

1 MWT (Metal Wrap Through) silicon solar cell which can be modified for illumination levels from 5 to 25 suns.

2 MWT solar cells interconnected and encapsulated on metal substrate.

3 Prototype linear concentrator with receiver and secondary optical element.

## LOW CONCENTRATING PV – LCPV: CELL, RECEIVER, SYSTEM

Low concentrating photovoltaic (LCPV) systems utilizing industrial “one-sun” manufacturing equipment is an interesting path for producing low cost electricity from solar energy. Fraunhofer ISE has extensive experience in solar cell technology, concentrating technologies and system development. We partner with industry to achieve the highest performance on the component as well as on the system level.

Customized back contact silicon solar cells are modified for illumination levels up to 25 suns reaching cell conversion efficiencies up to 21.5% at 10 suns. Due to reduced (MWT) or no (Back Contact Back Junction – BC-BJ) front metallization, these cell types feature less shading losses compared to standard front-back solar cells. In order to modify the receiver for high current densities, we have developed special interconnection designs and advanced thermal management systems. Furthermore our industry partners benefit from innovative process technologies geared towards potential mass production.

### Our services:

Solar cell development

- customized solar cell design
- advanced solar cell concepts
- solar cell pilot series production
- total cost of ownership analysis

Receiver development

- receiver arrangement
- material selection and thermal design
- electrical interconnection
- production technologies

Concentrator optics

- design
- characterization

Prototype manufacturing

- production of receiver units
- interconnection of receiver units to full size arrays

Testing and analysis

- performance analysis
- characterization
- reliability testing

### Fraunhofer Institute for Solar Energy Systems

Heidenhofstrasse 2  
79110 Freiburg, Germany  
Phone +49 761 4588-0

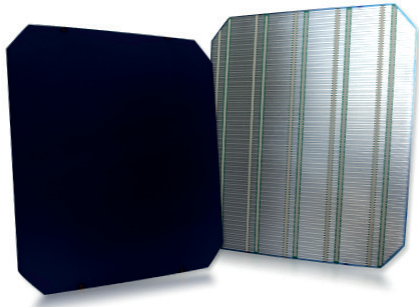
### Photovoltaics –

### III-V and Concentrator Photovoltaics

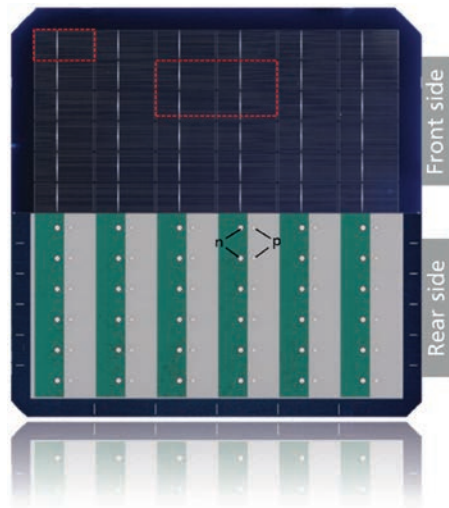
Maike Wiesenfarth  
cpv.lowconcentration@ise.fraunhofer.de

Dr. Florian Clement  
cpv.silicon@ise.fraunhofer.de

[www.ise.fraunhofer.de](http://www.ise.fraunhofer.de)



4



5

## Concentrator Solar Cells

- individually adaptable process sequences for MWT or BC-BJ solar cells
- implementation of high-efficiency features (e.g. selective emitter, surface passivation)
- integration of novel metallization technologies (e.g. dispensing, plating, stencil printing)
- quality control by a large selection of characterization techniques
- concentration and temperature dependent I-V-curves up to 30 A between 0.01 and 25 kW/m<sup>2</sup>
- modeling and rating of optical, electrical and resistive losses

## Concentrator Back Contacted Solar Cells

- prototype production of customized back contact cells
- cell processing of individually adaptable back contact cell structures (e. g. MWT or BC-BJ)
- unit cell approach for customized contact layouts and cell sizes
- characterization of solar cells
- solution-oriented failure analysis
- conversion efficiencies of more around 21.5% at 10 suns 25 °C on Cz-Si
- process development for optimized solar cells via resistance measurements)

## Receivers and Systems

### Interconnection technology

- electrical and thermo FE modelling of cell connector ribbons and strings
- thermal-mechanical FE modelling of strings
- development of optimized connector ribbons for back contact solar cells
- interconnecting of customized solar cells with different soldering, bonding or gluing techniques

### Receiver technology

- thermal-mechanical FE modelling of heat fins and complete receiver compound
- design of receiver (thermal design, encapsulation technologies)
- material characterization
- process development on prototype level for receiver production

### Analysis and characterization

- indoor and outdoor characterization
- yield measurement of receiver prototypes
- long term outdoor monitoring

### Reliability testing of components and receiver compound

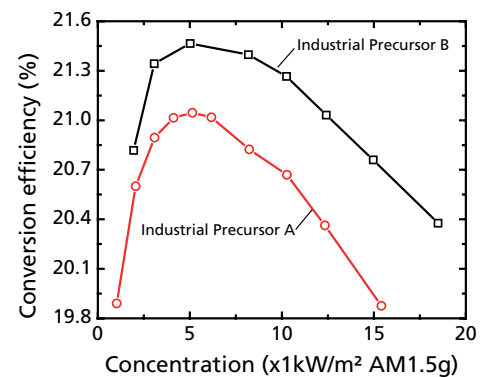
- thermal cycling, temperature degradation
- UV- and damp-/heat test
- high-voltage test

### Analysis and cost studies

- lab-to-fab preparation
- cost study

4 Back Contact Back Junction (BC-BJ) solar cell without any front side shading and 3D busbars on the rear.

5 PERC-MWT unit cell approach featuring, as indicated customizable cell sizes on a wafer with an edge length of 15.6 cm. The size of a single unit cell is 11.5\*23 mm<sup>2</sup>. Therefore, final cell sizes consist of multiple quantities of it.



6 Concentration dependent conversion efficiencies achieved by the PERC-MWT solar cell unit cell approach using industrial precursor A and B from different vendors.