Silicon Wafers Cutting by Laser MicroJet® for PV Applications

LASYS Stuttgart

SLT ´08

Stuttgart, 05.03.2008

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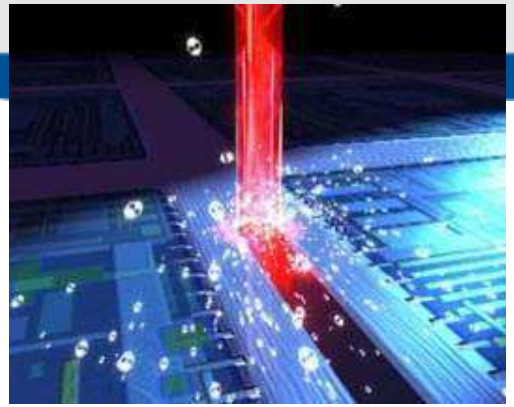
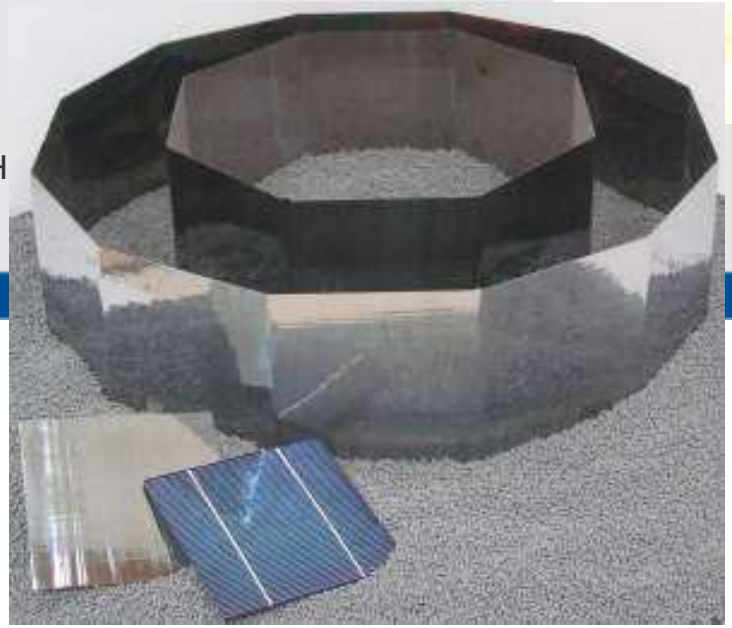




SYNOVA

WACKER SCHOTT solar

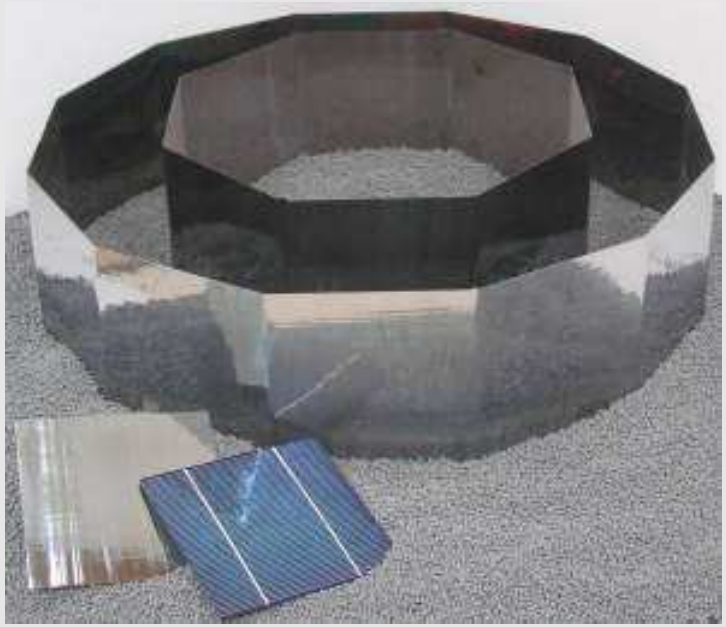
Outline

- WACKER SCHOTT Solar GmbH
  - Introduction
  - The EFG Wafer Technology
  - Cutting process and challenges
- SYNOVA SA
  - Introduction
  - The Laser MicroJet® Technology and Advantages
  - Results for WACKER SCHOTT application

WACKER

SCHOTT solar

Thorsten Grahl
Wacker SCHOTT Solar GmbH



WACKER SCHOTT Solar GmbH

Joint Venture by Wacker Chemie AG und SCHOTT Solar GmbH

Purpose: Common R&D activities, production and sales of multicrystalline wafers
(for photovoltaic solar cells)

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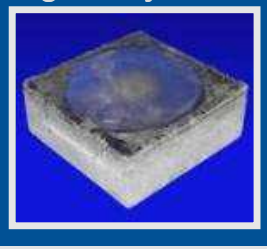
Jena

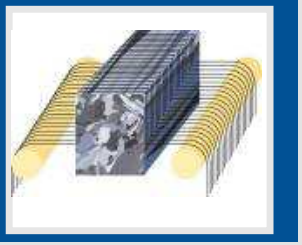
Conventional Wafer Technology

① Ingot-Crystallisation



② Blocking

③ Wafering



Alzenau

EFG-Technologie
(**E**dge Defined **F**ilm Fed **G**rowth)

① Pulling

② Wafering by Laser

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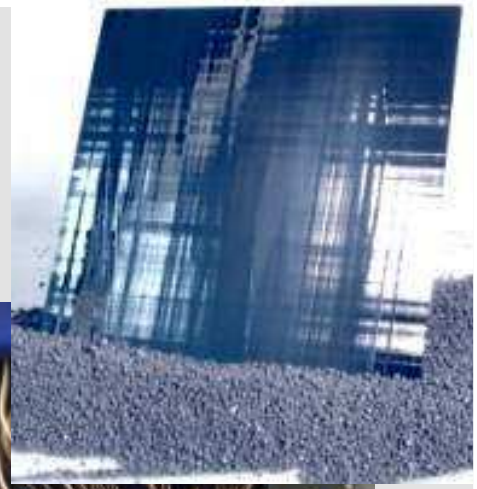
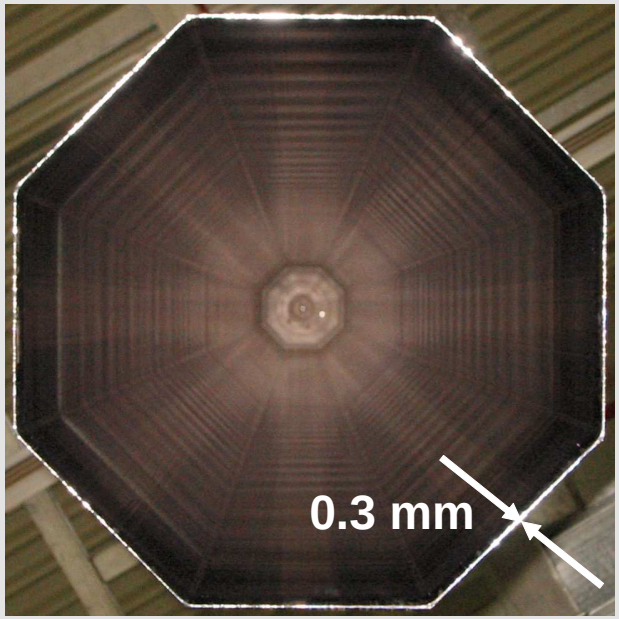
Alzenau
Crystallisation of thin silicion tubes (EFG-Technology)
Laser cutting of wafers



6,5 m



125 mm

Crystal Growing

Laser Cutting

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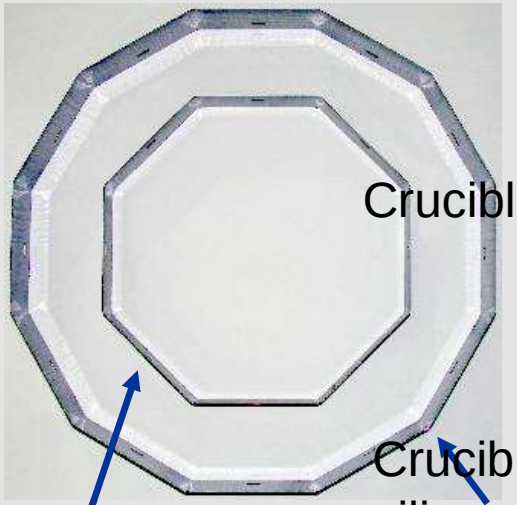
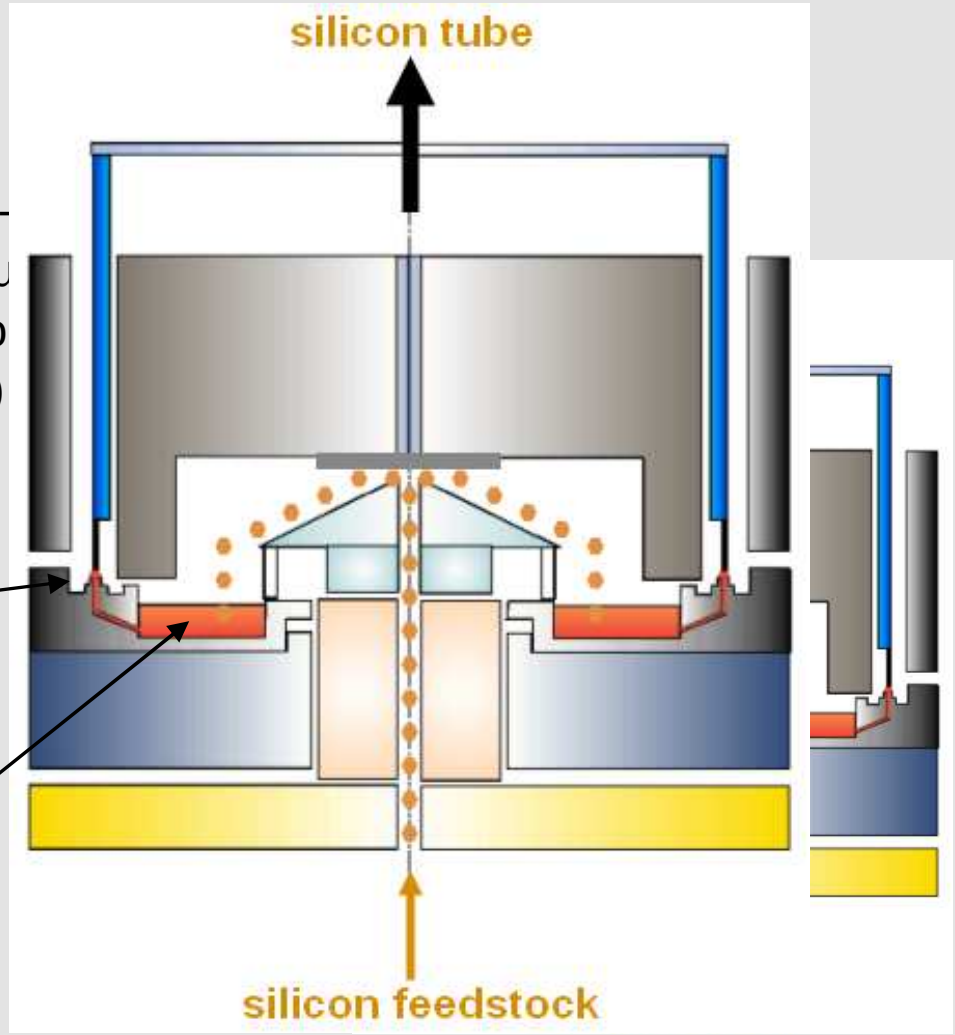
Wafer technology by WACKER SCHOTT Solar
Crystallisation of thin tubes

- EFG: „**E**dge-defined **F**ilm-fed **G**rowth“
- Feedstock: Granular silcion
- Drawing of thin tubes directly out of Si-
- Tube length ca. 6,5 m, thickness 270 µ
- Tube geometries: 8-corners and 12-co
  9-corners (156 mm)



Oktagon 125 mm Dodekagon 125 mm



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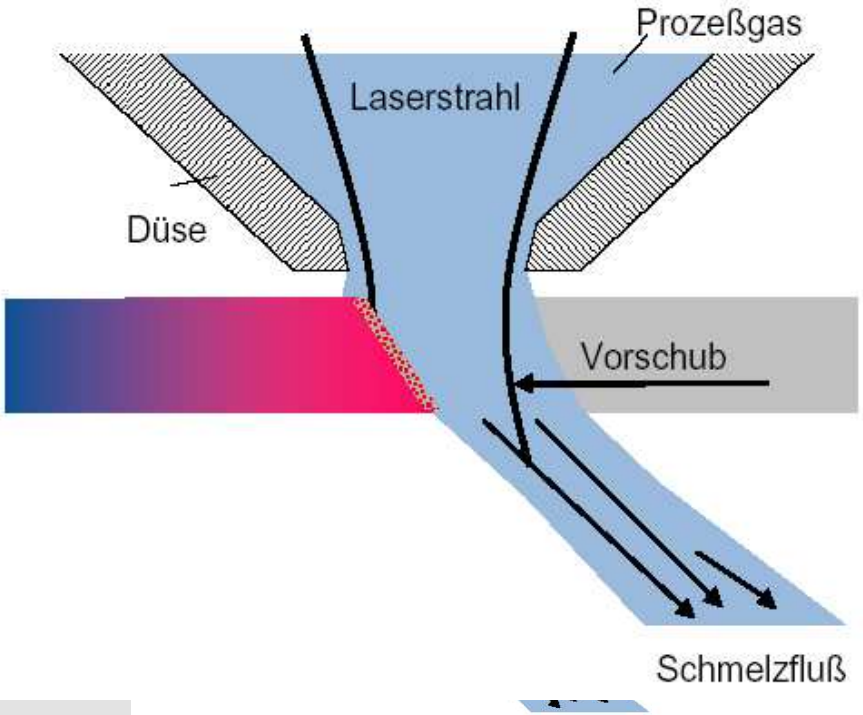
Wafer technology by WACKER SCHOTT Solar
Crystallisation of thin tubes - Production

Wafer technology by WACKER SCHOTT Solar

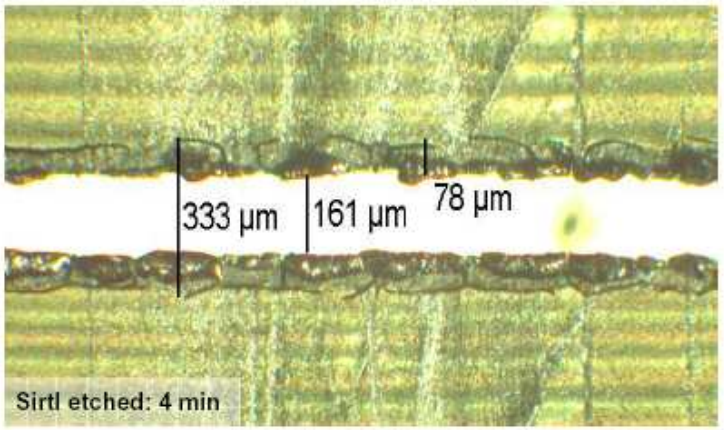
Laser cutting – conventional fusion cutting process

- Successive laser cutting of wafers out of each face of the tube
- Wafer dimensions: 125x125 mm^2 (5“)

Fusion cutting process



Schmelzfluß



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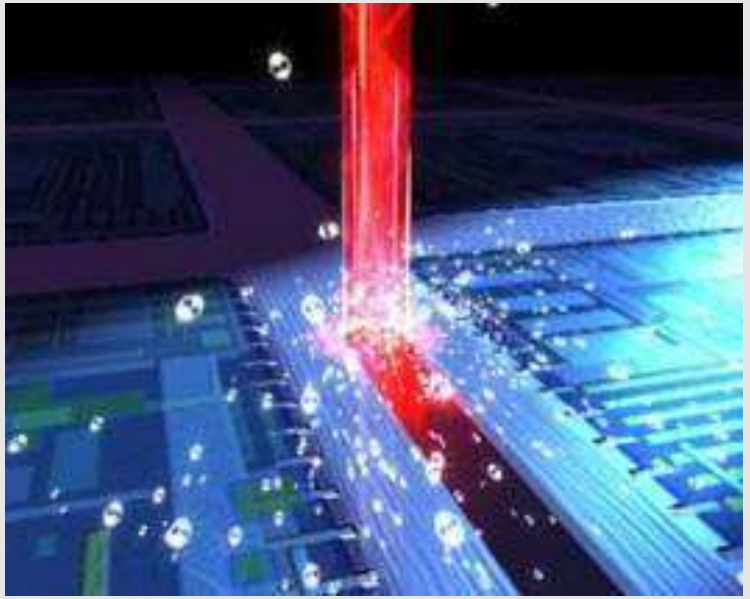
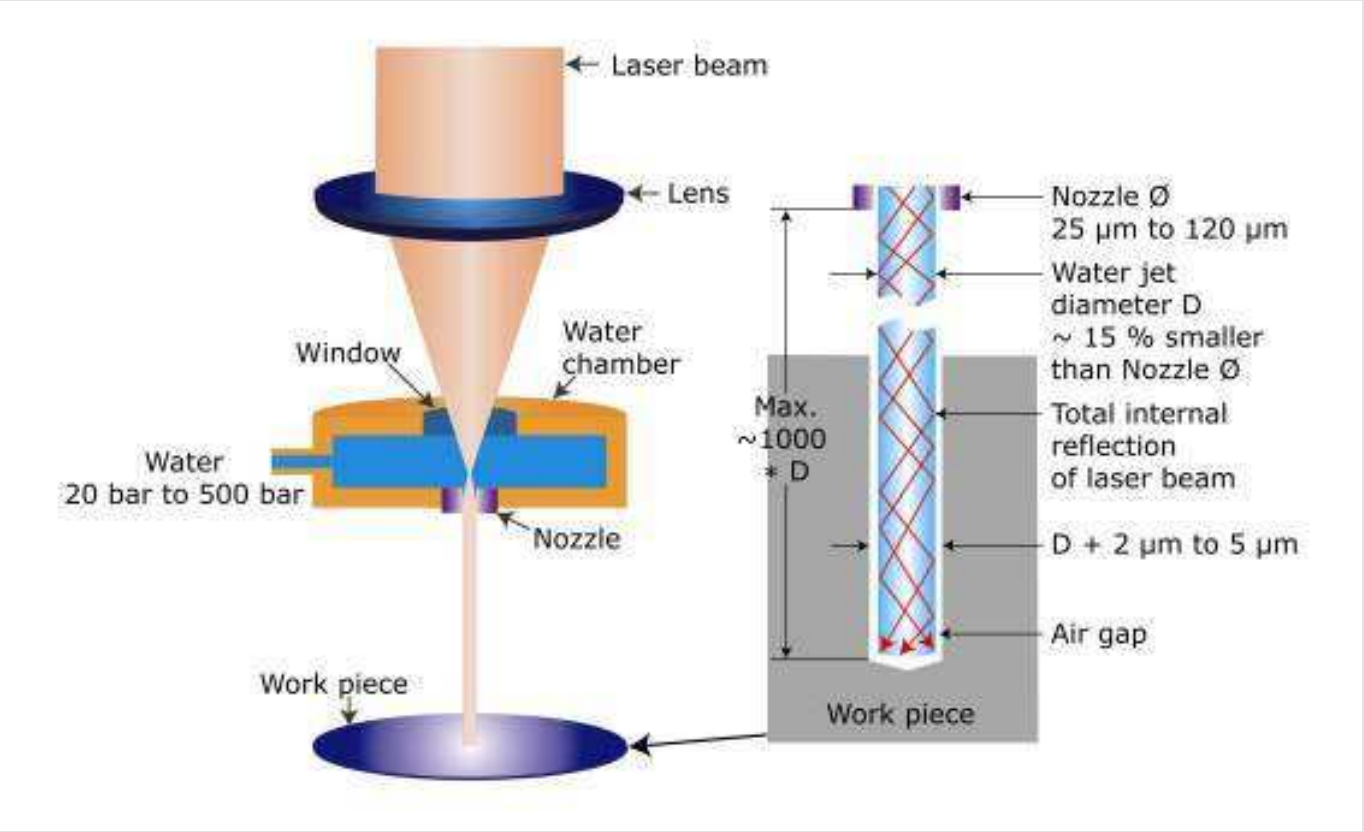
Synova S.A.



Synova SA – Company highlights

- **Founded:** 1997
- **Headquarter:** Ecublens / Lausanne, Switzerland. Subsidiaries in USA and Asia.
- **Technology IP:** Laser MicroJet® — water jet-guided laser technology = damage-free laser processing
- **Applications:** Cutting, dicing, edge grinding, drilling, scribing
- **Business markets:** Semiconductors, solar cells, electronics, FPD, automotive, tooling and other micro-machining industries
- **Products**: Semi- or fully automatic laser machines and integration modules
- **Employees:** 70 (+25), a majority of which are engineers

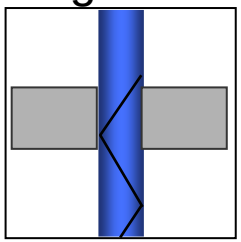
The patented Laser MicroJet® Technology (LMJ)



- Laser is focused in water jet nozzle
- Laser is entirely contained within the water jet as a parallel beam
- Laser is guided by total internal reflection, similar in principle to an optical fiber

General benefits of the LMJ vs dry lasers

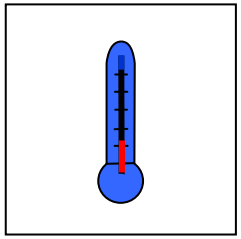
The water jet works as a fiber, avoiding a divergent laser



Depth of focus due to water jet guiding up to 50 mm

→ No focus control needed

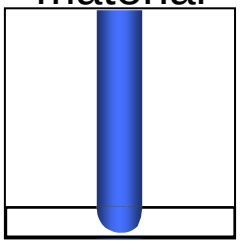
The water jet cools the work piece during laser ablation



Cutting kerf is cooled in a very efficiency way

→ After each laser pulse the deposited heat is immediately removed by the water

The kinetic energy of the water jet expels molten material



→ No damage on the material because of the small size of the jet

→ Pressure force due to water jet is smaller vs. gas jet

The low-pressure water jet is not abrasive. The material is ablated only by laser.

General advantages of the LMJ

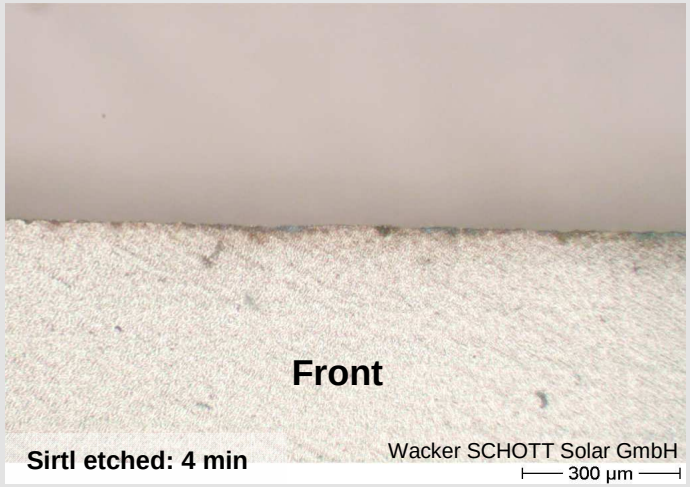
- Negligible heat damage to the material
- High fracture strength
- Long working distance thanks to the parallel laser beam
- Parallel and smooth cut walls
- No chipping
- No slag / burr formation
- Low surface contamination
- Very efficient expulsion of ablated material from the kerf

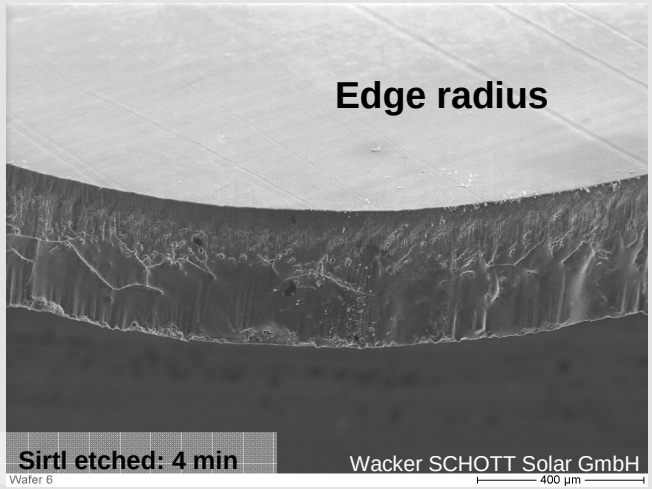
Defined cutting parameters

300 µm thick silicon EFG wafers

	Set 1	Set 2	Set 3
Cutting speed	200 mm/s	225 mm/s	260 mm/s
Number of passes	4	3	4
Overall speed	50 mm/s	75 mm/s	65 mm/s

Cutting results by Wacker SCHOTT Solar





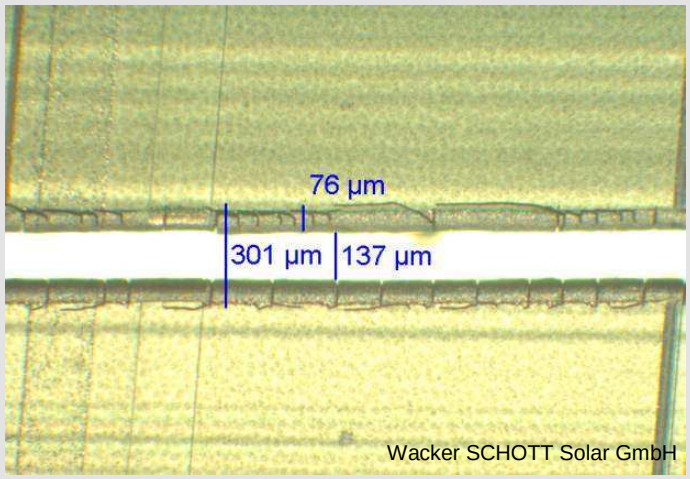
Laser MicroJet® Technology

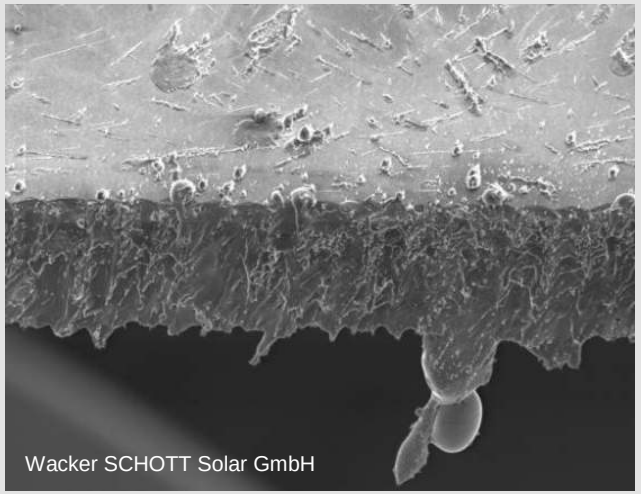
→ No micro cracks along the whole wafer edges on both front and back

→ No droplets

→ No burr formation

→ High fracture strength



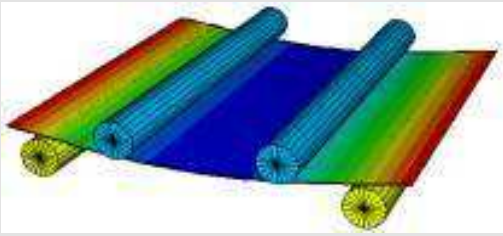


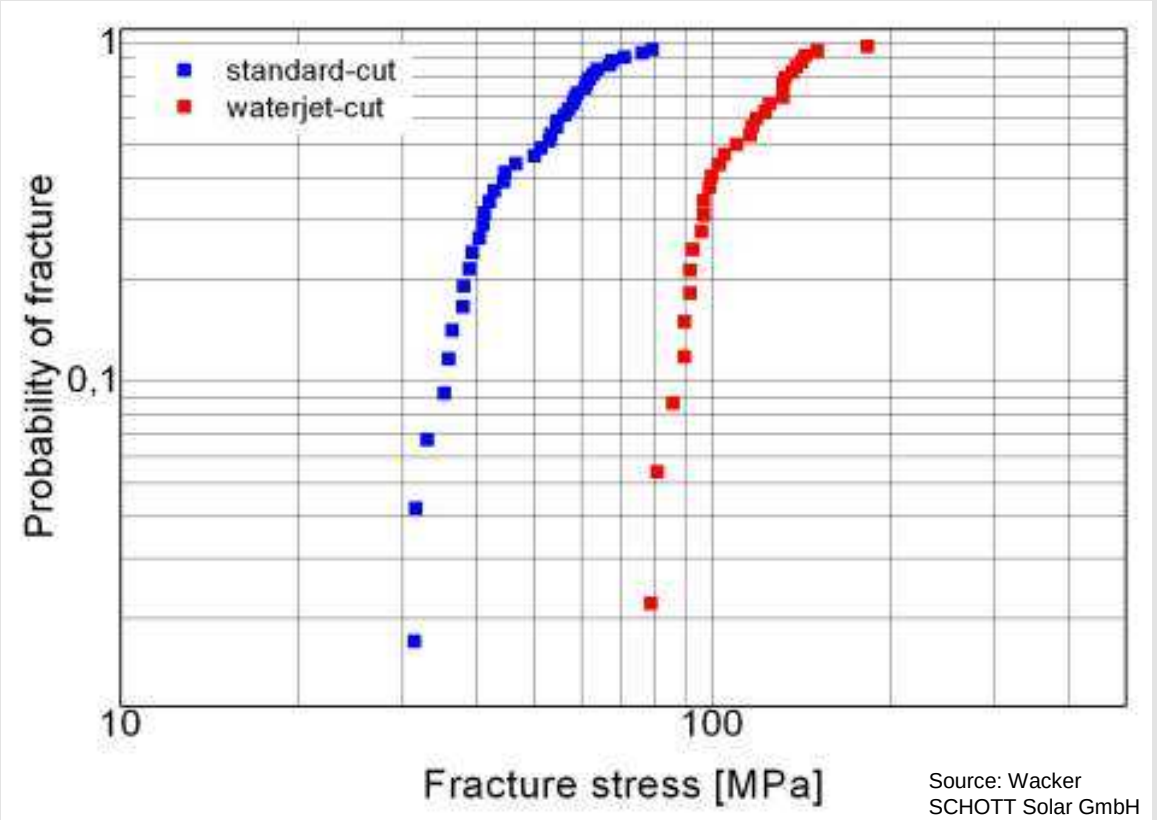
Conventional Technology

(dry laser)

Wafer fracture strength
measured by Wacker SCHOTT Solar

- Nearly damage-free edges
  → no edge etching necessary
- As cut wafer strength (4 point bending test): 120 … 150 MPa
- Comparable to MC wafer strength





Source: Wacker SCHOTT Solar GmbH

2.5 higher fracture strength compared to dry laser

Conclusion

Motivation for Wacker-Schott to select the LMJ technology for the raise-up of production:

- Much higher fracture strength of wafers
- No micro cracks along the cutting kerf
- No edge etching necessary anymore
- No distance control necessary
- Clean surfaces, no front and back contamination
- No burrs
- High cutting speed of up to 80 mm/s

Thank you

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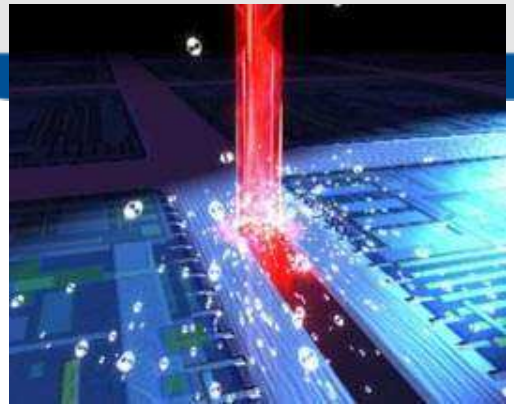

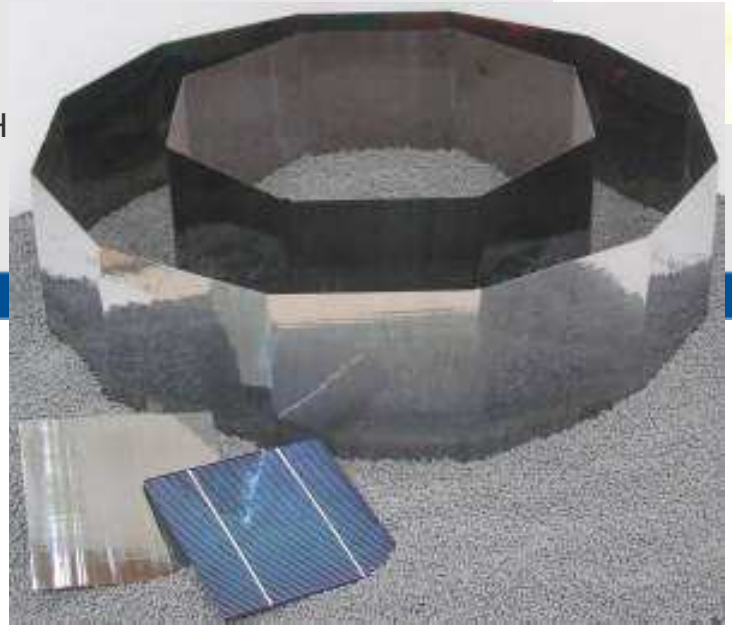

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