BCworkshop2024

TU Delft

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ISC research for a sunny future

TNO innovation for life

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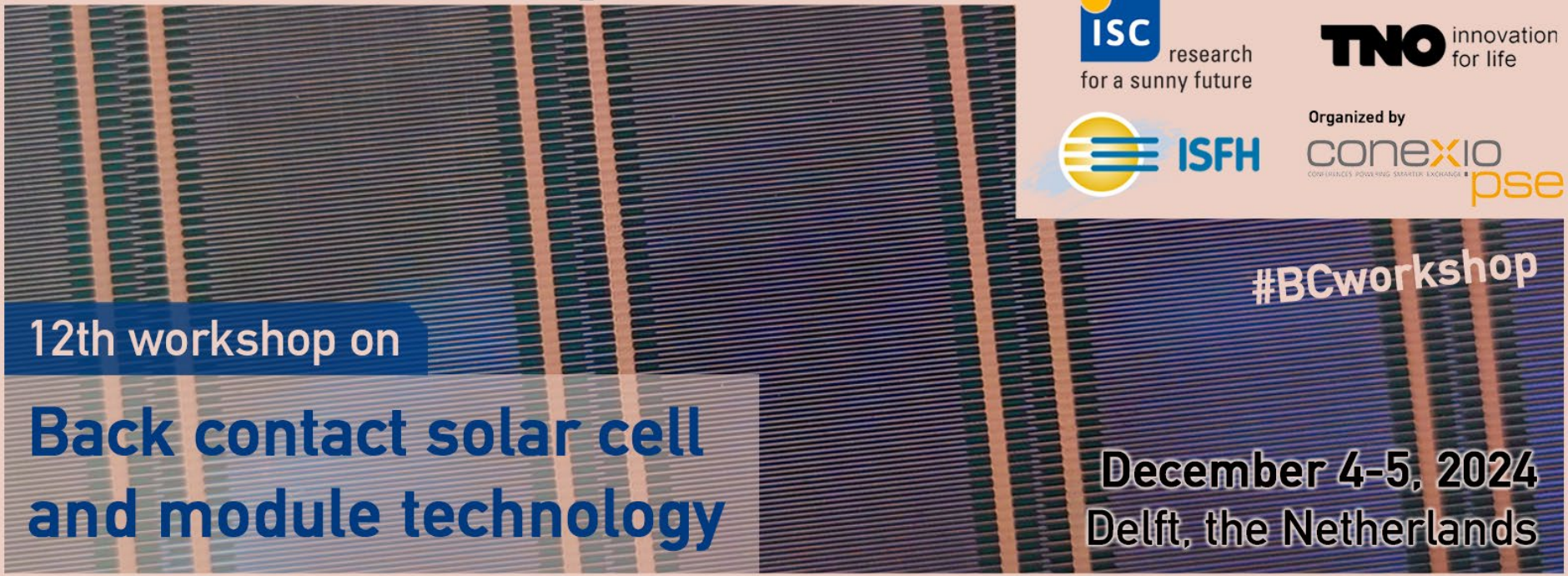


#BCworkshop

12th workshop on

Back contact solar cell and module technology

December 4-5, 2024

Delft, the Netherlands

Hosted by TU Delft

Thanks to our sponsors for their support

Highlights first day

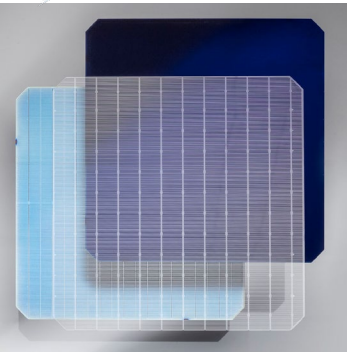
BC Workshop 2024

TU Delft

BC Workshop 2024 - Day 1 Agenda - A few highlights

09:00 - 09:20	**Conference opening**
09:20 - 10:40	**S1: Back contact cells & modules in R&D**
10:40 - 11:20	Coffee break
11:20 - 12:40	**S2: Back contact cells in industry**
12:40 - 13:20	Lunch
13:20 - 14:00	Visiting the Green Village
14:00 - 15:20	**S3: Materials and tools for BC cell technology**
15:20 - 15:50	Coffee break
15:50 - 17:30	**S4: Characterization / Outdoor testing / Shading resilience**
17:30 - 17:40	End of the first day, reaching X Center @ TU Delft
18:00 - 21:00	Social dinner

S1: Back contact cells & modules in R&D



From 2026, POLO² IBC cells on M10 wafers

$in\eta_{POLO\ IBC} = iV_{oc} \times iFF \times J_{sc} = 26.7\%$

$\eta_{POLO\ IBC} = 23.9\%$ (1.0 Ωcm < r_{Ga} < 2.0 Ωcm)

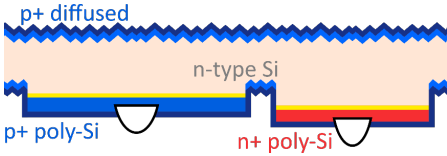
$\eta_{POLO\ IBC\text{-}target} = 25\%$ (optimized Ag/Al)

$J_{0,p\text{-}poly} = 2.3\ fA/cm^2$ (in-situ doped LPCVD)

Two different industrial POLO² IBC designs

$\eta_{polyZEBRA} = 24.12\%$

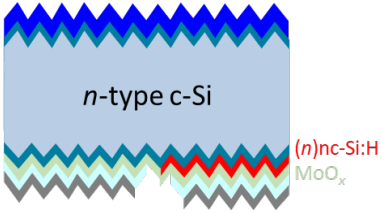
Potential $\eta_{polyZEBRA} > 25\%$

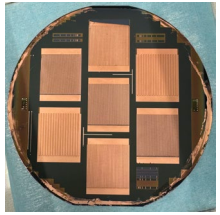


Transfer results from test structures to cell

Production cost of Cu-polyZEBRA module close to TOPCon

Investigating PVD fabrication route of TBC cells



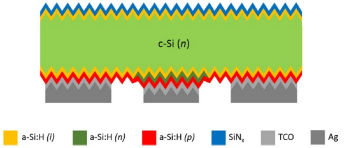


TMO-based IBC SHJ cell

Unveiled transport mechanisms across novel ETL stack

η = 23.10% (with Cu-plated contacts)

η_{target} > 24% in the short term



η = 24.7% (mini-module)

Several times surviving IEC tests

Excellent platform for 3TT devices with η =29.56% (24.5 cm^2)

S2: Back contact cells in industry

maxeon
POWERING POSITIVE CHANGE

通威股份 TONGWEI CO., LTD.

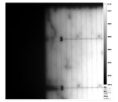
Currently prototyping Maxeon 7 process with self-aligned micro-trench structure.

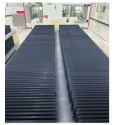
Efficiency loss analysis done for Maxeon 7 and projected for Maxeon 8 (minimal J_0).

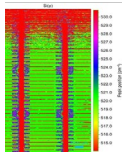
$\eta_{Maxeoon\ 8}$ > 26% (anticipated, with Al metallization)

Largest remaining loss: poor infrared absorption

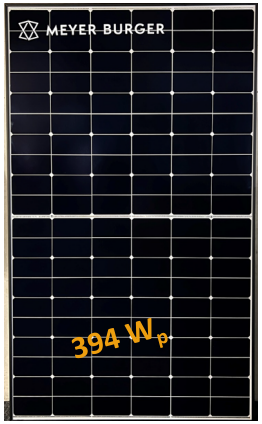
Several blocks fot TBC cell mass production:

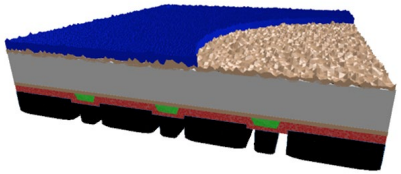






1. Bifacial limit, at most 75% in HTBC
2. TOPCon in-line upgrade rapidly ($\Delta\eta_{2025}$ = +0.4%$_{abs}$)
3. Δη negative in case half cut wafers
4. Simplified TBC structure with boron diffusion junction but not easy in experiment trial
5. Expensive laser and low yield,
6. Thermal cycle induced delamination,
7. Ag consumption in solder joint.



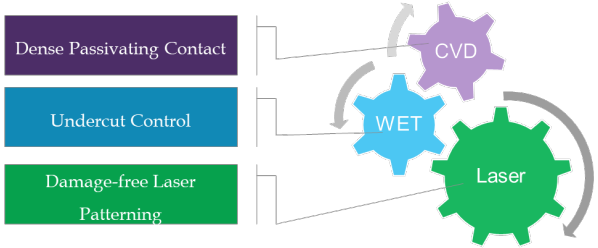


η > 25%

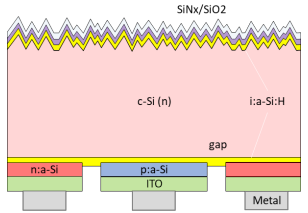
10 process steps (In-free, 3.3 mg/W_p)

IEC superior reliability

MEYER BURGER



η_{record} > 27.3%



CVD: dense a-Si:H layers (T_{depo} = 240 °C)

WET: controlling SiNx undercut with KOH + SDBS

LASER: smart combination of sacrificial layers

LONGi

S3: Materials and tools for BC cell technology

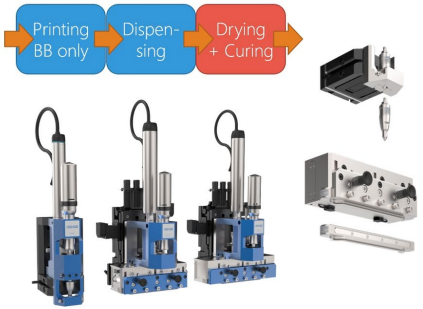
Take Aways for Today

HIGHLINE

Technology:
- Reliable Printheads + Nozzle Kits
- AI controlled Process

Key Applications:
- Fine Line Dispensing down to <20µm
- Dots and Intermittent Coating

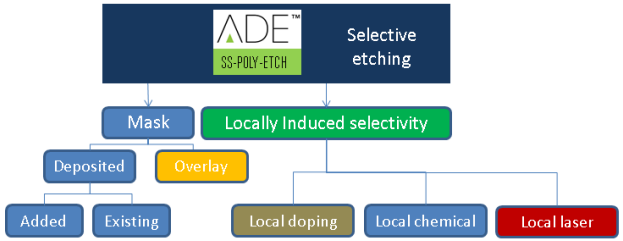
Strong Partnerships for integration in Cell and Module!

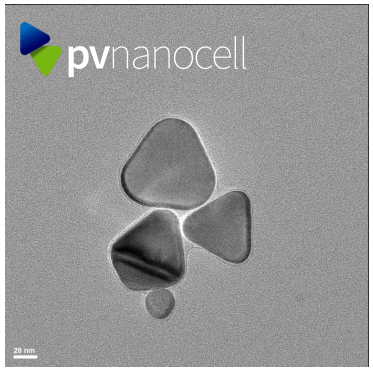


High selectivity of ADE single-side gas-phase etch

Nines Photovoltaics

Enables several paths and options for patterning poly-silicon layers

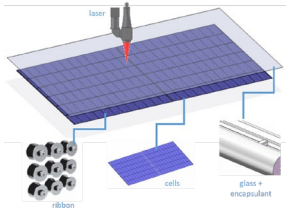




Single-crystal nanoparticles offer superior oxidation resistance

PVN own produces copper nanoparticles (d = 40 nm)

Printing 25-µm wide line with PTP technique



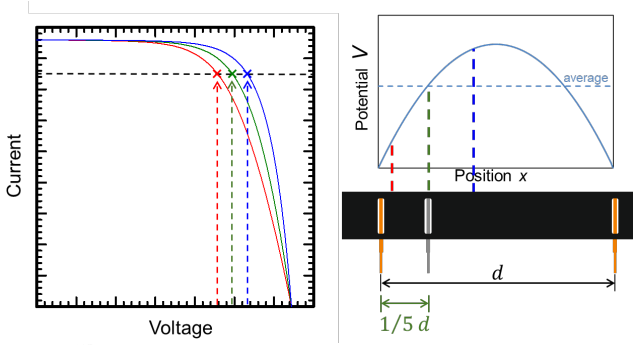
Laser Integrated Bonding for module manufacturing

Addressed reliability

ΔCTM ratio > 0.5% --- $\Delta P_{mpp} > 4W_p$

DR Laser 帝尔激光

S4: Characterization / Outdoor testing / Shading resilience



Multi-spectrum spectral responsivity using a LED solar simulator

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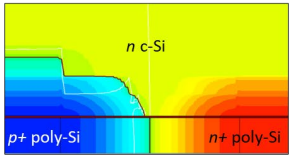
***Fakir* vs *PCB* vs *Custom* chucks**

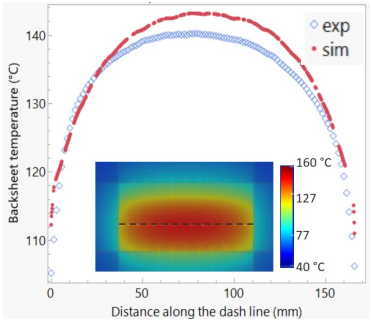


Band-to-band tunneling between BSF and emitter in IBC solar cells

20% energy yield gain with cells with -0.3 V breakdown voltage and partially shaded for 20% of the time

Measured 7.9% increase in specific yield with IBC cells with -3 V breakdown

PVMD Delft University of Technology



Ideal uniform breakdown can still show high temperature

High V_r → T_{peak} increases with power of the substring

Low V_r → T_{peak} depends on reverse IV curve

Challenging modelling

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High-η solar cells show capacitive behavior during fast sweeps → solar simulators needed with long pulse or steady-state capability

PVK modules are metastable. Sweep times > production cycle times → standardized characterization methods mainly based on MPP and inline characterization can be performed using a controlled offset from offline characterization

Double-side method for accurate characterization of both bifacial modules with asymmetric design and bifacial 2T tandem modules

eternalsun


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AIKO
exateq
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BC Workshop 2024 - Day 2 Agenda

09:00 - 09:20	**Highlights first day**
09:20 - 10:40	**S5: Novel interconnection technologies for BC moduules**
10:40 - 11:20	Coffee break
11:20 - 12:00	**Round table 1: *Will BC technology be the next big thing?***
12:00 - 12:40	**Round table 2: *Technology challenges in BC technology?***
12:40 - 14:00	Lunch
14:00 - 16:15	**S6: Industrial BC modules and field applications**
16:15 - 16:30	Closing remarks and announcement next BC workshop

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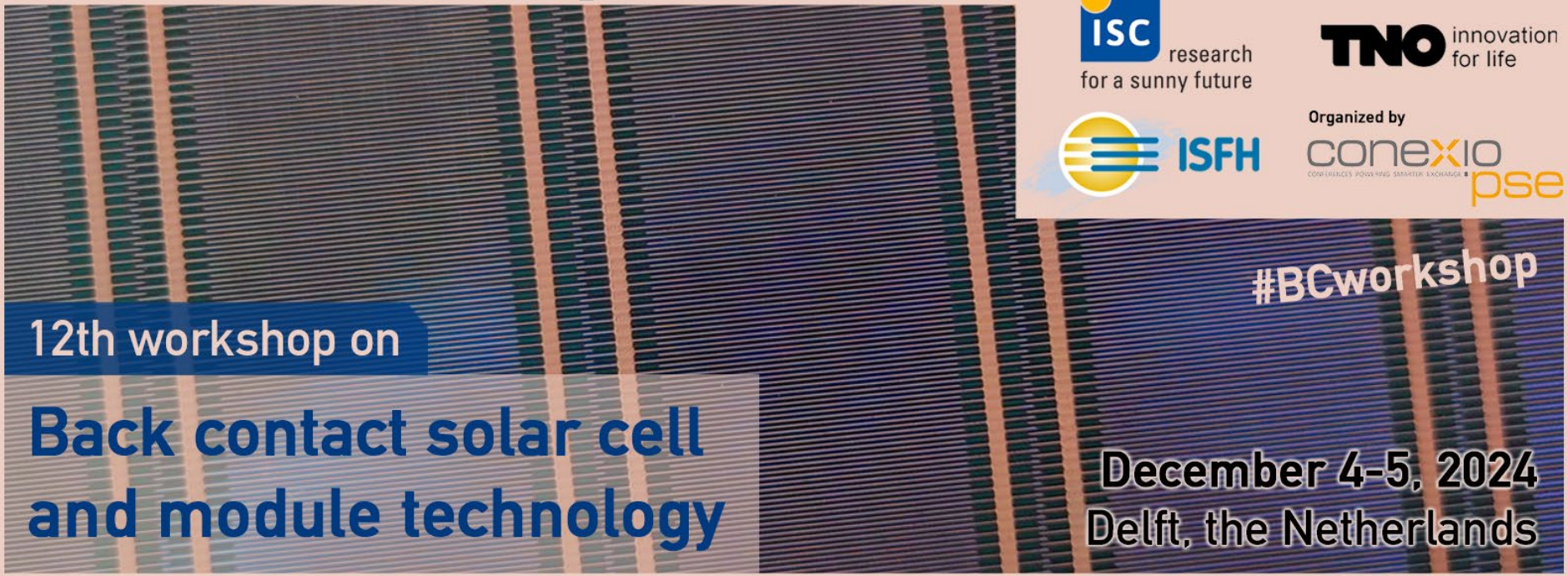

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