Hetero- Junction Module Technology

Martin Späth
Some Like it HOT others NOT
Hetero- Junction & Conventional Solar Cell

Hetero junction solar cell

- Efficiency on industrial level 21.6 %
- Formation of junction & BSF by PECVD
- Low temperature processing 200°C
Thermal Budget Cell Processing

Hetero-junction cell processing
TCO layer, a-Si/c-Si
Conductive Adhesive Background Technology

Module with Conductive Adhesive interconnection & Conventional Cells, High Temperature Ag metallization, SiNx, manufactured in the year 2006

- DH 1000 hours 0% absolute change in FF
- TC 200 cycles 2% absolute change in FF

Outdoor testing of full size module > 4 years
European Hetero- Junction Project

Objective:
• Demonstrate the industrial feasibility of Hetero- junction cells in Europe

Sub-objectives:
1. Demonstrate high efficiency cells on large and thin wafers
2. Demonstrate high efficiency hetero- junction concept at module level

Participants: INES-CEA, CNRS, ECN, UU, ENEA, IMEC, EPFL, HZB, Photowatt, Q-Cells, SOLON, ALMA, Session 2A0.2.1
Low Temperature Interconnection Materials

• Target 19% cell efficiency & 1% cell to module loss
• Achieved 21.3% cell efficiency (lab) & >19% at pilot scale (Session 2A0.2.1)

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\begin{align*}
R_{CA} & : \quad \rho = 5 \cdot 10^{-4} \ \Omega m \\
& \rightarrow \quad 0.15 \text{ m}\Omega \text{ per cell} \\
R_{c2} + R_{c3} & : \quad r_c' = 0.1 \text{ m}\Omega \text{ cm}^2 \\
& \rightarrow \quad 0.11 \text{ m}\Omega \text{ per cell} \\
R_{tab} & : \quad \rho = 2 \cdot 10^{-8} \ \Omega m \\
& \rightarrow \quad 2.33 \text{ m}\Omega \text{ per cell}
\end{align*}
\]
Hetero- Junction Module with conductive adhesive

Loss from cell to module:

- **1.07 %** absolute efficiency on aperture area
- **5.44 %** FF relative
- **0.43 %** Voc relative
- No Isc loss → good optical match
Hetero- Junction Module Reliability

• Hetero- junction cell sensitive to humidity

Single cell module with edge-seal

Cross section of module
Hetero- Junction Module Stability

Damp Heat single cell modules

IEC 61215 criteria
Hetero- Junction Module Stability

Thermal cycling single cell modules

![Graph showing relative I-V parameters (%) over thermal cycles with IEC 61215 criteria indicated.](image)
Hetero- Junction Full Size Module

72 cells hetero- junction module with conductive adhesive interconnection
Conclusions

- Low temperature low stress interconnection for thin solar cells
- Resistivity of conductive adhesive not a limiting factor
- Hetero- junction single cell modules stable regarding IEC61215 temperature cycling
- Moisture blocking back- sheet required to pass IEC61215 damp heat
- Full-size hetero- junction module successfully demonstrated
Thank you for your attention