





Manufacturing solutions for today and tomorrow: Cutting-edge production equipment for TOPCon and beyond

Speaker:

Dr. Josua Stückelberger

Director of Technology - International Business Unit

COMPANY PROFILE

Multiple Breakthroughs in Solar Innovation:

- Pioneer of TOPCon for mass production
- Vanguard of TOPCon+
- Innovator of Back Contact (BC) with almost 100% market share
- New deposition platform for perovskite-based tandem





PROJECT EXPERIENCE



- >470 GW of TOPCon/P-IBC/N-IBC/PERC equipment delivered (CNY ~ 15 BN, USD ~ 2.1 BN)
- >20GW outside of China from Southeast Asia and USA
- Biggest project: 30GW
- 1,000+ people in support: extensive experience in manufacturing of TOPCon & BC technology with cutting-edge performance and IP



CUSTOMER RECOGNITION

LONGi

Jinko^{Solar}
Building Your Trust in Solar

AIKO

 **通威太阳能**
TW SOLAR

Trinasolar
天合光能

JTPV 捷泰科技

 **CanadianSolar**

JASOLAR
晶澳太阳能

 **ASTROENERGY**

 **东磁**
DMEGC

SILFAB
SOLAR®

VSUN
Innovative & Smart



International Customers

- USA
- Southeast Aisa

Laplace international

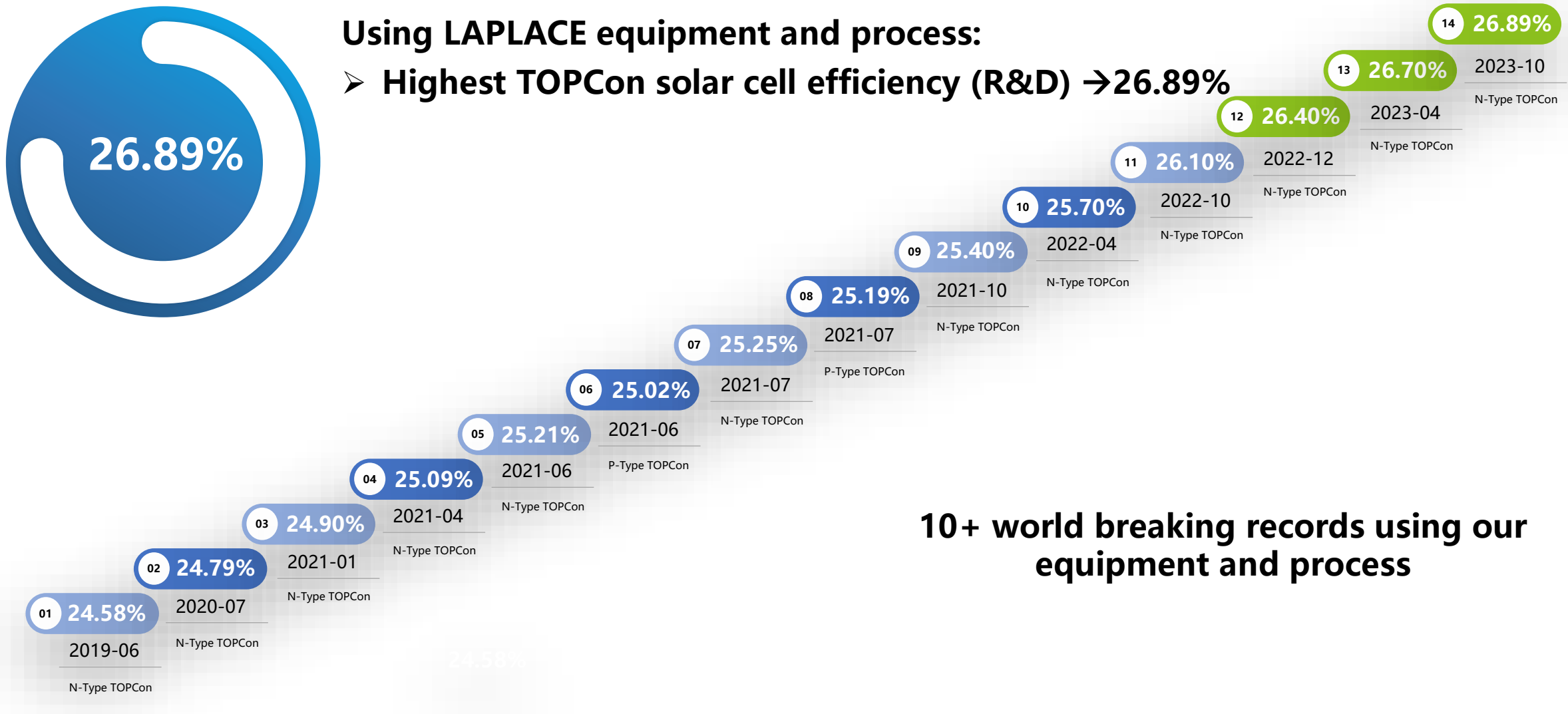
- Hong Kong (China)
- Southeast Asia
- Europe
- USA

Manufacturing and R&D Sites

- Shenzhen (Headquarter)
- Wuxi
- Haining
- Taizhou
- Xi' an
- Guangzhou



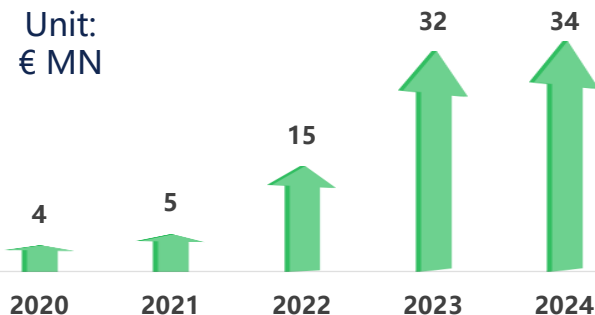
Using LAPLACE equipment and process:
➤ Highest TOPCon solar cell efficiency (R&D) →26.89%



10+ world breaking records using our equipment and process

R&D Investment

Unit:
€ MN



90+
Million €
Cumulative R&D expenditure

01

Pioneering transition from BBr_3 to BCl_3

- > 70% cost reduction

02

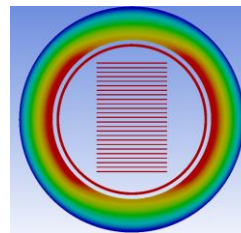
Double-loading (back-to-back wafers)

- Diffusion, Oxidation and LPCVD
- Doubled throughput without need of change in process flow
- Highest throughput for LPCVD, much lower CoO in comparison with PECVD

03

In-House Heating elements

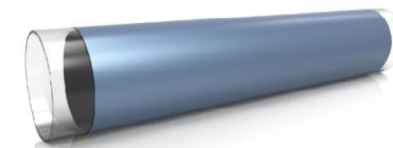
- Improved thermal uniformity, shorter processing time
- Longer quartz parts lifetime



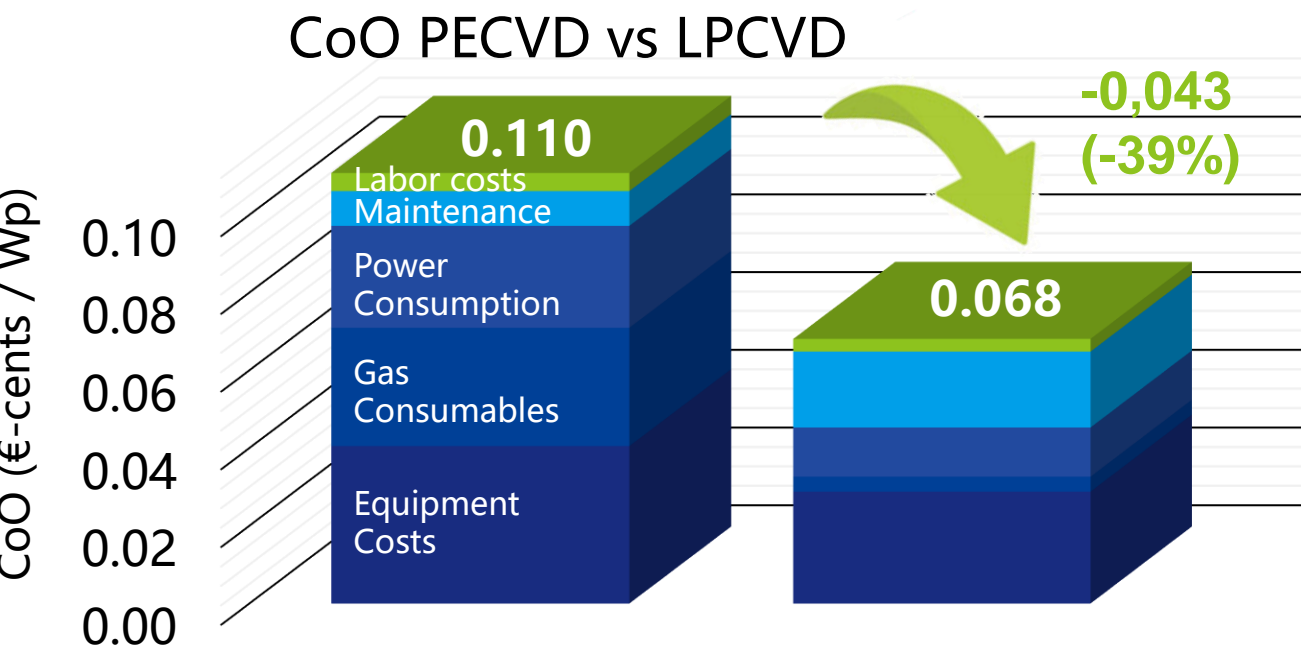
04

Quartz tube inside coating

- Pre-coating by nano crystallization technology
- Tube lifetime increase to over 6-9 months

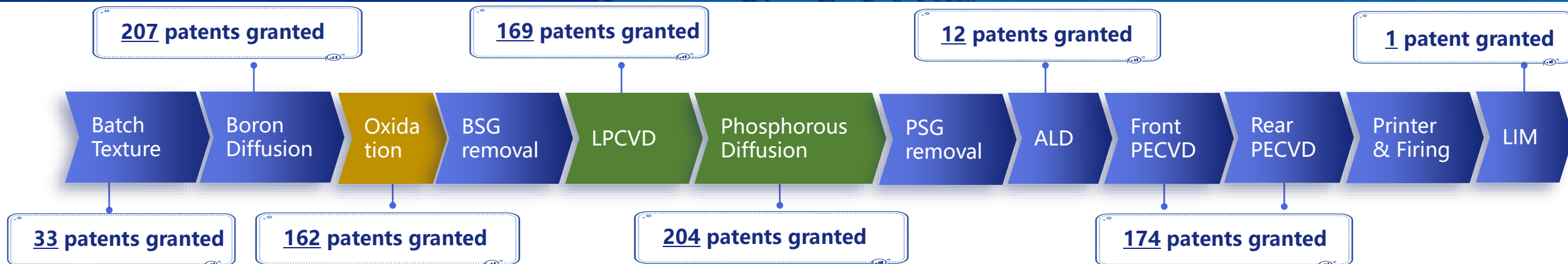


- **Laplace has improved the tool efficiency:**
For M10 wafers, besides double loading, GEN 4 Laplace tools have 2400 wafers/tube while GEN 5 has 2880 wafers/tube
- **Quartz tube inside coating:**
Pre-coating by nano crystallization technology increased tube lifetime to over 6-9 months



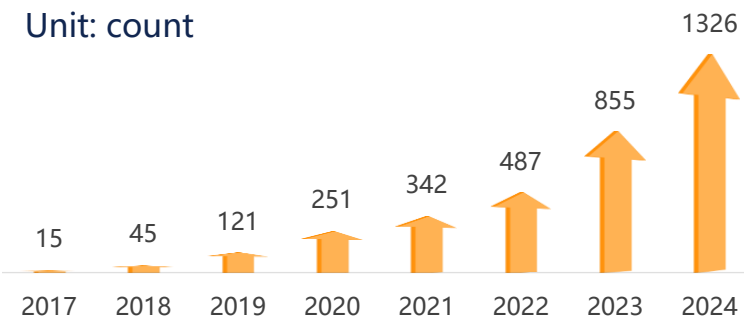
GEN5 tools (double loading) combined with increased tube lifetime have improved significantly the CoO of LPCVD with today a **~40% lower CoO than PECVD**.

LAPLACE Equipment Patent Portfolio



Accumulated Patent Applications

Unit: count



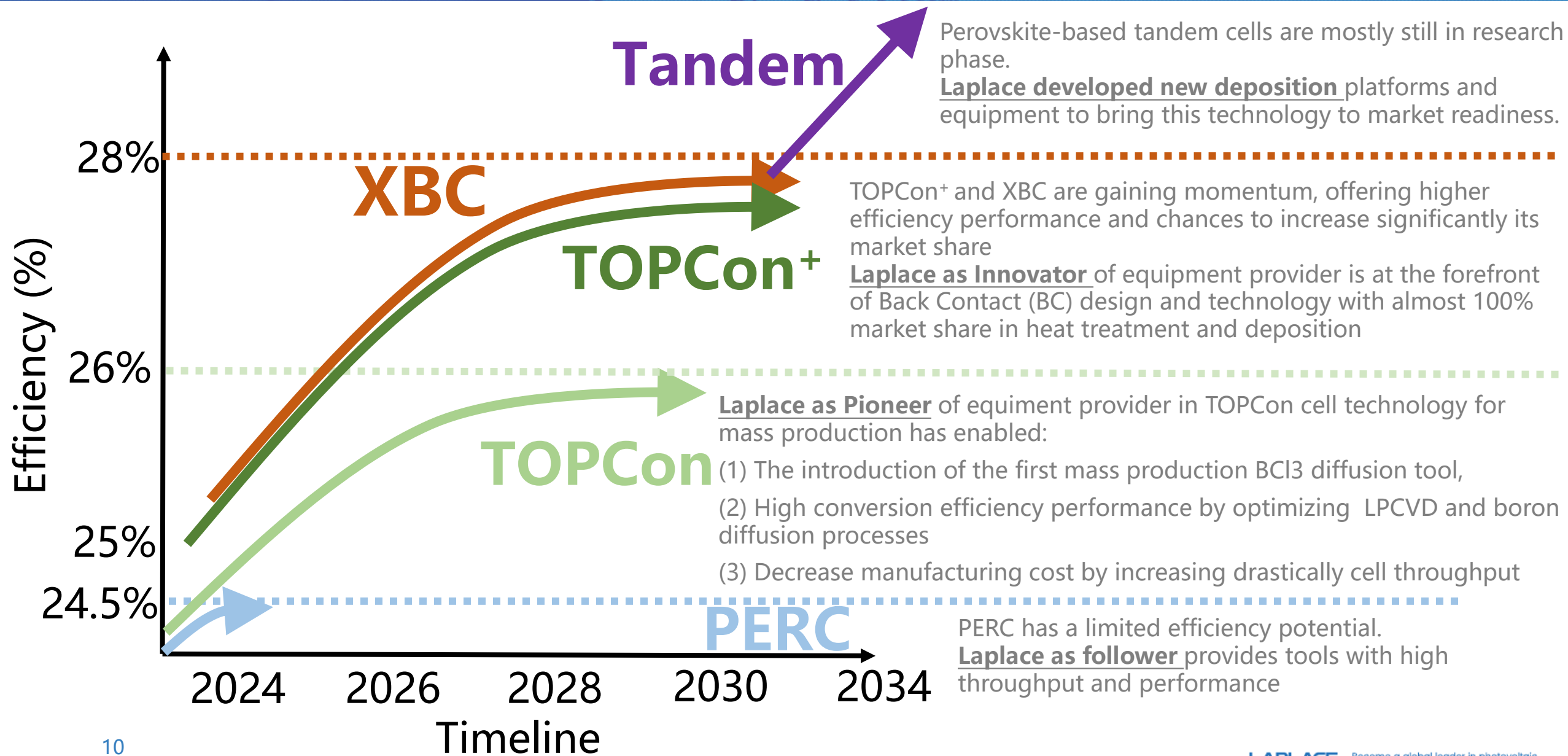
1,300+
Applied Patents

700+
Granted patents

- Laplace has a strong patent portfolio and is protecting its customers
- Laplace continuously analyses upcoming patents and lawsuits to ensure a seamless adaptation of upcoming technologies.

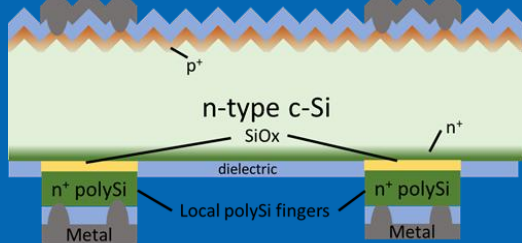
Laplace proprietary **LPCVD with ex-situ doping** technology allows customers to sell to USA and Europe

LAPLACE Technology Roadmap of PV Cell



TOPCon

TOPCon +

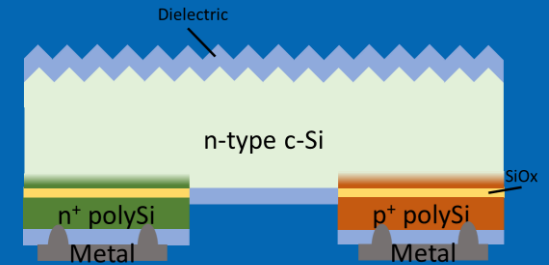


Eff. up to **27.62 %** [1]

Similar requirements

- **Stable, uniform, thermal SiO_x**
- **Lasers gain importance**

XBC



Eff. up to **27.99 %** [1]

Tandem

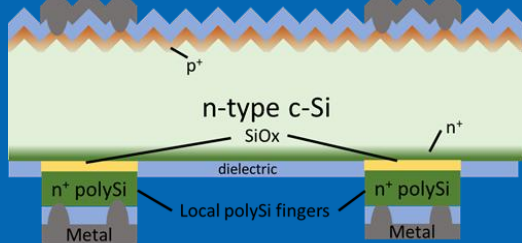
Perovskite-based tandem cells are mostly still in research phase. Laplace has developed new platforms and equipment that are currently in pilot lines.

TOPCon

Today's presentation

TaiyangNews
December 2024 (Youtube)

TOPCon +

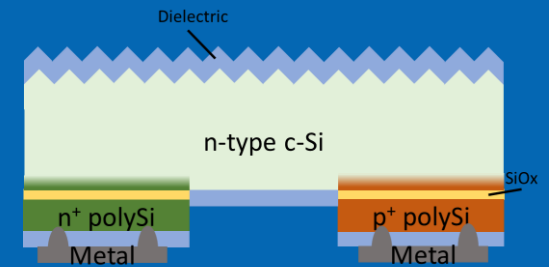


Eff. up to 27.62 % [1]

Similar requirements

- Stable, uniform, thermal SiOx
- Lasers gain importance

XBC



Eff. up to 27.99 % [1]

Tandem

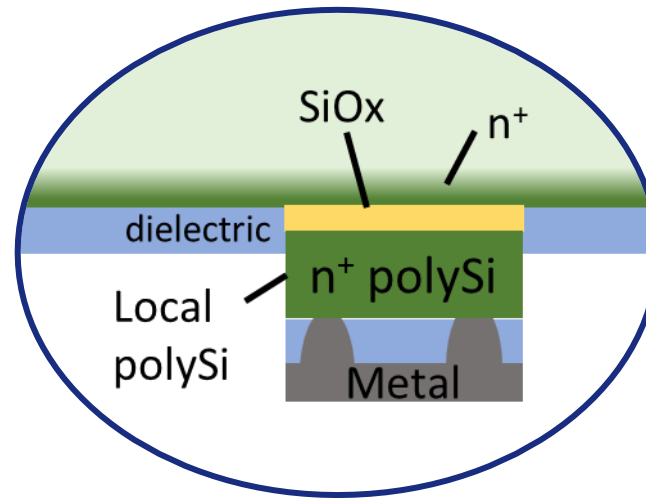
Perovskite-based tandem cells are mostly still in research phase. Laplace has developed new platforms and equipment that are currently in pilot lines.

LAPLACE' s leading role for TOPCon plus and XBC equipments

Laplace is strongly supporting our customers to achieve their goals in mastering TOPCon plus and XBC

Most important demand for all TOPCon plus and XBC cells:
Stable, reproducible, uniform, thermal SiOx layer

——> Implementation to TOPCon plus and XBC requires the use of **LPCVD for the deposition of both the tunnel SiOx and polysilicon layers**



For localized polySi, either as polySi fingers or XBC design, lasers are the most cost-efficient way for patterning

Laplace developed advanced laser technology for all critical steps in TOPCon plus and XBC manufacturing

Our system is **fully compatible** for the polySi implementation in TOPCon⁺ and XBC cells, with equipment already delivered and operating successfully.

LAPLACE next generation solar cells in the Industry

Laplace has delivered successfully equipment for the critical process steps with almost 100% market share for TOPCon⁺ and BC cells

	TOPCon	TOPCon ⁺	Back Contact
Capacity			
Installed:	≥ 700 GW ¹	50 GW ¹	52.5 GW ¹
Expected total in 2025:	≥ 750 GW ¹	≥ 100 GW ¹	≥ 105 GW ¹
Cells:			
Average warehouse efficiency	~ 25.0 % ¹	~ 25.2 % ¹	~25.6 % ¹
Modules:			
Current G12R commercial efficiency:	22.8 % (615 W) ²	23.5 % (635 W) ³	24.2 % (655 W) ⁴
Next commercial efficiency: (announced for 2025)	-----	24.8 % (670 W) ⁵	24.8 % (670 W) ⁶
Bifaciality:	80 %	85 %	70 %
Manufacturing Complexity weighted score: (1:easy, TOPCon: 6, difficult: 10)	6 (moderate)	7 (moderate)	10 (hard)
Required manpower: (TOPCon as reference 100%):	100 %	103 %	120%

[1] Company financial and Public Investor Meeting Minutes

[2] <https://taiyangnews.info/topmodules/top-solar-modules-listing-november-2024>

[3] <https://www.jinkosolar.com/en/site/dwparametern>

[4] <https://taiyangnews.info/technology/aiko-solar-module-efficiency>

[5] December 2024, Taiyang News Conference

[6] taiyangnews.info/technology/longi-breaks-global-module-mass-production-efficiency-record



LAPLACE Equipment Portfolio for TOPCon Cell Line

Wet
etch

B Diff.

Oxidation

Etch &
Clean

LPCVD

P Diff.

Etch &
Clean

ALD

Front
PECVD

Rear
PECVD

Metalli
zation

Test
Sort

Heat treatment

Solid State diffusion and Oxidation

Boron Diffusion

- Pioneering BCl₃
- 5TH GENERATION
- > 900 machines delivered
- Rank first by market share

Oxidation & Annealing

- 5TH GENERATION
- > 700 machines delivered
- coating film.

Phosphorous Diffusion

- 5TH GENERATION
- > 300 machines delivered
- Larger production capacity, and can reduce costs

Deposition

LPCVD

- 5TH GENERATION
- > 1,100 machines delivered
- Rank first by market share

ALD

- 2ND GENERATION
- Double-layer sealing ensures the uniformity of the coating film.

PECVD

- 5TH GENERATION
- > 500 machines delivered
- Larger production capacity, and can reduce costs


Automation

Loading, transfer,
up to full
automation for
entire cell line

- > 1,700 machines delivered







Atomic Edge Passivation Deposition Complete Solution (EPD)

Function:

Cut wafers in half and passivate to edges to recover the losses

Mechanism:

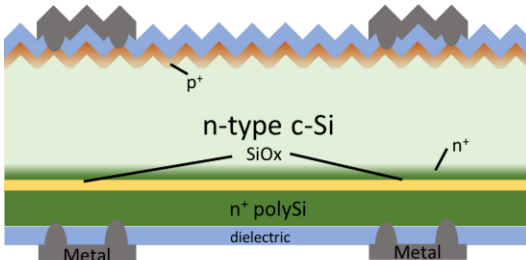
Non-destructive laser is used to separate the wafer in two pieces. Half cells are stacked to a coin-stack and a passivation layer is deposited on the edges.

Dimensions:

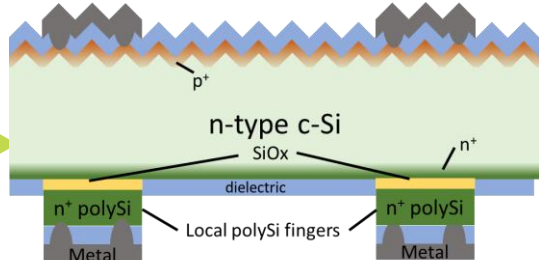
19,04 x 4,60 x 3,70 m

Throughput:


10000 pcs/h (M10)



	Warehouse Cell Efficiency	G12R Module Power	G12R Module Efficiency
TOPCON	25.2 %	635	23.5 %
EPD	+ 0.3 %	+ 6 W	+ 0.2 %
TOPCon Plus	25.5 %	641 W	23.7 %







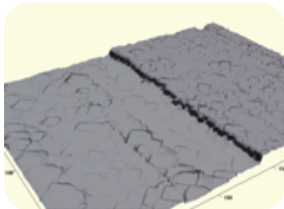
Poly Thickness Removal via Laser Ablation

Function:
bifaciality factor

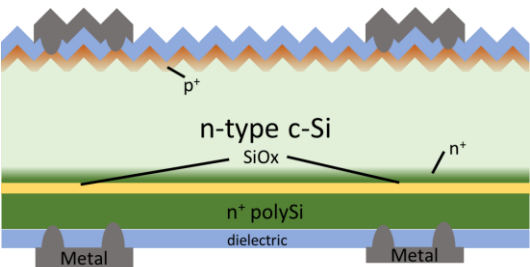
Mechanism:
Remove poly-silicon locally

Dimensions:
5,56 x 4,00 x 2,80 m

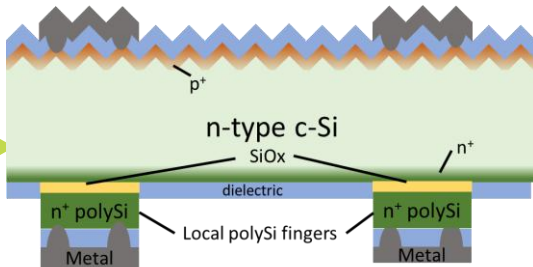
Throughput:
9000 pcs/h (M10)



3D morphology of etching edge




	Warehouse Cell Efficiency	G12R Module Power	G12R Module Efficiency
TOPCON	25.2 %	635	23.5 %
EPD	+ 0.3 %	+ 6 W	+ 0.2 %
PolSi fingers	+ 0.15 %	+ 3 W	+ 0.1 %
TOPCon Plus	25.65 %	644 W	23.8 %





Additional ALD tools are required to passivate front and rear side



Poly Thickness Removal via Laser Ablation

Function: bifaciality factor

Mechanism:

Dimensions:

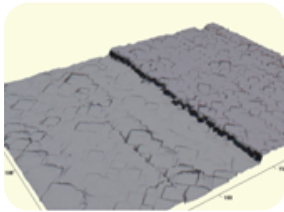
Throughput:

Reduce parasitic absorption, increase conversion efficiency and

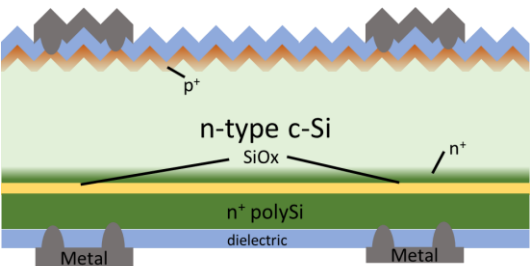
Remove poly-silicon locally

5,56 x 4,00 x 2,80 m

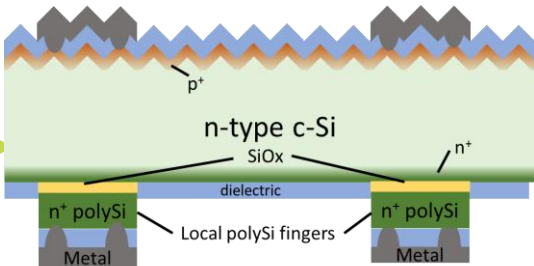
9000 pcs/h (M10)



3D morphology of etching edge



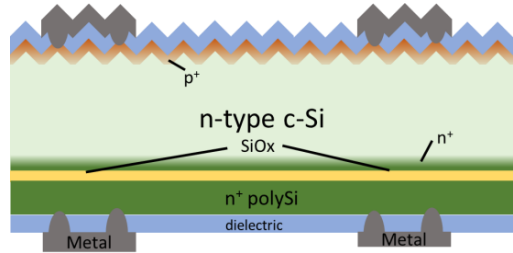
	Warehouse Cell Efficiency	G12R Module Power	G12R Module Efficiency
TOPCON	25.2 %	635	23.5 %
EPD	+ 0.3 %	+ 6 W	+ 0.2 %
PolSi fingers	+ 0.15 %	+ 3 W	+ 0.1 %
TOPCon Plus	25.65 %	644 W	23.8 %



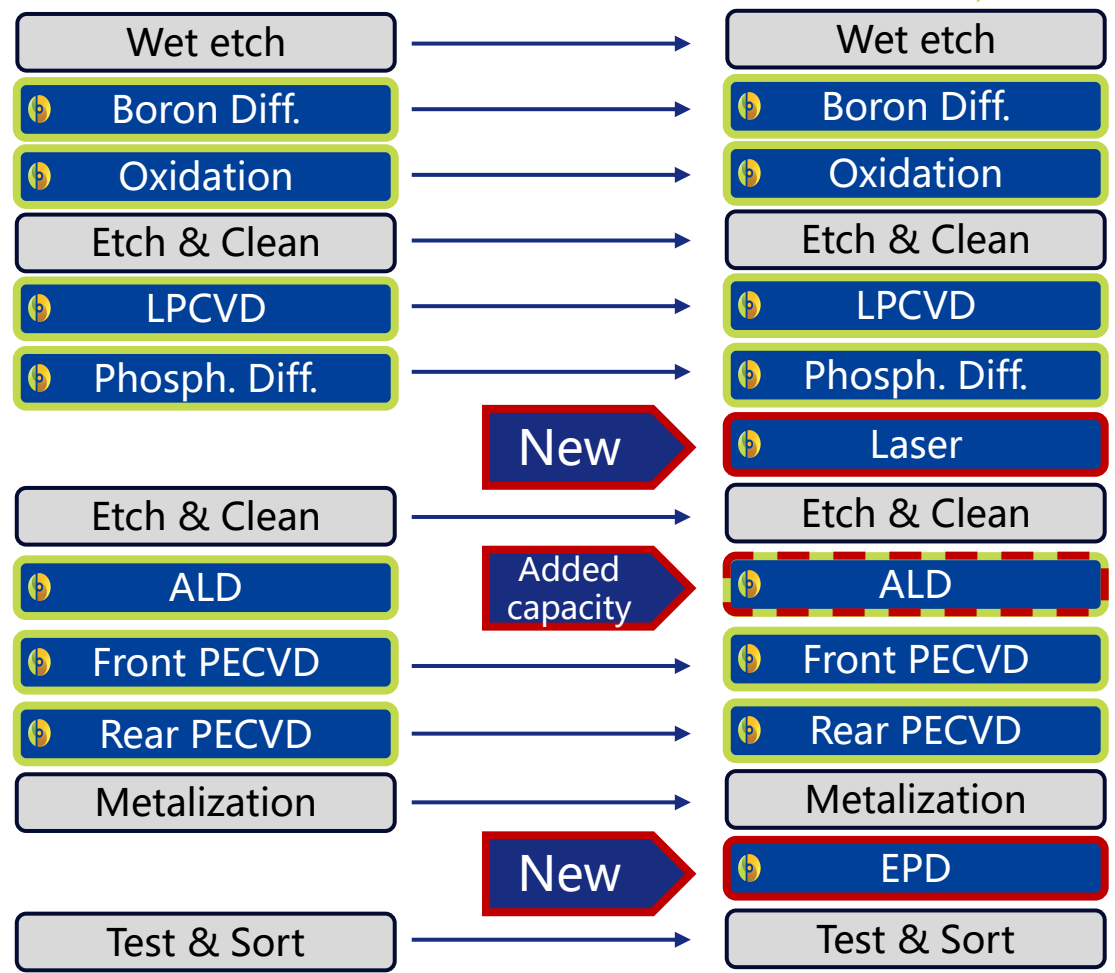


From TOPCon to TOPCon plus

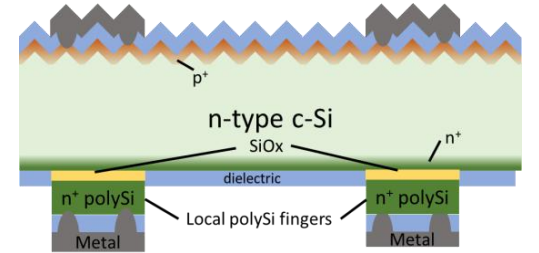
TOPCon



Efficiency + 0.45 %
Module gain + 9 W



TOPCon+



Experience:

Pioneers of TOPCon for mass production with
> **470 GW** equipment delivered

Double-loading for LPCVD

→ Highest throughput in the market: 40% lower CoO compared to PECVD deposition tools

Proprietary coated quartz tube

→ Double and potentially triple the lifetime of quartz tubes



Leading equipment for TOPCon+ and XBC:

- Laplace toolset is fully compatible for TOPCon+ and XBC integration.
- Strong support for our customers to achieve their goals in successfully achieve mass production
- **New equipment:**
New laser tools for TOPCon+ and BC, facilitating the process flow with local openings



THANKS!

推动新能源技术创新，造福人类
Enable Renewable Energy Innovation for a Sustainable Future

