
LAPLACE

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

Speaker:

Dr. Josua Stückelberger

Director of Technology - International Business Unit

TaiyangNews

Solar Technology Conference India 2025

New Delhi – India

April 2025

LAPLACE Renewable Energy Technology Co., Ltd.

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

LAPLACE Experience

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
JA SOLAR 晶澳太阳能
ASTRONERGY
东磁 DMEGC
SILFAB SOLAR
VSUN Innovative & Smart

LAPLACE International

International Customers

- USA
- Southeast Aisa

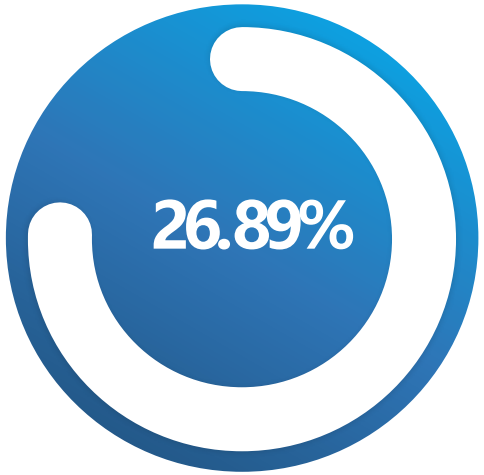
Laplace international

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

Manufacturing and R&D Sites

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

Development of Cutting-edge Technology at LAPLACE



Using LAPLACE equipment and process:

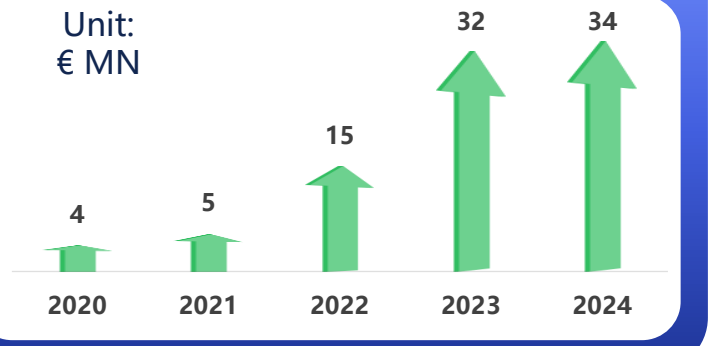
- **Highest TOPCon solar cell efficiency (R&D) →26.89%**

01	24.58%	2019-06	N-Type TOPCon
02	24.79%	2020-07	N-Type TOPCon
03	24.90%	2021-01	N-Type TOPCon
04	25.09%	2021-04	N-Type TOPCon
05	25.21%	2021-06	N-Type TOPCon
06	25.02%	2021-06	P-Type TOPCon
07	25.25%	2021-07	N-Type TOPCon
08	25.19%	2021-07	P-Type TOPCon
09	25.40%	2021-10	N-Type TOPCon
10	25.70%	2022-04	N-Type TOPCon
11	26.10%	2022-10	N-Type TOPCon
12	26.40%	2022-12	N-Type TOPCon
13	26.70%	2023-04	N-Type TOPCon
14	26.89%	2023-10	N-Type TOPCon

10+ world breaking records using our equipment and process

LAPLACE innovations for TOPCon

R&D Investment



90+

Million €
Cumulative R&D expenditure

01

Pioneering transition from BBr_3 to BCl_3

- > 70% cost reduction

02

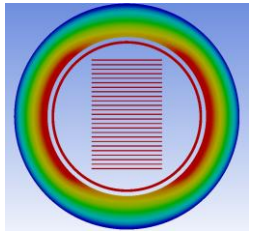
Double-loading (back-to-back wafers)

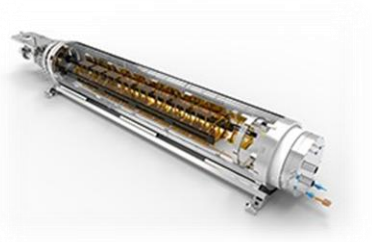
- Diffusion, Oxidation and LPCVD
- Doubled throughput without need of change in process flow
- Highest throughput for LPCVD, much lower CoO in comparison with PECVD

03

In-House Heating elements

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

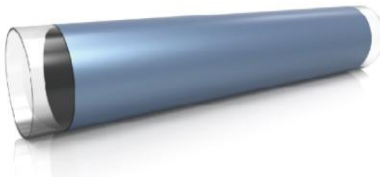




04

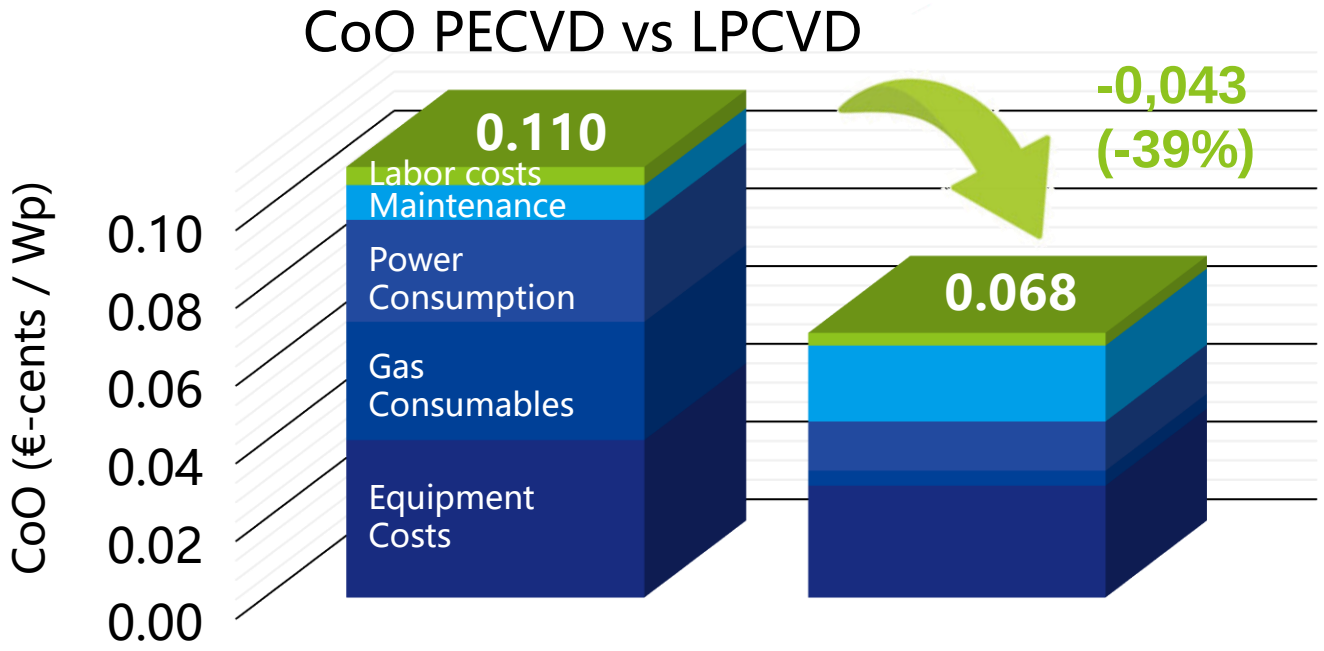
Quartz tube inside coating

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



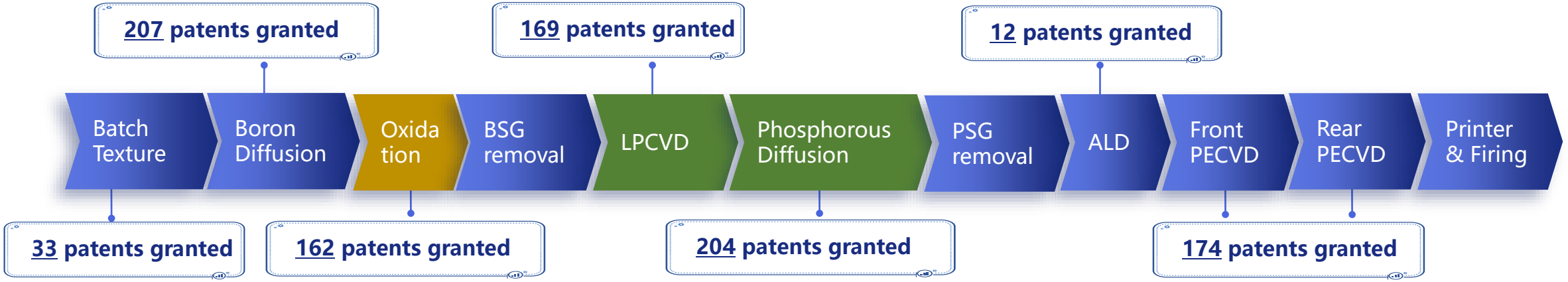
LAPLACE LPCVD route

- **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

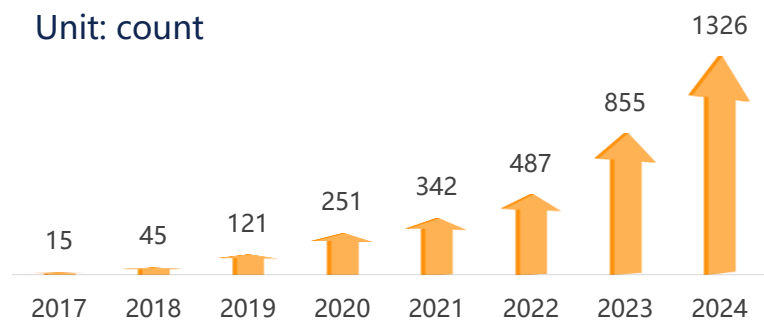


GEN5 tools (double loading) combined with increased tube lifetime have improved significantly the CoO of LPCVD with today a **~40% lower CoO than PECVD.**

LAPLACE Equipment Patent Portfolio



Accumulated Patent Applications



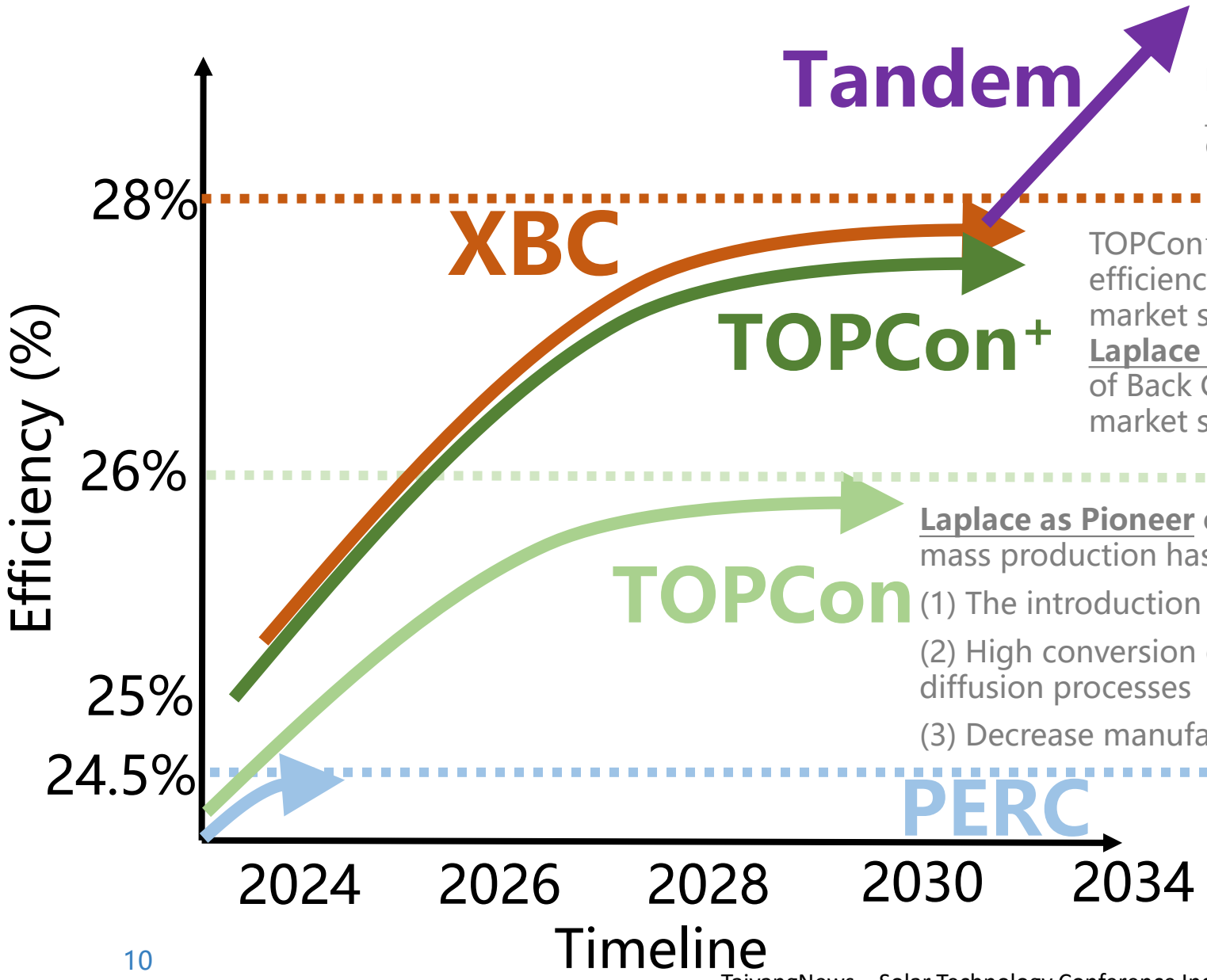
1,300+
Applied Patents

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



Perovskite-based tandem cells are mostly still in research phase.
Laplace developed new deposition platforms and equipment to bring this technology to market readiness.

TOPCon⁺ and XBC are gaining momentum, offering higher efficiency performance and chances to increase significantly its market share
Laplace as Innovator of equipment provider is at the forefront of Back Contact (BC) design and technology with almost 100% market share in heat treatment and deposition

Laplace as Pioneer of equiment provider in TOPCon cell technology for mass production has enabled:

(1) The introduction of the first mass production BCl3 diffusion tool,

(2) High conversion efficiency performance by optimizing LPCVD and boron diffusion processes

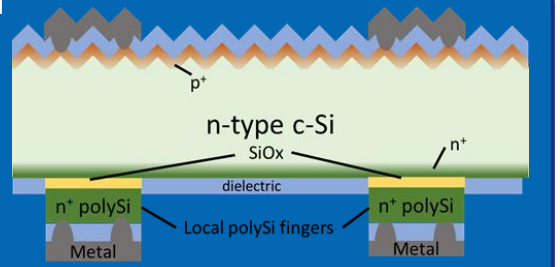
(3) Decrease manufacturing cost by increasing drastically cell throughput

PERC has a limited efficiency potential.
Laplace as follower provides tools with high throughput and performance

LAPLACE Technology Roadmap

TOPCon

TOPCon +

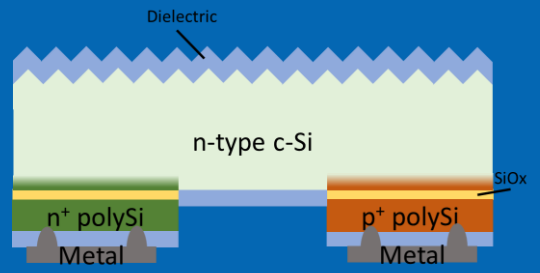


Eff. up to **27.62 %** [1]

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.

[1] Q. Wang et al., Prog. Ph. Res. Appl., 2024, doi.org/10.1002/pip.3839.

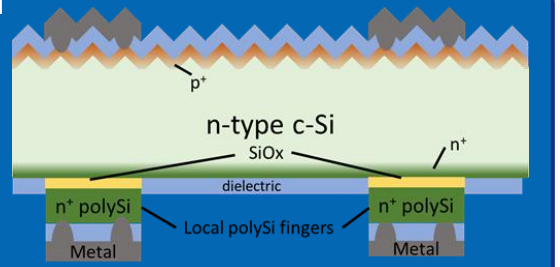
LAPLACE Technology Roadmap

TOPCon

Today's presentation

TaiyangNews December 2024 (Youtube)

TOPCon +

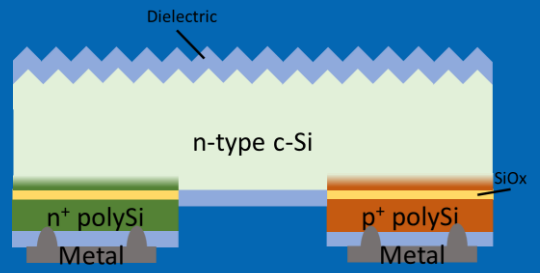


Eff. up to **27.62 %** [1]

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.

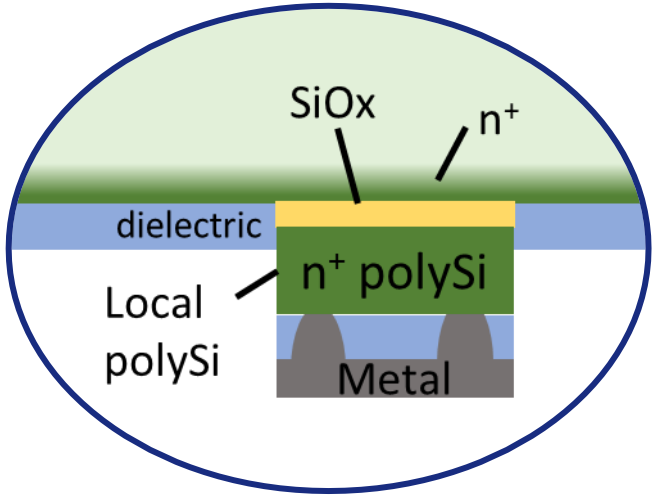
[1] Q. Wang et al., Prog. Ph. Res. Appl., 2024, doi.org/10.1002/pip.3839.

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: Expected total in 2025:	 **≥ 700 GW[1]** **≥ 750 GW[1]**	 **50 GW[1]** **≥ 100 GW[1]**	 **52.5 GW[1]** **≥ 105 GW[1]**
Cells: Average warehouse efficiency	 **~ 25.0 %[1]**	 **~ 25.2 %[1]**	 **~25.6 %[1]**
Modules: Current G12R commercial efficiency: Next commercial efficiency: (announced for 2025)	 **22.8 % (615 W)[2]** ------	 **23.5 % (635 W)[3]** **24.8 % (670 W)[5]**	 **24.2 % (655 W)[4]** **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 TaiyangNews – Solar Technology Conference India – April 2025
[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 | Metallization | Test Sort

Heat treatment

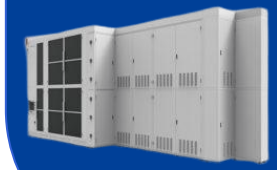
Solid State diffusion and Oxidation

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

From TOPCon to TOPCon plus

Wet etch | B Diff. | Oxidation | Etch & Clean | LPCVD | P Diff. | Etch & Clean | ALD | Front PECVD | Rear PECVD | Metallization | EPD | Test Sort

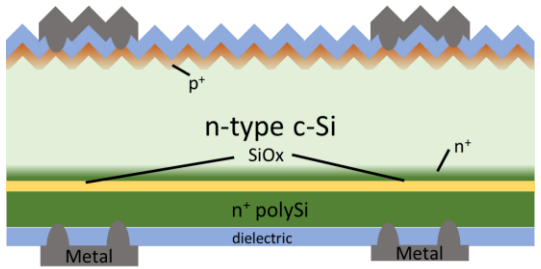
Atomic Edge Passivation Deposition Complete Solution (EPD)

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

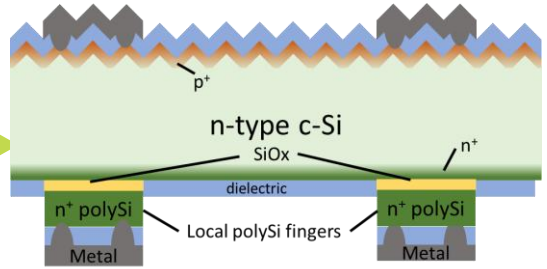
Mechanism: Non-destructive laser is used to separate the wafer in two pieces. Half cells are stacked to a coin-stack and a passivation layer is deposited on the edges.

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 %

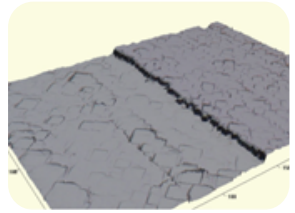


From TOPCon to TOPCon plus

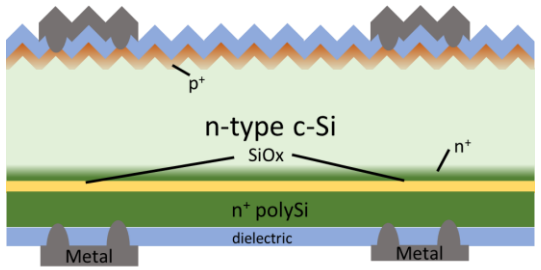
Wet etch | B Diff. | Oxidation | Etch & Clean | LPCVD | P Diff. | **Laser** | Etch & Clean | ALD | Front PECVD | Rear PECVD | Metallization | EPD | Test Sort

Poly Thickness Removal via Laser Ablation

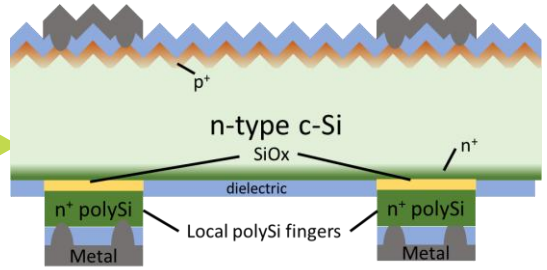
Function: Reduce parasitic absorption, increase conversion efficiency and bifaciaity factor
Mechanism: Remove poly-silicon locally
Dimensions: 5,56 x 4,00 x 2,80 m
Throughput: 9000 pcs/h (M10)



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 %**



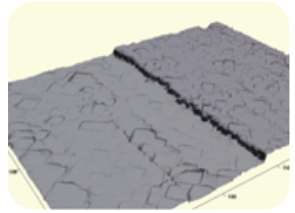
From TOPCon to TOPCon plus

Wet etch | B Diff. | Oxidation | Etch & Clean | LPCVD | P Diff. | Laser | Etch & Clean | ALD | Front PECVD | Rear PECVD | Metalli zation | EPD | Test Sort

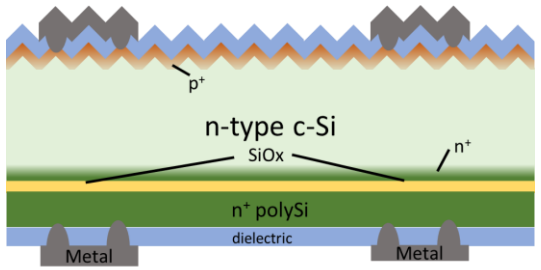
Additional ALD tools are required to passivate front and rear side

Poly Thickness Removal via Laser Ablation

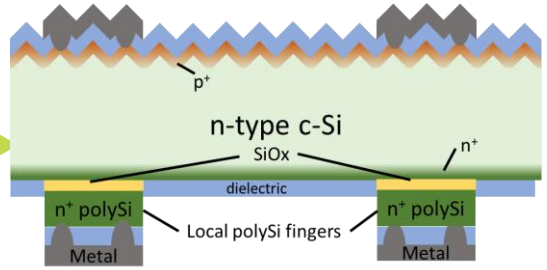
Function: Reduce parasitic absorption, increase conversion efficiency and bifaciaity factor
Mechanism: Remove poly-silicon locally
Dimensions: 5,56 x 4,00 x 2,80 m
Throughput: 9000 pcs/h (M10)



3D morphology of etching edge

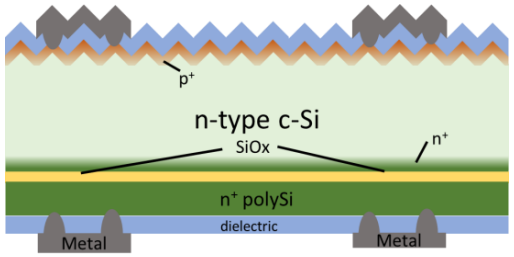


	Warehouse Cell Efficiency	G12R Module Power	G12R Module Efficiency
TOPCON	**25.2 %**	**635**	**23.5 %**
EPD	+ 0.3 %	+ 6 W	+ 0.2 %
PolSi fingers	+ 0.15 %	+ 3 W	+ 0.1 %
TOPCon Plus	**25.65 %**	**644 W**	**23.8 %**



From TOPCon to TOPCon plus

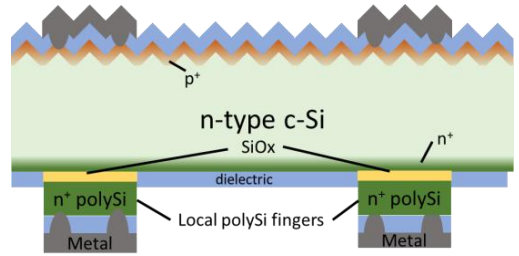
TOPCon



Efficiency + 0.45 %
Module gain + 9 W

TOPCon	TOPCon+
Wet etch	Wet etch
Boron Diff.	Boron Diff.
Oxidation	Oxidation
Etch & Clean	Etch & Clean
LPCVD	LPCVD
Phosph. Diff.	Phosph. Diff.
	New: Laser
Etch & Clean	Etch & Clean
ALD	Added capacity: ALD
Front PECVD	Front PECVD
Rear PECVD	Rear PECVD
Metalization	Metalization
	New: EPD
Test & Sort	Test & Sort

TOPCon+



19

Summary

Experience:

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

Innovation for TOPCon:

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

LAPLACE

THANKS!

推动新能源技术创新，造福人类

Enable Renewable Energy Innovation for a Sustainable Future