Epitaxial Wafers: A game-changing technology on its way to mass production
NexWafe: producer of high-quality silicon wafers

NexWafe will supply to solar cell manufacturers superior quality n-type mono-crystalline silicon wafers as a drop-in replacement for conventional wafers at competitive price.
Founded in 2015 as a spin-off of Fraunhofer ISE

Series A closed in March 2016

Currently expanding pilot production for EpiWafers
Agenda

Epitaxial Wafers: A game-changing technology on its way to mass production

- Market needs
- EpiWafers – properties and advantages
- NexWafe’s path to mass production
Mono and multi production 50:50 in 2018, but mono is the future

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Finley Colville joined Solar Media in June 2015 as head of the new Solar Intelligence activities. Until October 2014, he was vice president and head of solar at NPD Solarbuzz. Widely recognised as a leading authority on the solar PV industry, he has presented at almost every solar conference and event worldwide, and has authored hundreds of technical blogs and articles in the past few years. He holds a BSc in Physics and a PhD in nonlinear photonics.

Mono c-Si cell production is forecast to account for 49% of all c-Si cell production in 2018, and will become the dominant technology used in the PV industry by 2019, according to new research contained in the latest release of the PV Manufacturing & Technology Quarterly report, from the in-house research unit at PV-Tech's parent company Solar Media Ltd.
Market needs

Average stabilized efficiency values for Si solar cells (156x156mm²)

Fig. 39: Average stabilized efficiency values of c-Si solar cell in mass production (156 x 156 mm²).

Source: ITRPV Eighth Edition 2017

mono wafers of “high” and “highest” quality

efficiency gain of up to 25%_{rel}
The PV-industry needs disruptive approaches to cut cost

Drivers for future cost reduction

- High efficiency solar cells
- Minimized material consumption

Reducing wafer cost is key
Standard wafer processing: low material usage, high cost

1 kg Si → 0.4 kg wafer
Severe silicon losses - High energy consumption - Capital intensive

High wafer cost

- High losses limit cost reduction potential severely
EpiWafers – smart and efficient value chain by kerfless wafering

**Reduced silicon consumption**
Dramatically less energy needed
Significantly less CAPEX

**Very high cost cutting potential**
Drop-in replacement of conventional wafers for high efficiency cells
Kerfless EpiWafer process for mass production

- Idea: “Clone” a monocrystalline seed wafer
- Closed seed wafer loop and nearly no kerf allows for low production cost
- Wafer thickness: “standard” 180 µm or thinner – no problem to produce 80 µm thin wafers

Release layer

Epitaxy

Detachment

Kerfless Si wafer

re-usable Si seed wafer

Epitaxially grown Si wafer

re-usable Si seed wafer

Epitaxially grown Si wafer

re-usable Si seed wafer

Monocrystalline “EpiWafer”
Optimizing customer value by specific product advantages

- Full-square wafer format: **Higher solar cell and module power**
- Better control of wafer parameters: **Narrower module efficiency distribution**
- Wafer thickness down to 80 µm: **Disruptive cost reduction and efficiency increase**
- In-situ growth of pn junction: **Cost savings on solar cell production**
EpiWafer achievements

Efficiencies > 20% and lifetimes in ms range proven

C. Gemmel et al., Journal of Photovoltaics, 2016
Challenge “mass production”

Quality can be perfect...
...but how can we produce billions of good EpiWafers??
Mass production requires more than bulk lifetime!

- **Very high throughput, modular scalable**
  - 1000’s of wafers per hour per machine
  - 10.000’s of wafers per hour per factory

- **High Yield** > 95% (mechanical, electronic)

- **High OEE** > 80% (uptime, yield)

- **Low production cost**
  - Efficient BOM
  - Automation
  - Low CAPEX

→ **Not achievable with batch or single-wafer processing**

**Inline processing is a must-have to achieve low production cost**
Out of the lab into production

- 5 MW production line in operation 2H 2017
- Start of mass production in 2018

Mass production based on a mature inline process building on 20 years of R&D work at Fraunhofer ISE
Efficient and scalable 250 MW factory

- Two factory parts:
  - EpiWafer factory
  - Chemical plant for vent gas recycling
NexWafe’s EpiWafers – innovation, growth and competitiveness

NexWafe brings solar wafer production back to Europe

- Most innovative, proprietary and patented PV technology fundamentally changing the process chain and the cost of the wafer industry
- We ensure long-term competitiveness in Europe by creating a scalable and highly profitable business
- We create jobs in R&D and manufacturing in Europe
LET’S BE AMBITIOUS!
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