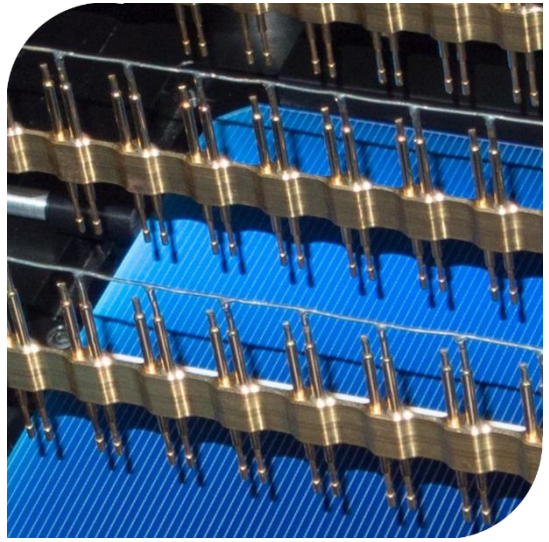



ZEBRA Technology: low cost IBC solar cells and modules for new applications

Jan Lossen, Valentin D. Mihailetchi, Joris Libal, Haifeng Chu, Christoph Peter, Florian Buchholz, Tudor Timofte, Andreas Halm, Qu Xiaoyong, Wu Xiang, Guo Yonggang, Dong Peng, Radovan Kopecek

ISC research for a sunny future

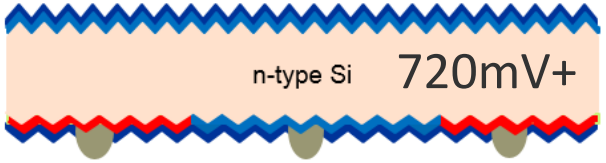
SPIC

Intersolar 2021, October 6

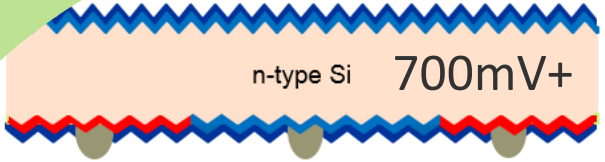
ISC's roadmap for advancement of c-Si cells

Reduced shading
Reduced front side recomb.

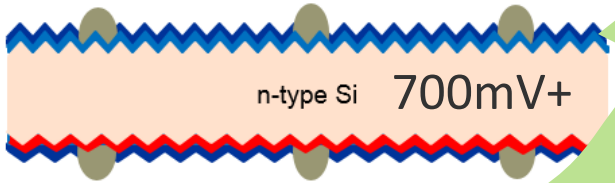
poly-IBC 25%+



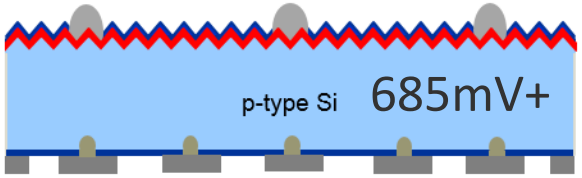
IBC (ZEBRA) 24%+



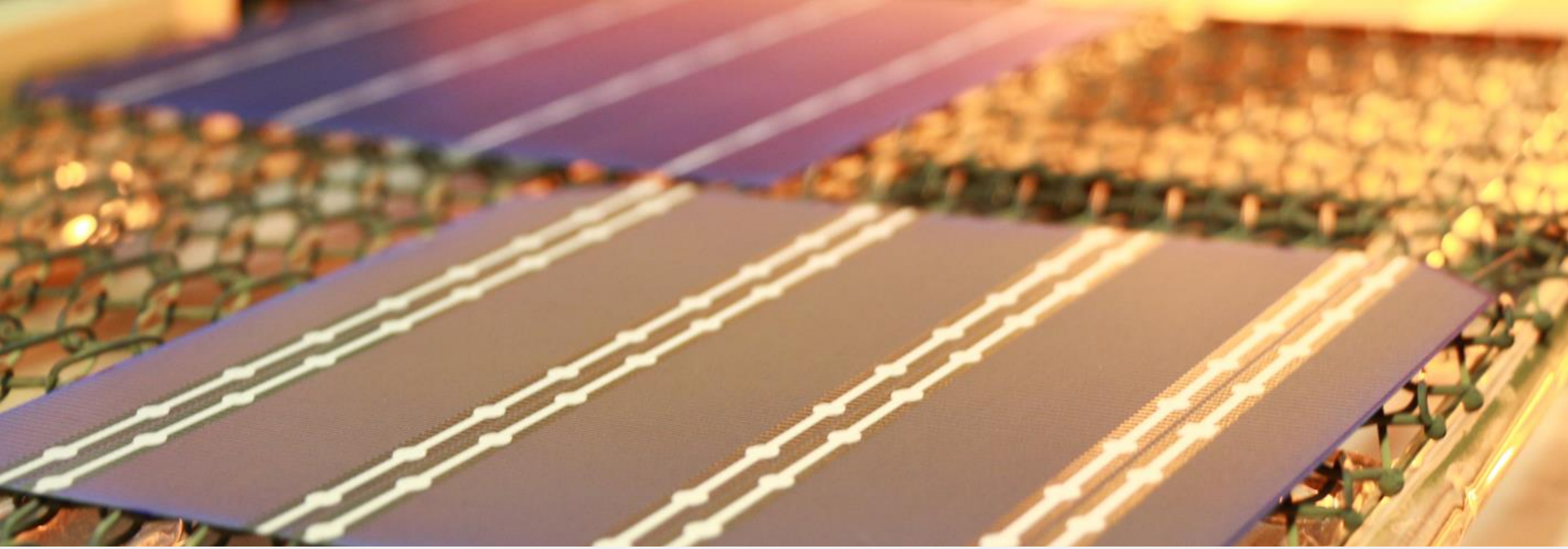
TOPCon (TOUCAN) 23.5%+



PERC 22.8%+



Reduced recombination

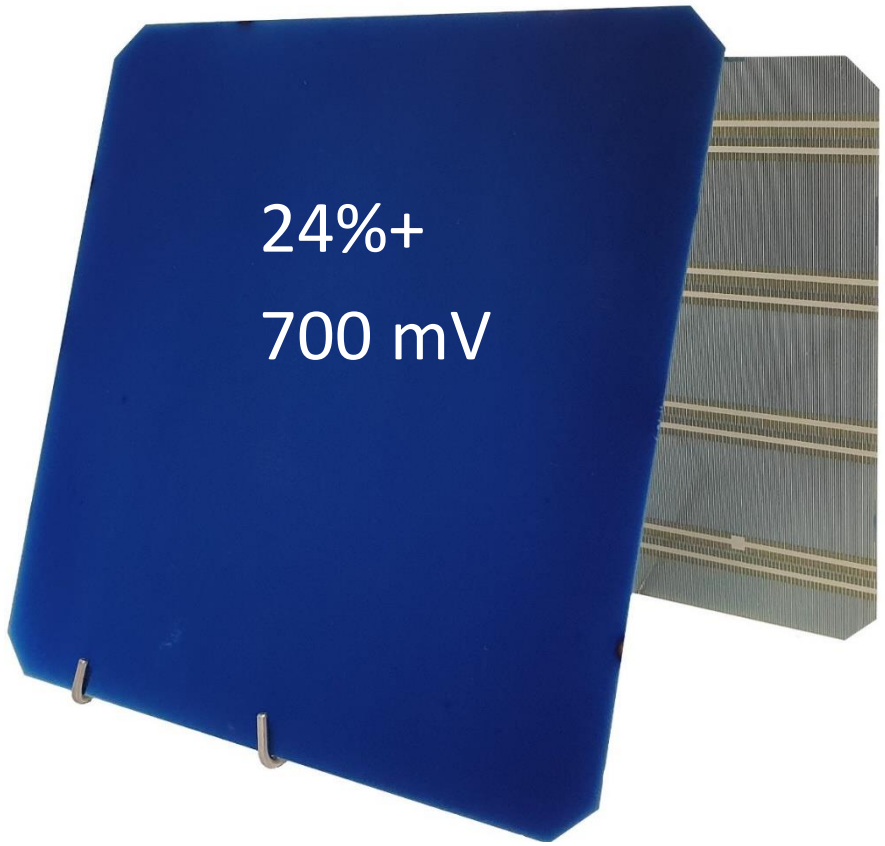


ZEBRA Solar Cells

ISC’s ZEBRA solar cells

A low-cost, high efficiency, n-type back contact back junction solar cell

- No metallization on front side
- Regular stripes of n+ and p+ doping on the rear
- Screen printed Ag-paste metallization
- Busbars on flexible positions

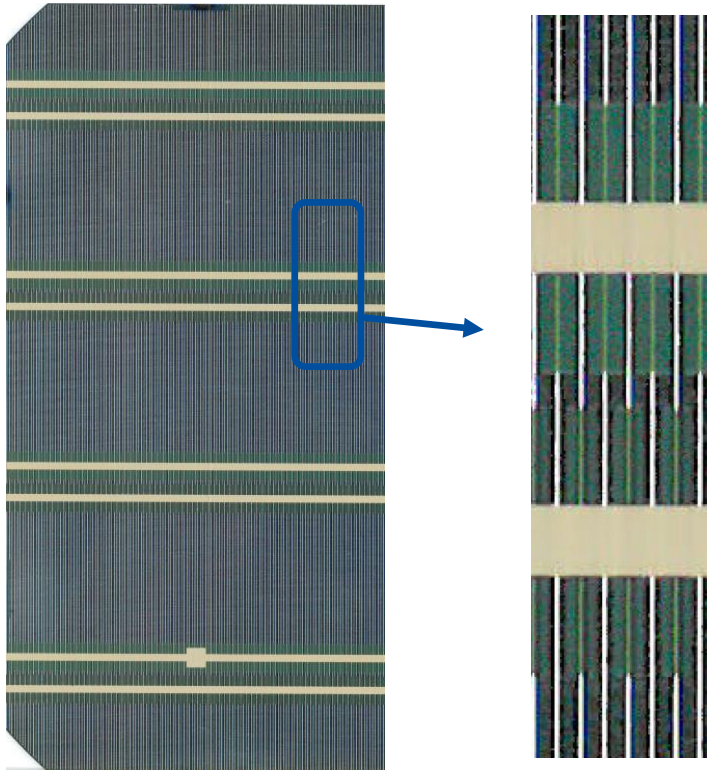


Technology & IP developed by ISC Konstanz

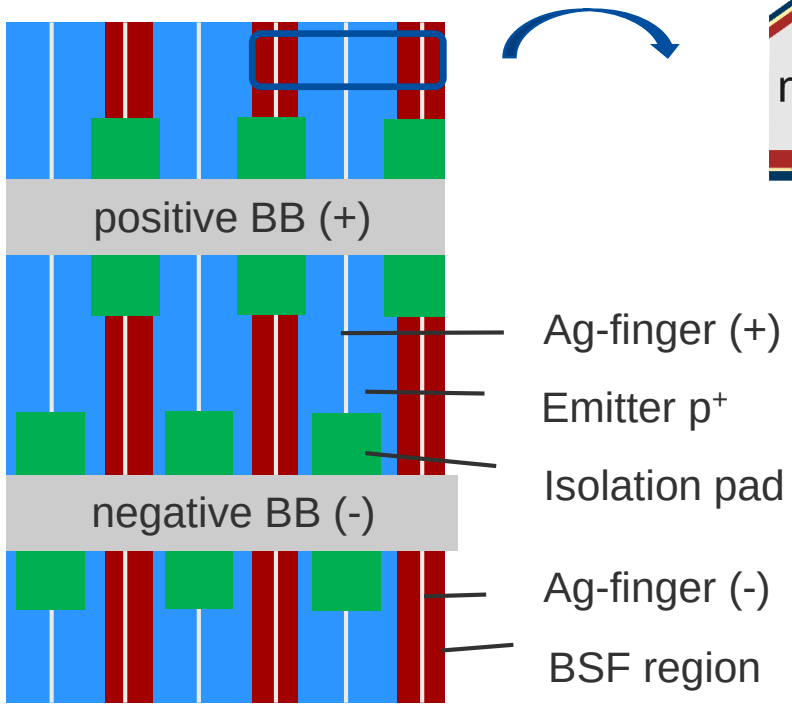
in over 10 years of R&D

The stripes of the ZEBRA Cell

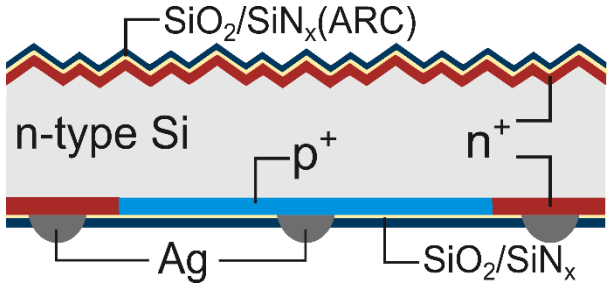
Photo of rear side



Schematic drawing

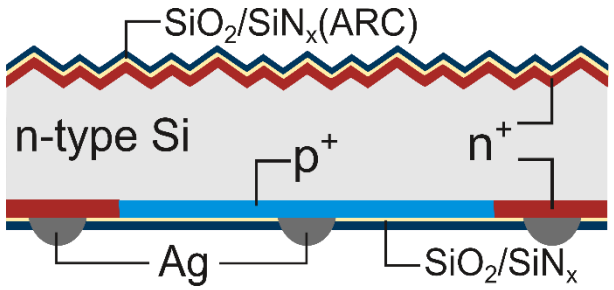


Drawing of cross section



The stripes are p+ and n+ doped regions of optimum width

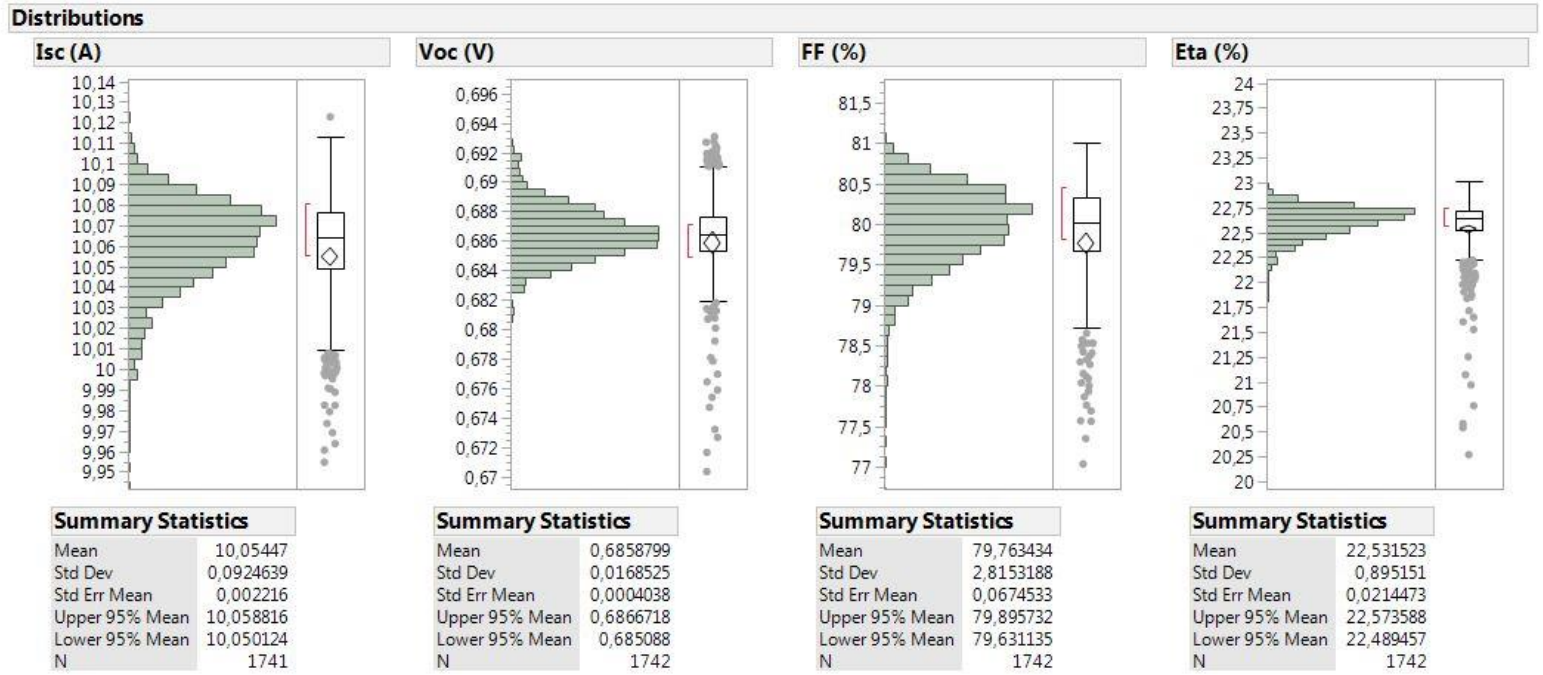
IV Data ZEBRA cell @ ISC



- Diffused junctions
- Diff. front surface field
- SiO_2 passivation layers
- Ag-Metallisation

Mature Technology

IV-Results of 3 lab runs at ISC



Best values in lab run

10.12A	693mV	81.0%	23.02%

Lean manufacturing process

PERC Process

- SDE and Texture
- POCl3 Diffusion
- PSG and Etching
- PECVD Rear side
- PECVD Front side
- Laser LCO
- Screen printing

Additional steps for ZEBRA

- PECVD rear (masking)
- Alkaline SDE
- BBr3 Diffusion
- BSG etching

Additional Tools

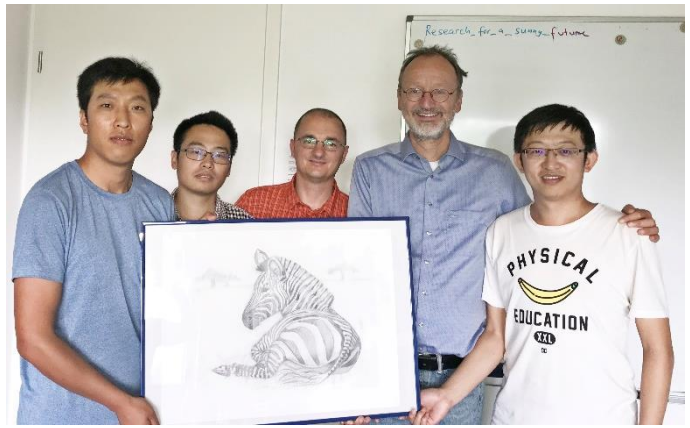
- ~~No AlOx~~
- PECVD tubes
- Diffusion furnace
- Batch etching

Additional steps are proven in mass production

Technology transfer by ISC

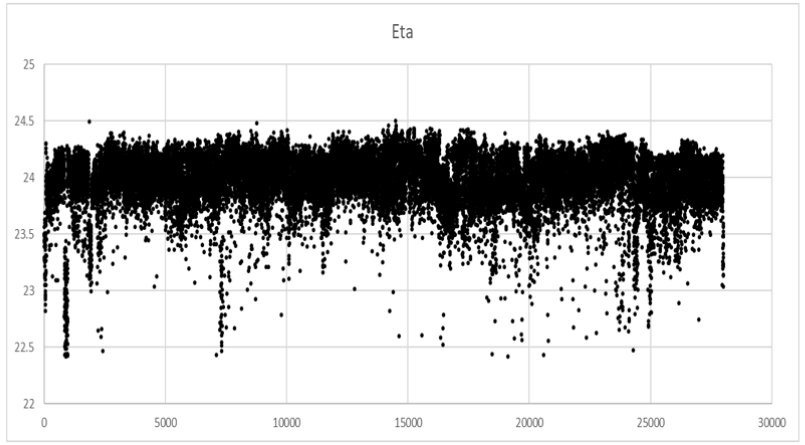
Experience from 5 successful transfer projects (BiSoN & ZEBRA)

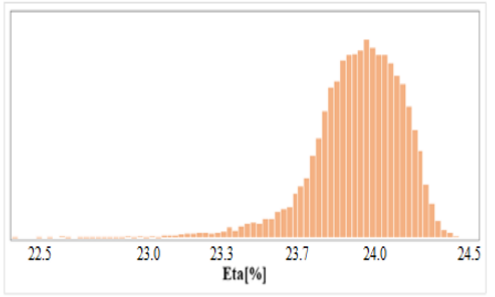
- Specification and procurement of equipment
- Commissioning, Ramp-up, Training
- Process optimization in team with customer

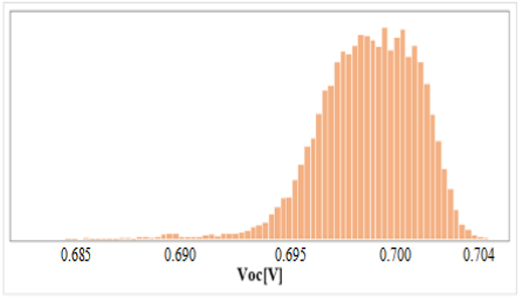


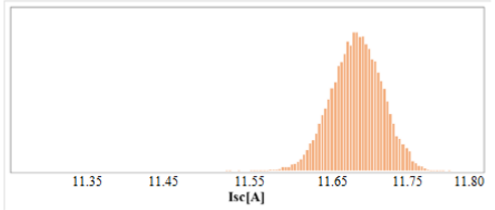
ZEBRA in series production at SPIC, Xining

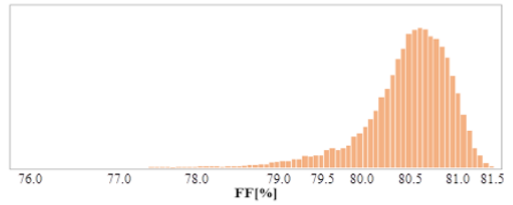
电池效率











IV data of one day of production, 10/2021

	Isc（A）	Voc（mv）	FF（%）	Eta（%）
average	11.69	697.46	80.57	23.97%
Best cell	11.78	701.31	81.31	24.50%

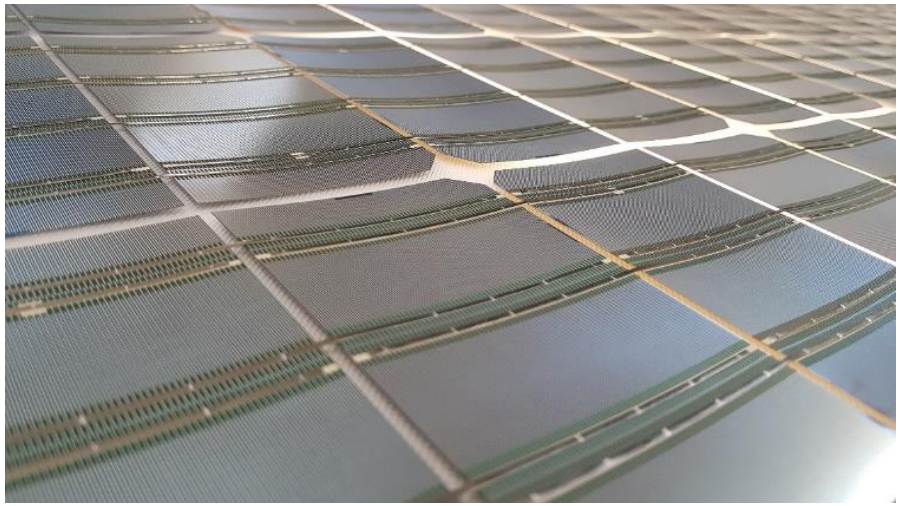
For more details, see also: Kopecek et al., ZEBRA technology: low cost bifacial IBC solar cells in mass production with efficiency exceeding 23.5%, IEEE 47th Photovoltaic Specialists Conference (PVSC), 2020 DOI: 10.1109/PVSC45281.2020.9300503.

ZEBRA Ramp-up at Valoe, Vilnius

ZEBRA Modules

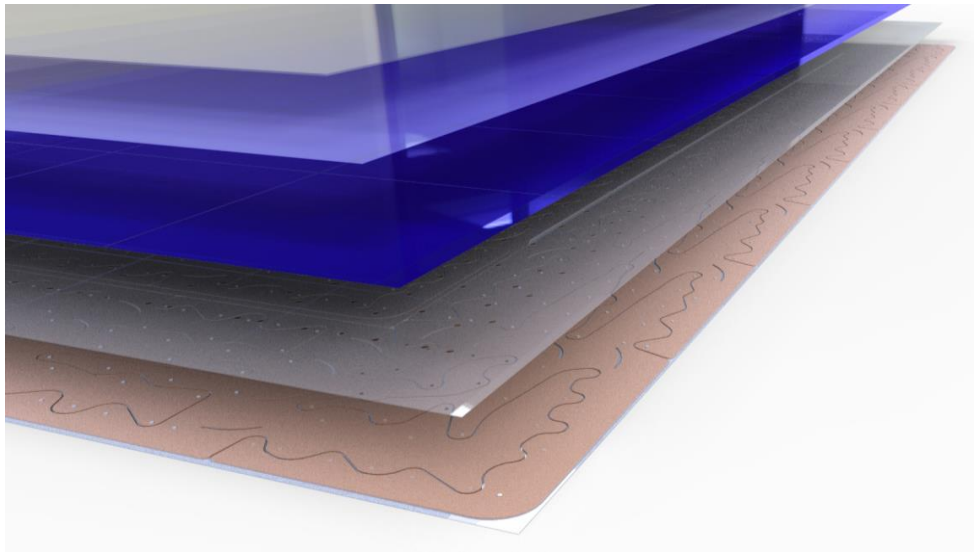
Interconnection possibilities

Ribbon based soldering



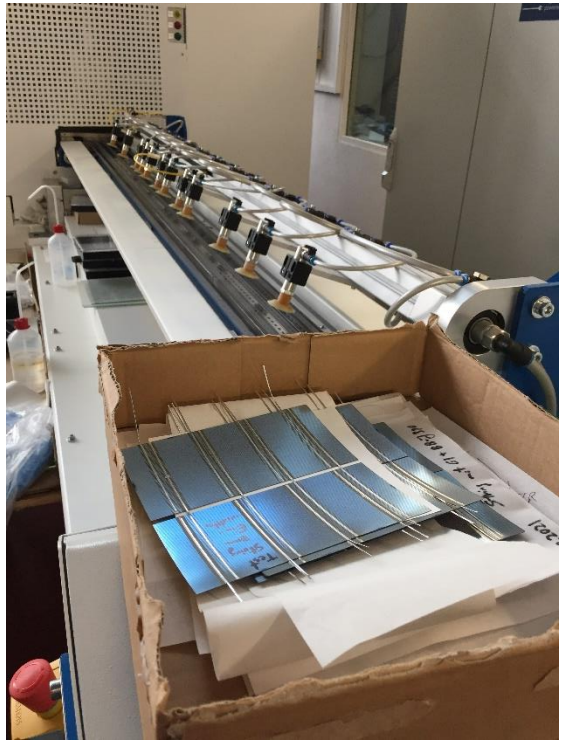
- Close to standard
- Only adjustment of stringer required
- Use of half cells recommended

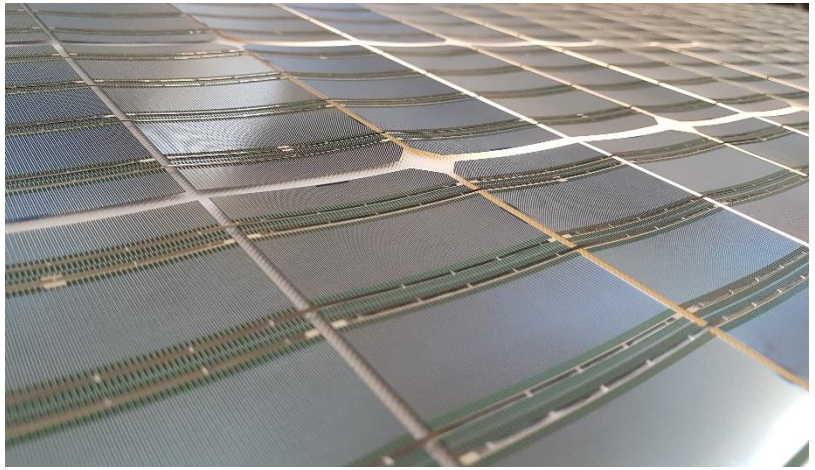
Conductive back sheet (CBS)



- Flexibility on module layout
- Pick-and-place process with low mechanical stress on cells

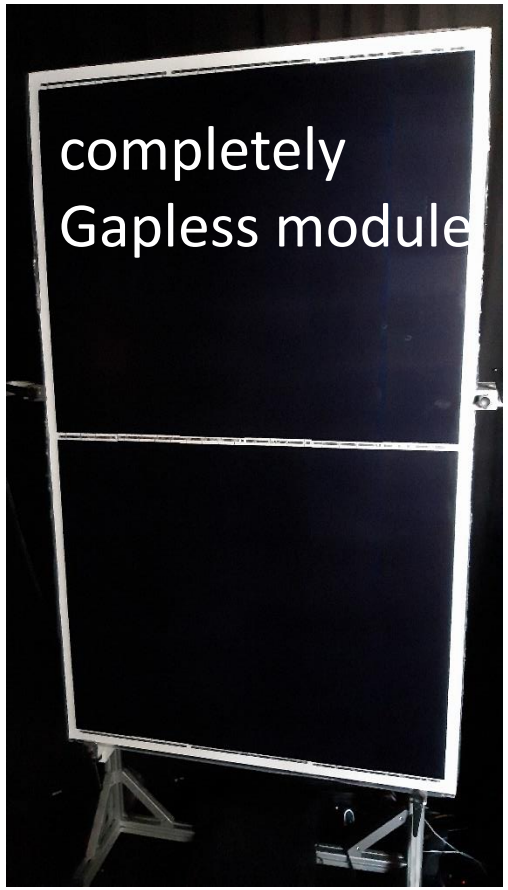
Team Technik Stringer for back contact cells





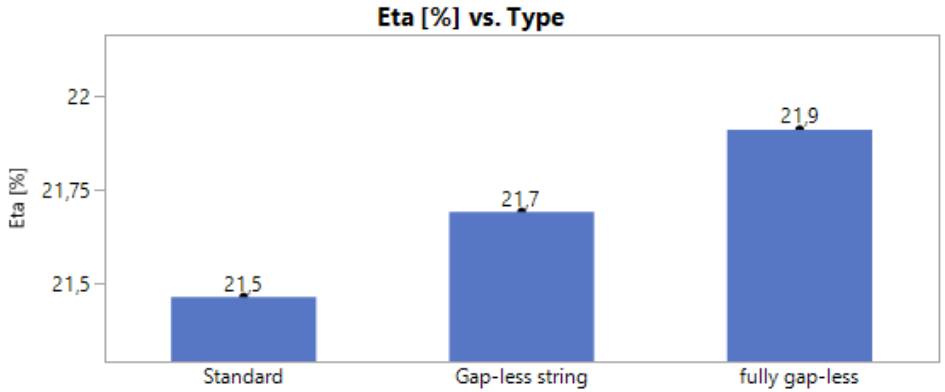
- Upgraded TT2100 at ISC Konstanz
- Automatic soldering of half cell back contact strings
- M2/G1, upgrade to M6

Gapless module development at ISC



- Lower solar cell costs
- Bigger wafers size
- Restriced size in rooftop applications

-> optimization of module efficiency



Commercial Modules – G1 cells

FuturaSun®
anticipate tomorrow

Commercial Modules – G1 cells

FuturaSun®
anticipate tomorrow

LIABILITY INSURANCE

IEC 61215
IEC 61730
Regular Production Surveillance
TÜVRheinland CERTIFIED
www.tuv.com
ID 1111231375

CE

Product guarantee

25 YEARS

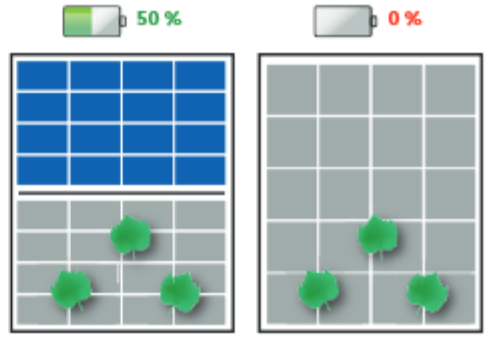
GENERAL FEATURES

- **IBC - Interdigitated Back Contact cells**
- Innovative **Zebra technology developed in Europe**
- **Superior module efficiency up to 21.28%**
- **Total black look** without ribbons on the cells
- **Excellent temperature coefficient -0.3%/°C**
- **Immunity to LID** (Light Induced Degradation) **and LeTID** (Light and elevated Temperature Induced Degradation)
- **Improved low light performance**
- **Better yield with various tilts**
- **No shading on the cell** thanks to **IBC technology**
- **2 independent section** design secures a higher energy yield in case of shading and **minimize the need of optimizers**

CERTIFICATIONS

- **IEC 61215:2016 - IEC 61730:2016 & Factory Inspection**
- **Fire Resistance - Class C**
- **Salt Corrosion Resistance** IEC 61701

NEW



Commercial Modules – M6 cells

ANDROMEDA 2.0

High Efficiency Series

425W|430W|435W

132 half cells M6

module size < 2 m^2

25 year product warranty

25 year performance warranty

FEATURES

- Up to 22.1% Efficiency
- Bigger dimension, More power generation
- IBC-No electrode to block sunlight
- N-Type cell has ZERO LID
- Excellent Temperature Coefficient
- Anti-PID
- Low mismatch loss
- Minimal power degradation (93% of initial after 25years)
- Double 25 Years Warranty

SPIC

PIC Xining Solar Power Branch

o.4 Jinggui Road,Chengdong District, Xining
Qinghai Province, China

ww.spicsolar.com
picsolar@spic.com.cn

New application

Strength of ZEBRA

- High power on restricted area
- Superior aesthetics
- Low temperature coefficient
- Good low light performance
- (Bifacial use possible)

ZEBRA for vehicle integrated PV

VIPV companies using ZEBRA Solar cells for charging the main battery

SONO MOTORS – SION

Clean Motion - Re:volt

Summary

- ZEBRA is a low cost, n-type, back contact back junction solar cell developed in Germany
- Lean production process based on standard equipment
- Module Integration by stringing or CBS-Technology
- Gapless modules with highest module efficiency
- New Applications: ZEBRA power replacing Horse power

L-City

What is your project, that we could help you to realize?

ZEBRA Technology: low cost IBC solar cells and modules, Intersolar 2021

ISC research for a sunny future

Thank you for your attention!

Contact information:

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www.isc-Konstanz.de