PSI-process on 6” Si substrates

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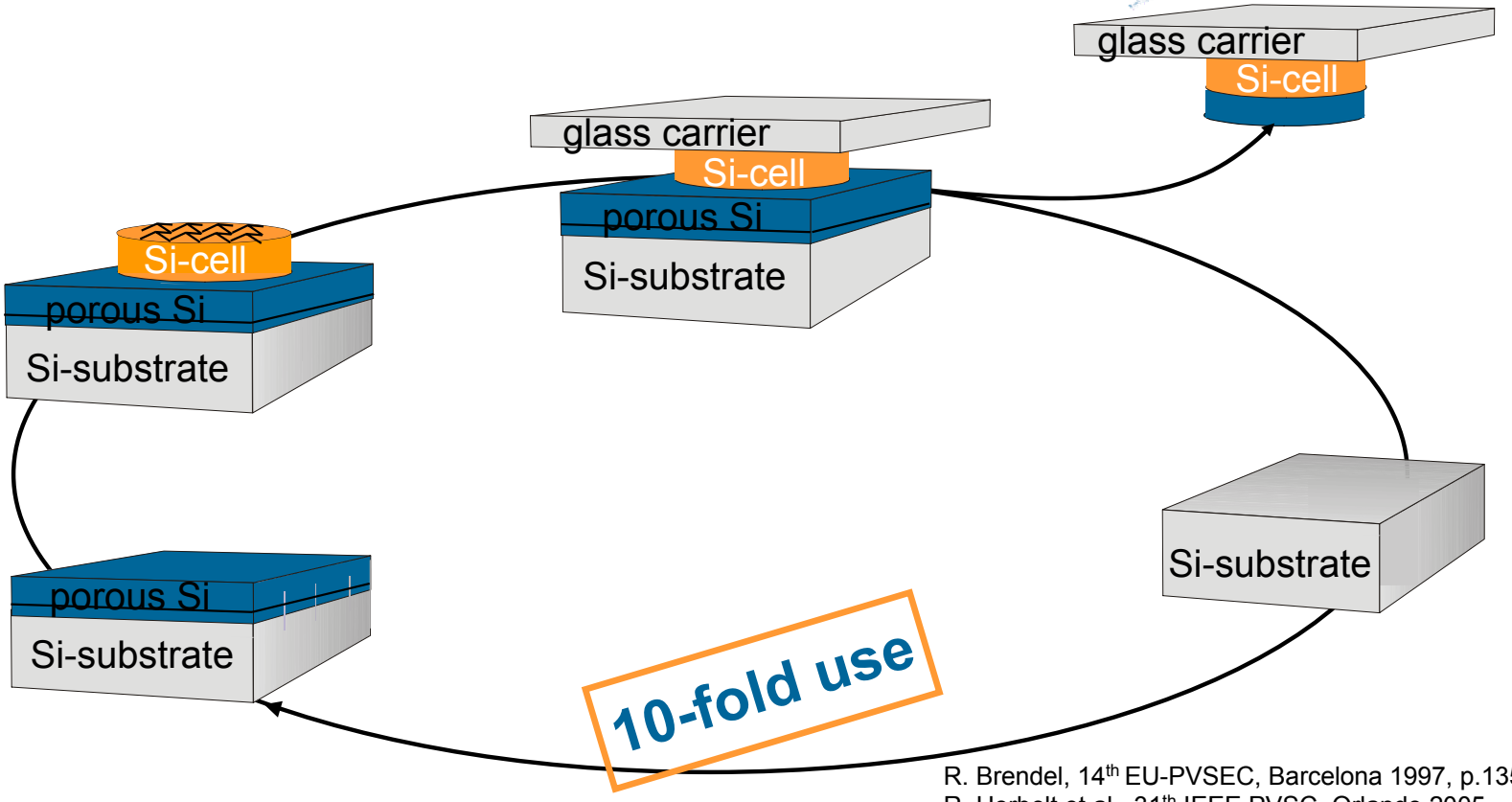
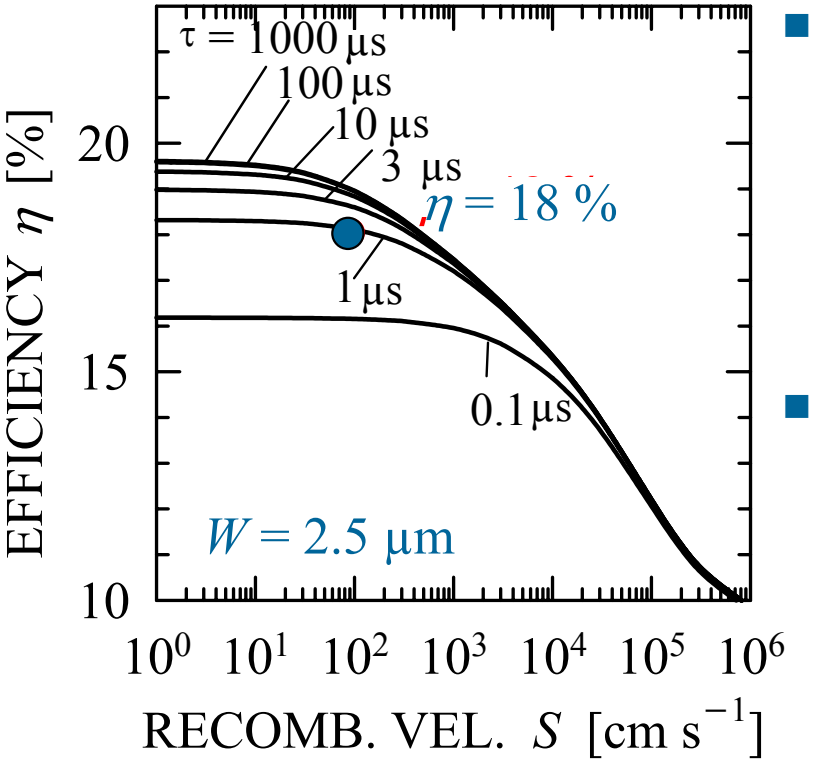
Re-use of Si growth substrate



R. Brendel, 14th EU-PVSEC, Barcelona 1997, p.1354
R. Horbelt et al., 31th IEEE PVSC, Orlando 2005

Efficiency potential of thin-film Si wafers

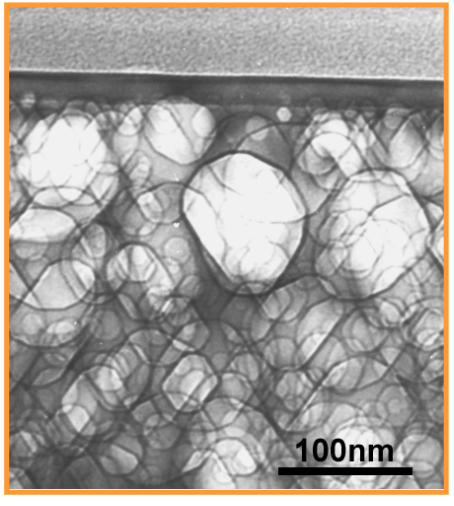


- Assumptions:
  - Good optics — 90% of Lambertian ✓
  - τ = 1 µs — 16 µs measured ✓
  - S = 100 cm/s — 120 cm/s measured ✓
- Simulated efficiency:
  - η = 18 %
  - W = 2.5 µm

R. Brendel, Solar Energy ***77***, 969, (2004).

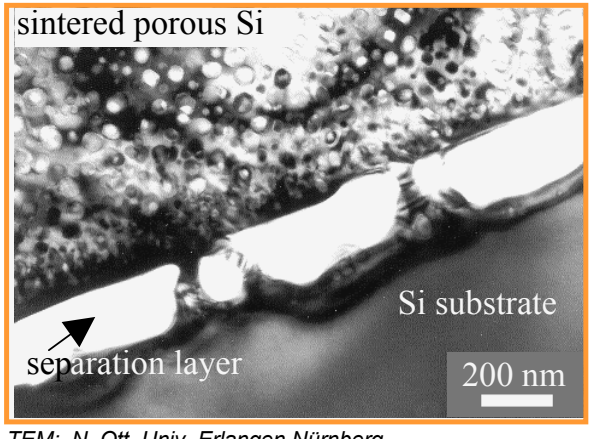
Porous double layer

Closure of porous surface



First report on surface closure:
*V. Labunov et al., Thin Solid Films **137**, 123 (1986)*

Building separation layer



TEM: N. Ott, Univ. Erlangen Nürnberg

First report on separation layer formation:
H. Tayanaka et al., in *Proc. 2nd World Conf., (Vienna 1998), p.1272, H. Tayanaka et al., Proc. 6th Sony Research Forum, (Sony 1996), p. 556, (in Japanese)*

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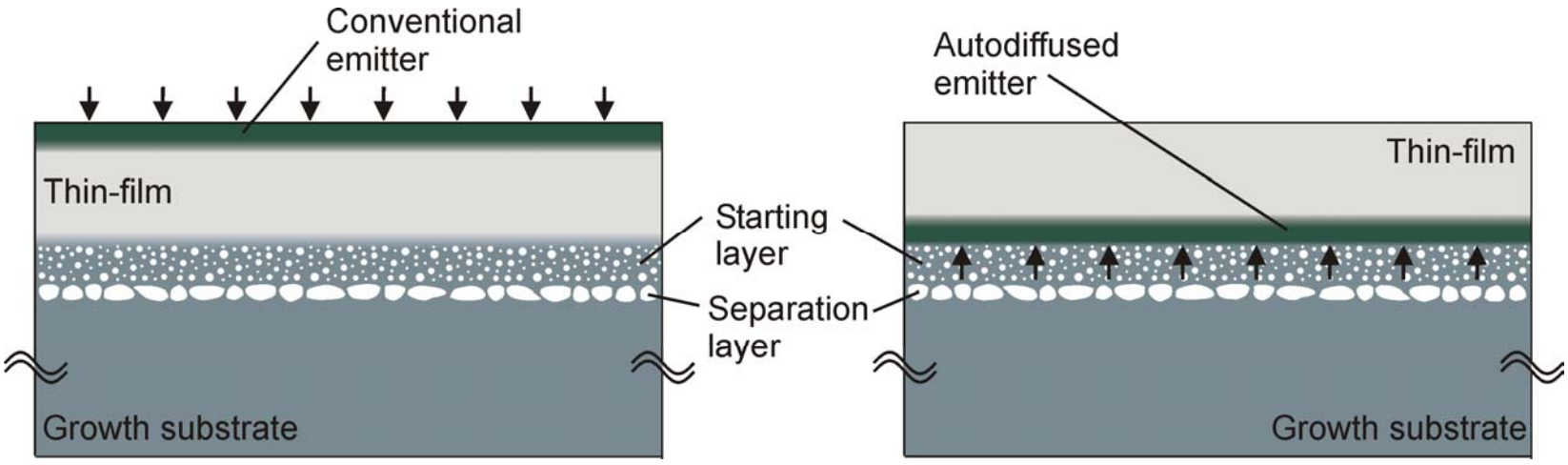
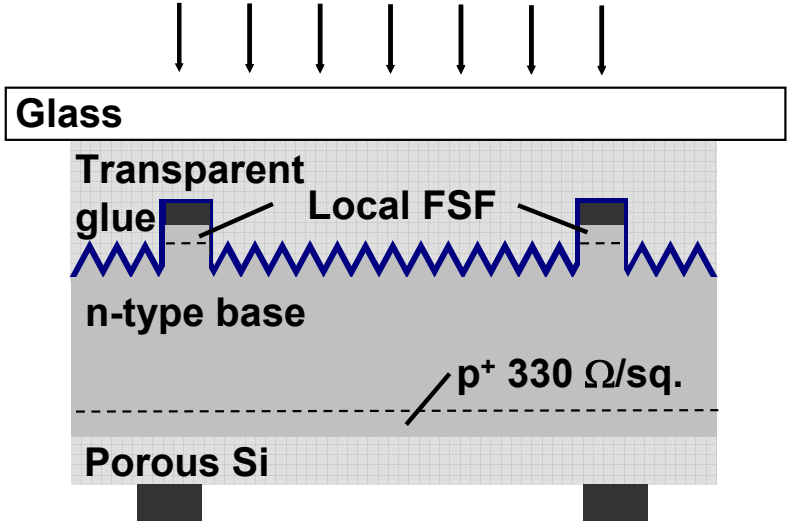
Autodiffusion



➡ **Utilize out-diffusion from growth substrate!**

A. Wolf, B. Terheiden and R. Brendel, *Prog. Photovolt: Res Appl*. (in press)

Boron autodiffusion: cell result



Cell area : 4 cm², thickness 24 µm

V_{OC} = 588 mV

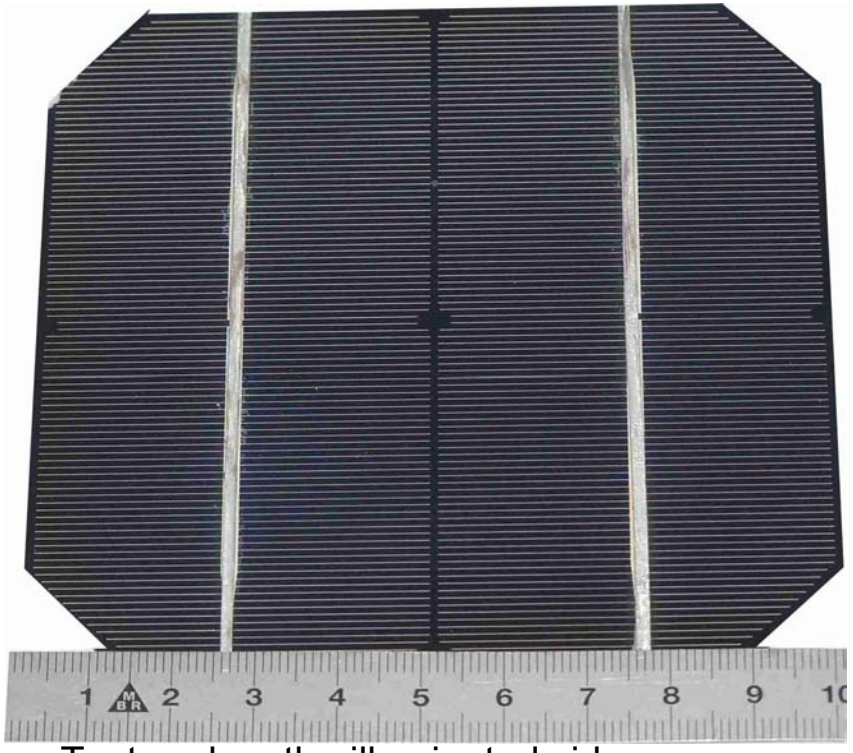
J_{SC} = 33,3 mA/cm²

FF = 74,2 %

η = 14,5 %

Independently confirmed @ ISE CalLab

FS: a-Si/SiN RS: B-BSF



Textured on the illuminated side

V_{OC} = 616 mV

J_{SC} = 29.0 mA/cm^2

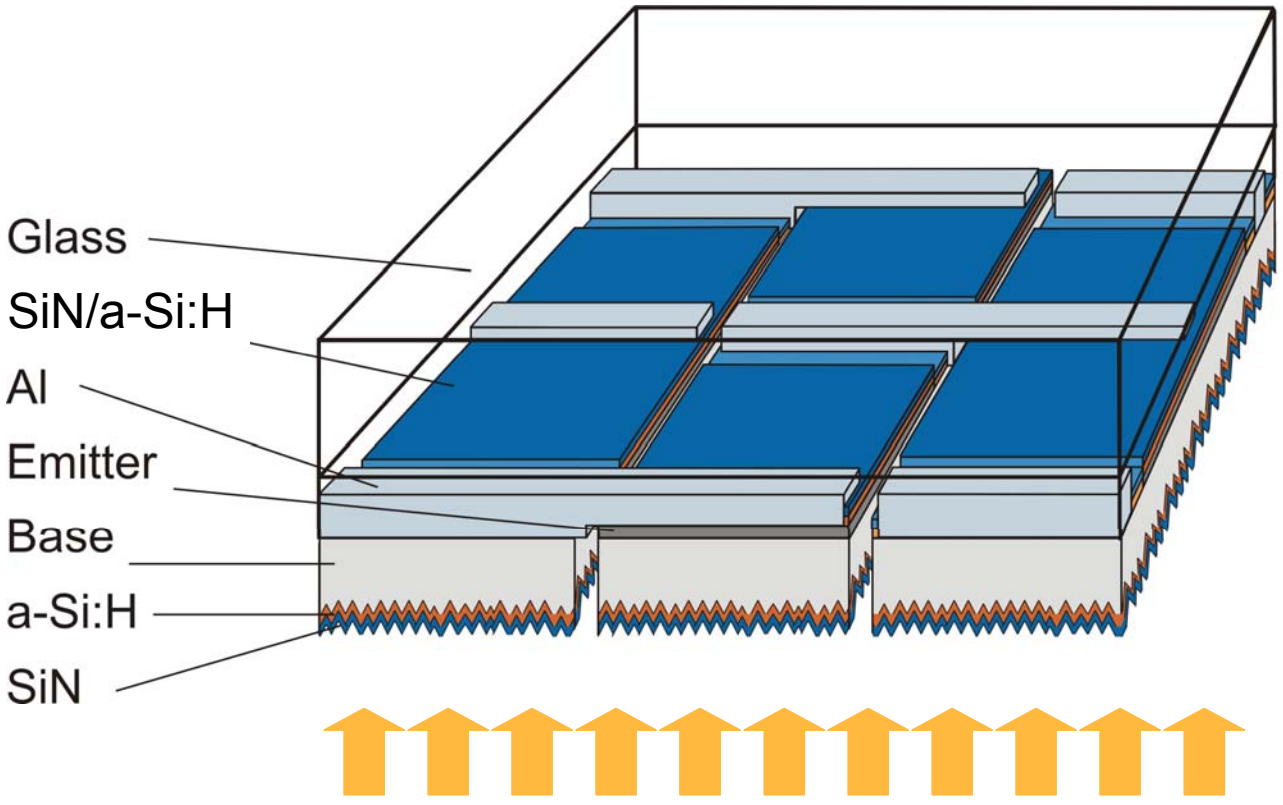
FF = 78.8 %

η **= 14.1 %**

Cell area : 95.5 cm^2

Si film thickness : 26 µm

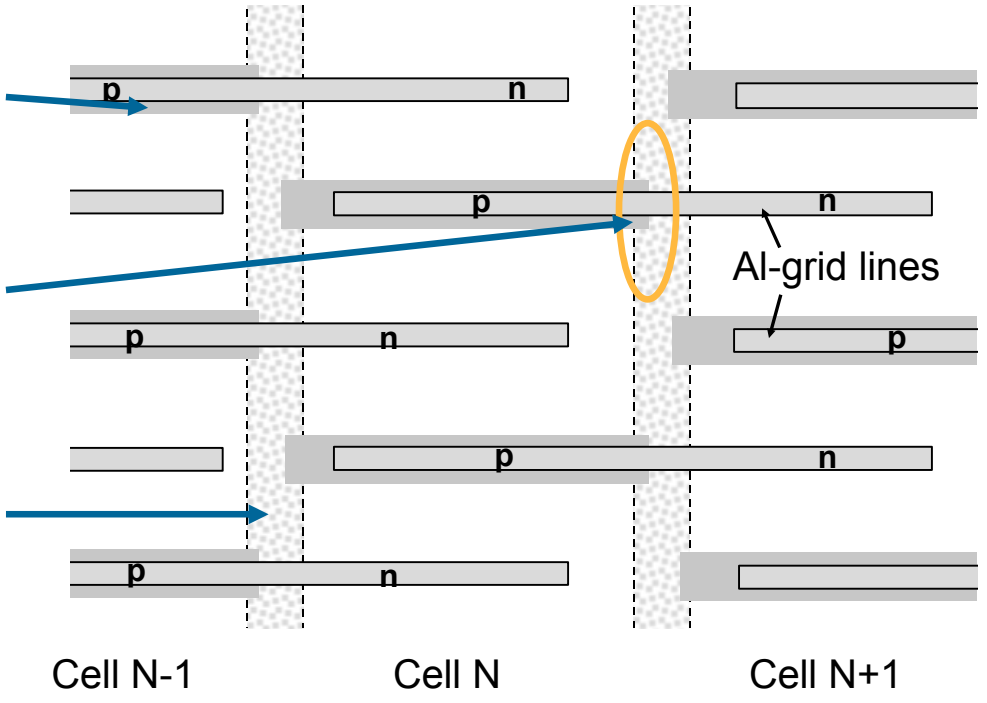
Rear contact - rear junction
PSI-module



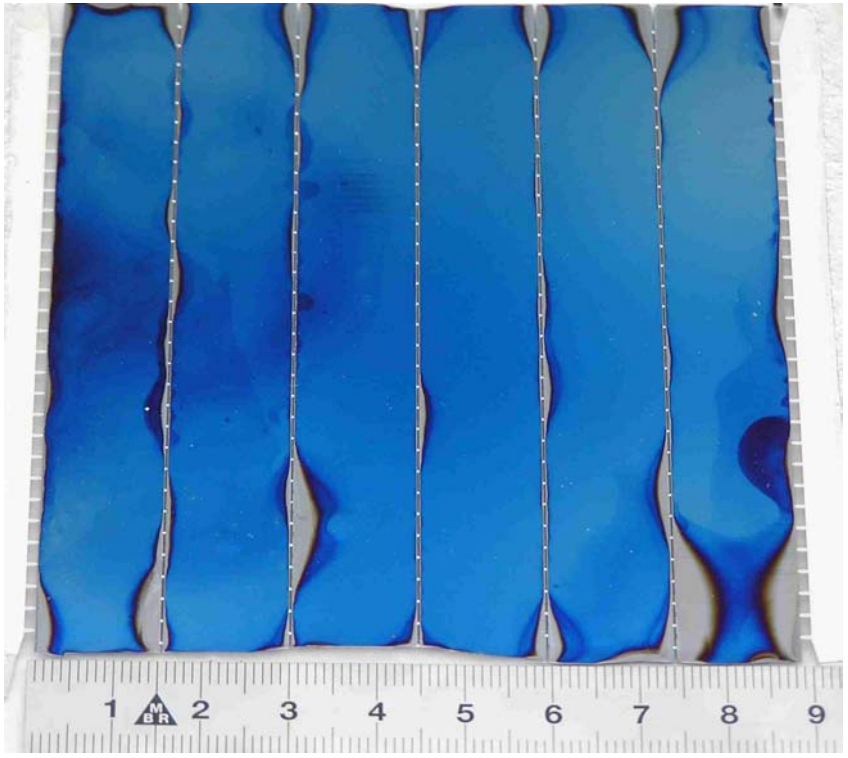
4S interconnection

- 2 µm deep trenches to contact p-type base (etched from the front)
- Short circuit prior to trench etching from the back
- Trenches separating the cells (etched from the back)

Top view, rear side



FS & RS: a-Si/SiN



Textured on the non-illuminated side

V_{OC} = 3754 mV

(V_{OC} = 626 mV/cell)

I_{SC} = 388 mA

(J_{SC} = 28.4 mA/cm^2)

FF = 67.3 %

η = **12.0 %**

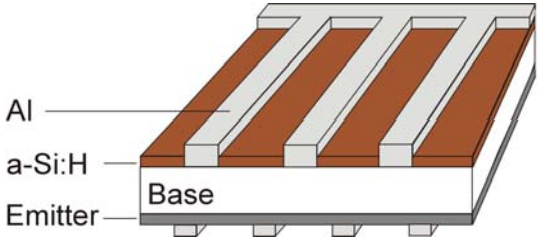
Area : 9 x 9.1 cm^2

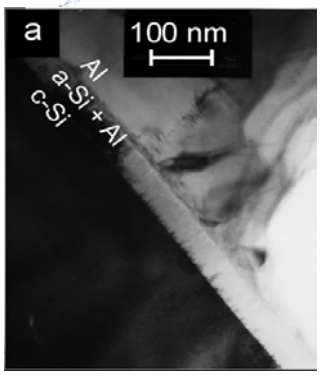
Si film thickness: 24 µm

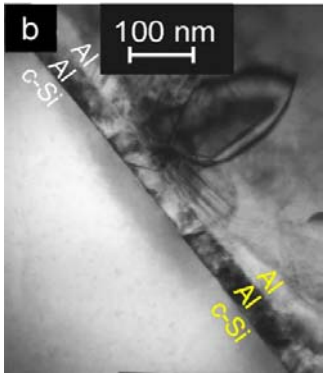
COSIMA contact formation

COSIMA: COntacts to a-Si:H passivated wafers by Means of Annealing

- a-Si:H deposition: PECVD, 225 °C
- Al deposition
- Annealing: 300 °C, 5 min







H. Plagwitz, M. Nerding, N. Ott, H. Strunk, and R. Brendel "Low-temperature formation of local Al contacts to a-Si:H-passivated Si wafers," Prog. Photovolt. **12**, 47 (2004)

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Summary

- Efficiency of large area PSI solar cell as high as **14.1 %**
- Utilization of porous Si as dopant source: η **= 14.5 %**
- Surface passivation by a-Si:H
  - Interface defect density lower than 10^9 cm^{-2}
  - Enhanced open-circuit voltage

Acknowledgements

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