Trends in back-contact cell, module and material technologies

Hugo Schoot
Business Director

Webinar
Competitive and Sustainable: The future of back-contact technology
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Topics

- Introduction to Endurans™ Solar and Worthen Industries
- Trends in back-contact cells technology
- Trends in back-contact module manufacturing
- Trends in materials for back-contact modules

Welcome to Endurans™ Solar!

DSM Advanced Solar
Backsheet and conductive backsheet businesses

100% subsidiary of **Worthen Industries**

Endurans™ Solar in a nutshell

Innovative material solutions for solar panel manufacturers

Experts
in solar materials, polymer science, co-extrusion technology

Global presence
Production and R&D facilities across Asia, Europe & America

Market leader in co-extruded backsheets
Endurans™ HP
Sustainable
High performance

Market leader in conductive backsheets
Endurans™ CB
For BC modules, aesthetics & output

Pipeline of new products
Rear Perforated Insulators
Encapsulants
Flexible frontsheets

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Worthen Industries in a nutshell

The new home of Endurans™ Solar

- Founded in 1866
- Family-owned
- US-based – HQ in Nashua, New Hampshire
- Broad portfolio of high-quality adhesives, coatings, extruded films and laminated products
- 7 production locations
- Serving a wide range of industries
- Acquired DSM's backsheet and conductive backsheet business on June 1st, 2021
- Company values
  - Innovation
  - Customer service
  - Sustainability & quality
  - Employee wellness, family and community investment

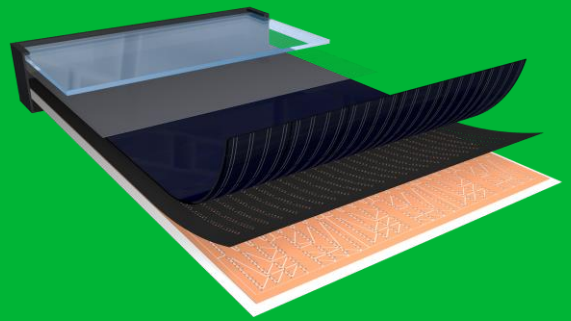
Global developments affecting the back-contact (BC) ecosystem

Supply chain challenges

- COVID
- Global logistics issues
- Transport cost exploding
- Feedstock costs
- Trade barriers (Import duties)

Technology trends

- Larger wafer sizes
- Half / third cells
- New cell technologies
- Cell interconnection technology



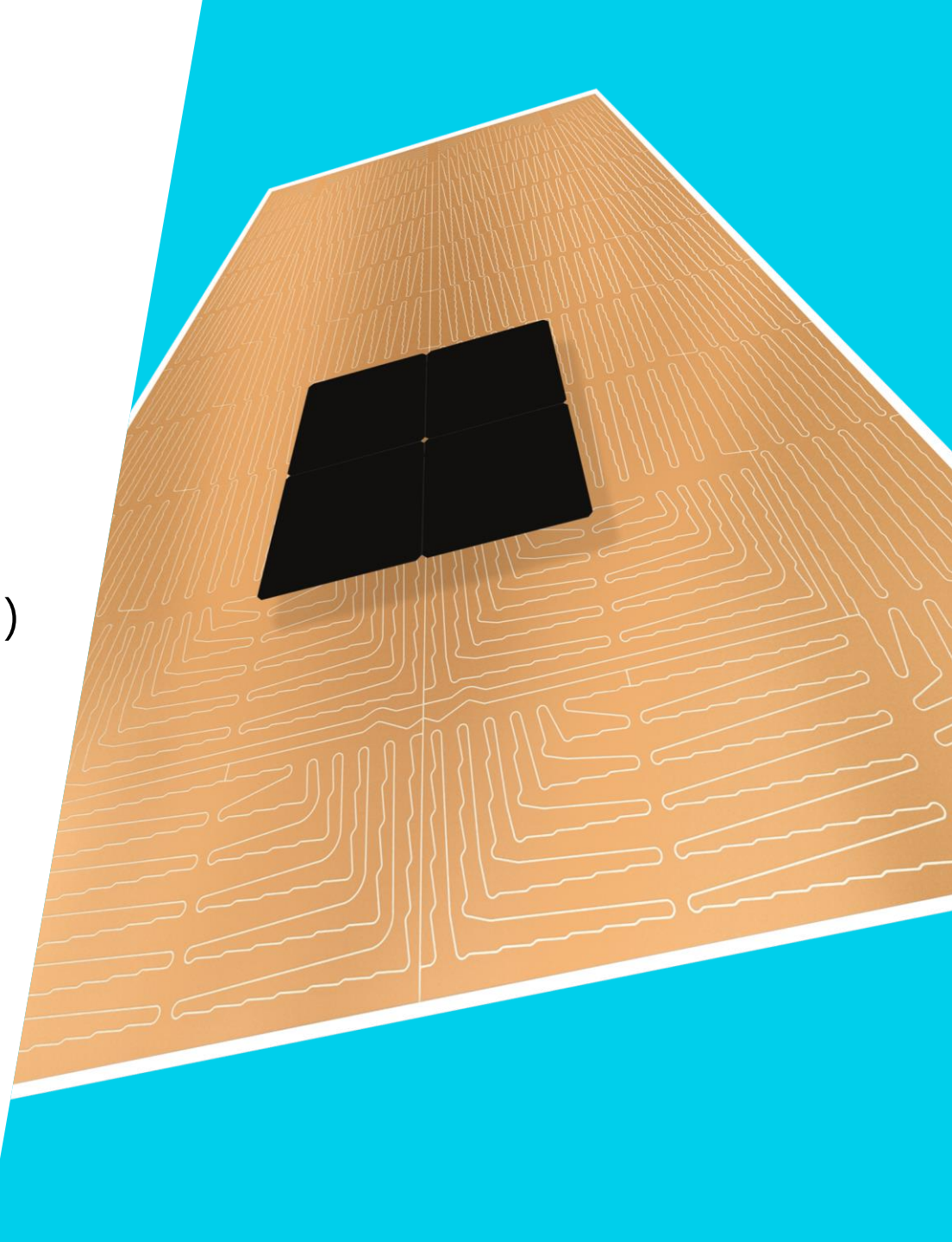
Emerging applications

- Building integrated PV (BIPV)
- Vehicle integrated PV (VIPV)
- Floating PV
- Agrivoltaics
- Lightweight & semi-flexible PV

Trends in BC cell technology

Expanding cell capacity and higher efficiency

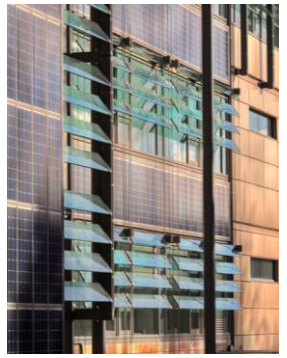
- Production capacity for MWT and IBC cells is ramping up
  - Existing suppliers and new entrants
  - Merchant and captive
  - Local-for-local production (logistics, tariffs)
- Trend towards larger cells (first M6, later to M10+)
  - Weight and size limitations in the rooftop segment
- Institutes and cell suppliers working on next generation BC cells (efficiency ánd cost), e.g.
  - ZEBRA IBC – ISC Konstanz
  - 4Terminal tandem SHJ MWT – TNO
  - SHJ IBC – Meyer Burger
  - IBC- Jinko



Trends in BC module technology

Increasing power and diversification

- Module production capacity is rapidly increasing
  - Existing BC modules suppliers ramping up production
  - Several new entrants expected in 2022
- Module power: steadily increasing driven by higher cell efficiency
  - Power density >210 Wp/m^2 and increasing!
- Local for local production
  - Lowest cost in residential is less of an issue than in the utility segment
  - Premium for 'made in'
- Diversification in module design:
  - Lightweight, semi-flexible & application specific
  - Odd shape and size modules for special applications like VIPV, BIPV and floating PV
  - Module size: not following the industry trend
- Sustainability
  - Design for recycling
  - Ease of disassembly enabling high value material recovery (PARSEC project TNO)
  - Use of sustainable recyclable materials replacing e.g. lead and fluorine



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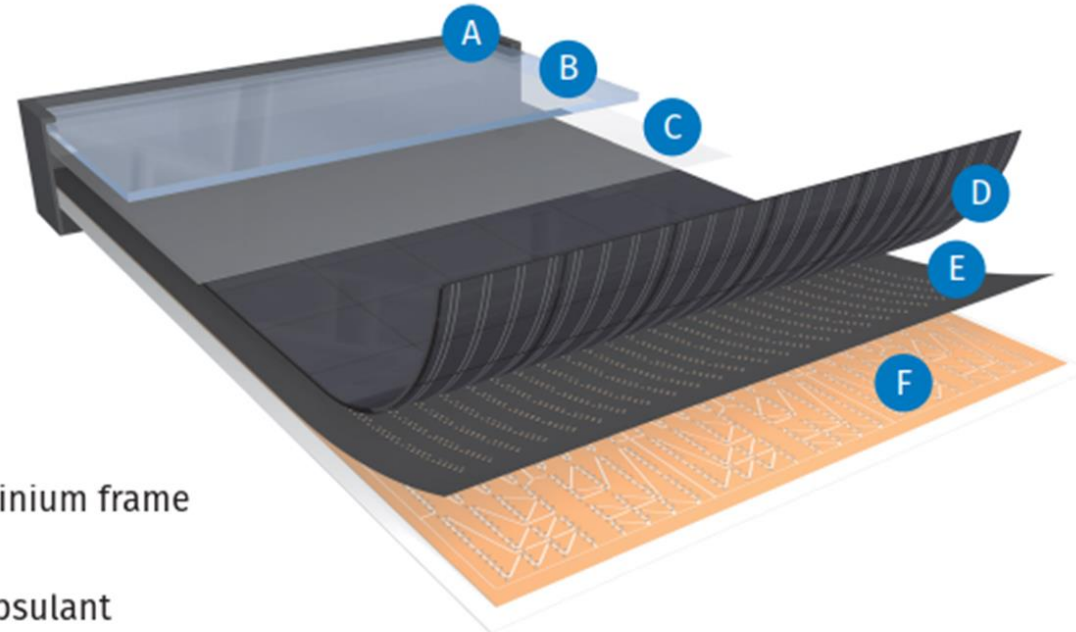
Trends in materials for BC modules

Driven by cost, performance and sustainability

- Conductive backsheet (CBS)
  - Introduction polyolefin based backsheet
  - Cost reduction by optimization of:
    - Materials
    - Supply chain
    - Manufacturing process
- Rear perforated insulator sheet (RPI)
  - New materials concepts providing:
    - Higher performance
    - Improved module output
    - Lower cost (materials, perforation technology)
    - Sustainability
- Encapsulants
  - Increasing use if POE
- Flexible front sheets for lightweight modules
  - Polypropylene, Polycarbonate, fluoropolymers



Same sun.
More power.™

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