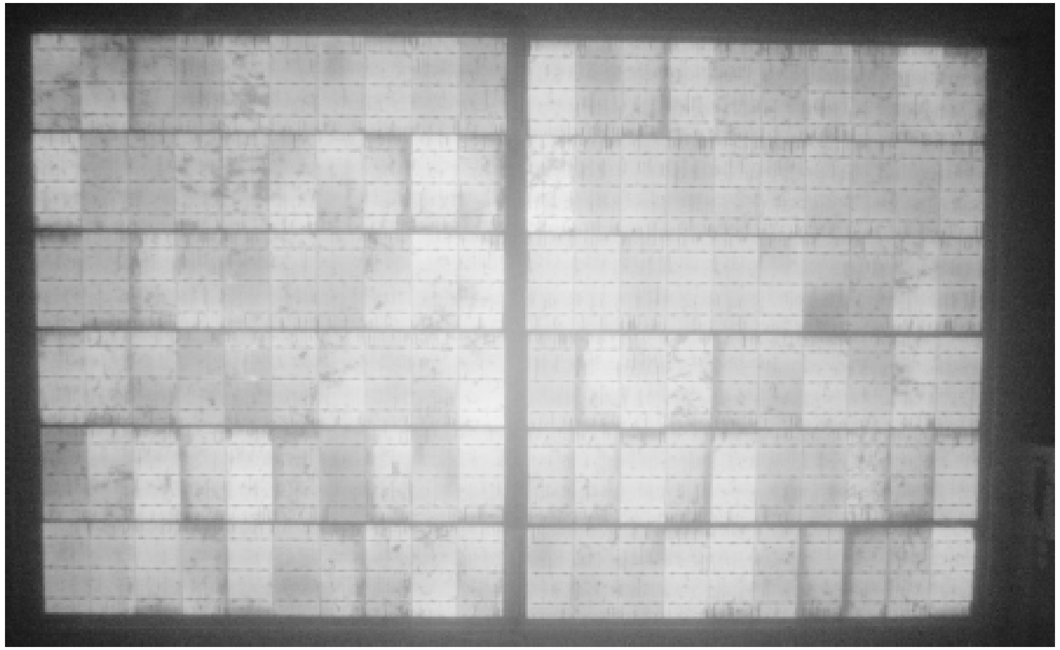
Module with seamless soldering





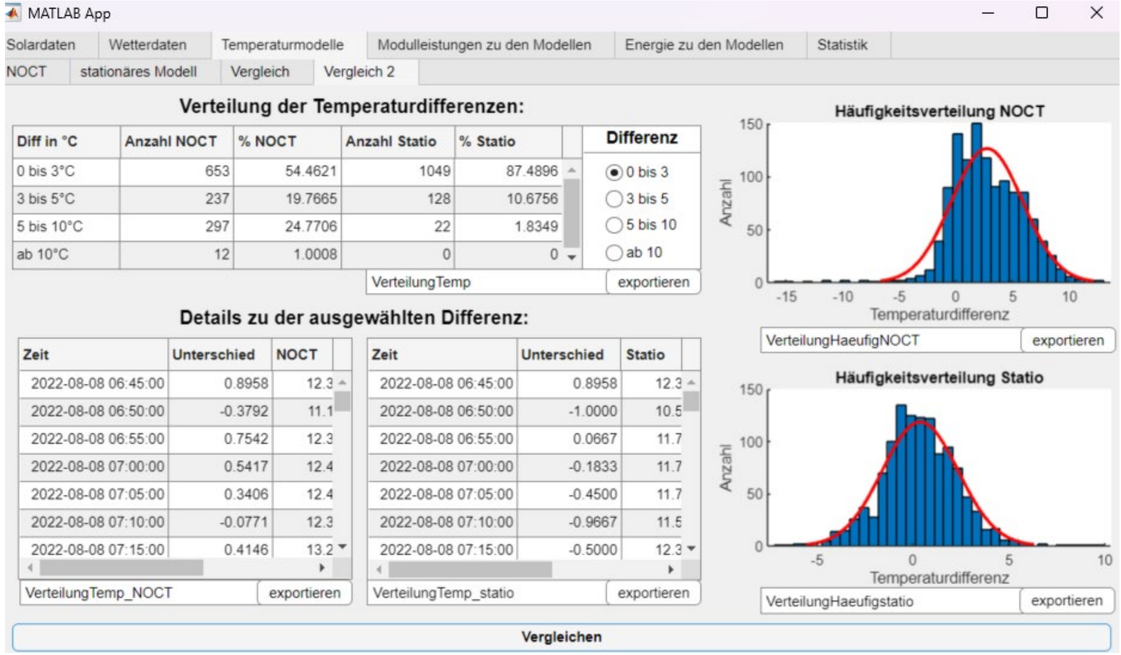


No damage after soldering, lamination and static mechanical load testing



Mechanical Load test with the full-size module. The weight was increased in increments of 20 kg. The maximum weight of the sandbags was 260 kg. Here the load is shown at about 200 kg.

Temperature modelling of bifacial PV modules



Implementation of temperature model in Matlab

Module type	**ID**	**Cell- / module technology**	**P (W)**	**T_{KPmpp} (%/K)**	**NOCT (°C)**
Panasonic VBHN 340 SJ53	1	HIT / standard	340	-0.26	44
Sunpower P3 325 BLK	2	PERC / shingled	325	-0.36	45
REC-Alpha-Series 365 W	3	HJT / SmartWire	365	-0.26	44

Module types used for temperature model validation

ID	*Temperature*		
	R^2	*RMSE(° C)*	*MAE*
1	0.955	0.247	0.235
2	0.960	1.168	1.102
3	0.964	0.813	0.769

Statistics of the **difference** between predicted and measured module temperature

Critical factors and lessons learned for future successful transnational R&I projects

Critical factors & lessons learned

- Good communication between partners necessary
- Regular meetings (in person & online) help progress the project
- Clear work plan and roles of partners

Positive experiences

- Willingness of funding agencies to continue project even when partner step out
- Flexibility with adaptations of the project goals
- Acceptance of delays caused by COVID pandemic

Problematic

- Additional country specific requirements make consortium building a challenge
- Different project starts and running times for different countries
- Different reporting periods & different languages for national reports