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LAPLACE RENEWABLE ENERGY TECHNOLOGY CO., LTD.

——Global Leading Supplier of Photovoltaic Equipment and Solutions

https://www.laplace-tech.com/

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An Introduction to the Development of N-type High-efficiency solar cell Equipment

13th BC Workshop:

Amsterdam - December 2025

Speaker:

Dr. Josua Stückelberger

Director of Technology - International Business Unit

COMPANY OVERVIEW

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

Headquarters in Shenzhen City, China

2016
Set up

2024
Listed on STAR Market SH688726

2,000+	**1,300+**	**500+GW**	**90%+**
Employees	Engineering staff	Delivery volume	Coverage rate of top customers

EXPERIENCE

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PROJECT EXPERIENCE

- >500 GW of TOPCon/P-IBC/N-IBC/PERC equipment delivered (CNY ~ 17 BN, USD ~ 2.4 BN)
- >100 GW BC equipment delivered
- >20GW outside of China from Southeast Asia and USA
- Biggest project: 30GW
- 800+ people in support: extensive experience in manufacturing of TOPCon & BC technology with cutting-edge performance and IP

CUSTOMER RECOGNITION

JinKO Solar
JTPV
LONGi
AIKO
Trinasolar
DMEGC
ASTRONERGY
SILFAB SOLAR
TW SOLAR
BYD
YINGLI SOLAR
VSUN Innovative & Smart
JOLYWOOD
LINYANG

LAPLACE INTERNATIONAL

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International Customers

- USA
- Turkey
- Indonesia
- Vietnam
- Ethiopia
- South Asia
- China

Manufacturing and R&D Sites

- Shenzhen(HQ) base
- Wuxi base
- Taizhou base
- Xi'an base
- Guangzhou base

BC TAKES EFFICIENCY LEADS

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TAIYANGNEWS ALL ABOUT SOLAR POWER

TaiyangNews Top Modules: Highest Efficient Commercial Solar Modules 11-2025

Rank	Company	Series	Model	Wafer type	Cell Size	Cells No.	Cell Tech	Module Technology	Power (W)	Efficiency (%)
1	AIKO	Comet 2U	AIKO-G660-MCH72Mw	n-type	182	144	ABC	Half-cell, Back Contact	660	24.4
2	LONGi	Hi-MO 9	LR8-66HYD 635-655M	n-type	182	132	HPBC	Bifacial, Half-cell, Back Contact	655	24.2
3	Trinasolar	Vertex N	TSM-NEG19RC.20	n-type	210R	132	TOPCon	Bifacial, Half-cell, MBB	640	23.7
4	JinKO Solar	Tiger Neo	JKM625-635N-66HL4M-BDV	n-type	210R	132	TOPCon	Bifacial, Half-cell, MBB	635	23.51

https://taiyangnews.info/topmodules/monthly-top-modules-update/top-solar-modules-listing-november-2025

Module WR: 25.2% efficiency (2024)

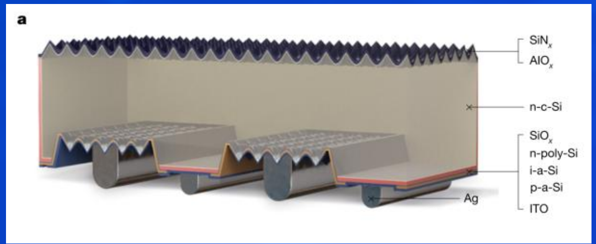
AIKO

- All-back-contact (ABC) cells
- mass-produced commercial product

[1] https://www.pv-magazine.com/2024/06/19/aiko-presents-abc-solar-module-with-world-record-efficiency-of-25-2-at-intersolar/

Cell WR: 27.81% efficiency (2025)

- hybrid interdigitated back-contact (HIBC) solar cell that combines advanced all-surface passivation with laser-treated tunnelling contacts
- Approaching theoretical silicon cell efficiency limit



LONGi

[1] Wang, G., et al., (2025). Silicon solar cells with hybrid back contacts. Nature

DRIVING BACK CONTACT FUTURE WITH LAPLACE

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Experience

- Supporting customers from early days on for implementation of BC technology
- >100 GW of XBC equipment delivered
- Almost 100% market share on critical equipment for XBC cells

Leading equipment for XBC

- Proprietary XBC process equipment created delivering > 27.3% (R&D) efficiency cells
- Reduced tool count and optimized fab layout for lower CAPEX / OPEX
- Smart factory: Implementation of AI powered tools including AI factory integration

Recent tool upgrades

- Temperature Control system
- Gas precursor availability
- Process optimization

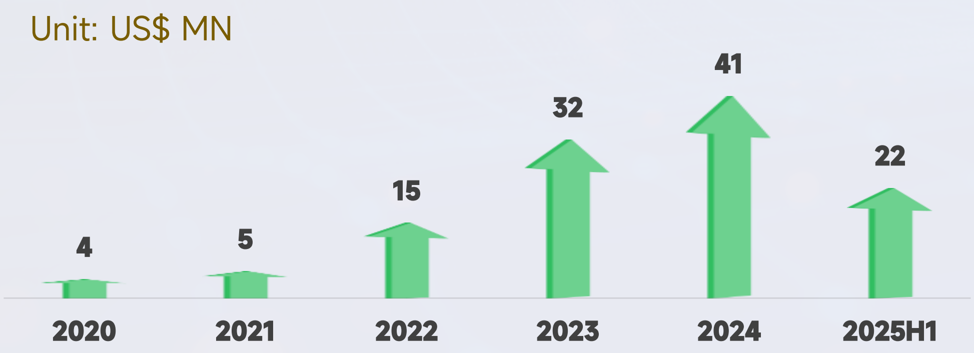
Laplace has a critical edge in developing new manufacturing tools for all BC cell technologies

TECHNICAL STRENGTH

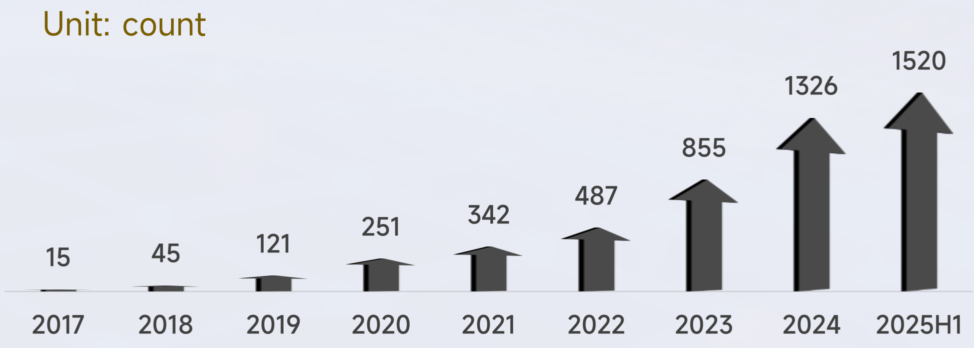
- Laplace has a strong patent portfolio and is protecting its customers
- Laplace continuously analyses upcoming patents and lawsuits to ensure a seamless adaptation of upcoming technologies.

Laplace proprietary TOPCon process flow, and LPCVD with ex-situ doping technology allows customers to manufacture and sell TOPCon products to the USA and Europe

R&D Investment



Accumulated Patent Applications



120+
million US$
Cumulative R&D expenditure

10+
Employees
with PhD degrees

1,500+
Applied Patents

900+
Granted patents

TECHNICAL STRENGTH

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Core technologies

01 **Photovoltaic-grade high-capacity LPCVD (including double loading)**

02 Third-generation semiconductor ultra-high-temperature oxidation annealing

03 Innovative low-pressure horizontal boron diffusion

04 **Laser application technology**

05 Heating and temperature control

06 Efficient and intelligent automatic loading and unloading

07 Novel quartz tube coating

08 **Uniform flow and precise gas control**

Ongoing Research Projects

- Core Vacuum Process Equipment for Perovskite
- ALD Equipment
- Edge Passivation Deposition (EPD)
- Core CVD Process Equipment
- Physical Vapor Deposition (PVD)
- ...

WHY LAPLACE HAS A LEADING ROLE FOR XBC TECHNOLOGY

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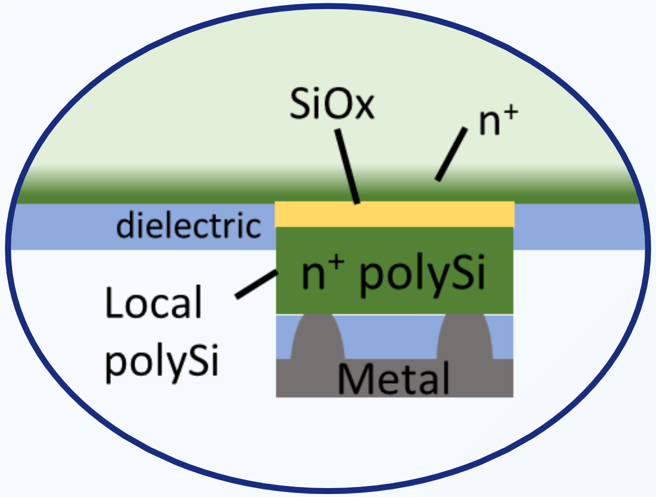
TBC solar cells could reach an efficiency of 27.99 % [1]

Most important demand for all XBC cells:

Stable, reproducible, uniform, thermal SiOx layer

→ Implementation to XBC requires the use of **LPCVD** for the deposition of both the tunnel SiOx and polysilicon layers



For localized polySi in XBC design, lasers are the most cost-efficient way for patterning

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

Our Solutions are <u>fully compatible</u> with the polySi implementation in XBC cells, with equipment already delivered and operating successfully.

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

EQUIPMENT PORTFOLIO FOR TBC CELL LINE

LAPLACE

Polish | LPCVD | B Diffusion | Laser n area | LPCVD | Polish | P Diffusion | Laser P & Gap area | Texture | Double ALOx | Front SINx | Rear SINx | SP & Firing

Heat Treatment

Solid State diffusion and Oxidation

Oxidation & Annealing

- 5TH GENERATION
- ＞700 machines delivered

Boron Diffusion

- Pioneering BCl_3
- 5^{TH} GENERATION
- ＞1,000 machines delivered
- Rank first by market share

Phosphorous Diffusion

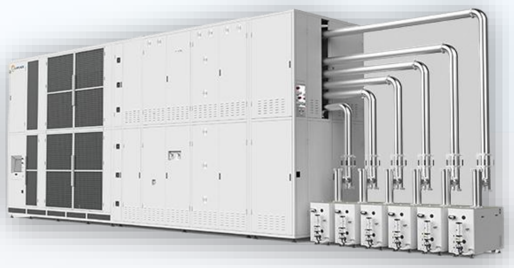
- 5TH GENERATION
- ＞400 machines delivered
- Larger production capacity, and can reduce costs

EQUIPMENT PORTFOLIO FOR TBC CELL LINE

LAPLACE

Polish | LPCVD | B Diffusion | Laser n area | LPCVD | Polish | P Diffusion | Laser P & Gap area | Texture | Double ALOx | Front SINx | Rear SINx | SP & Firing

Deposition



LPCVD

- 5TH GENERATION
- > 1,300 machines delivered
- Rank first by market share

ALD

- 2ND GENERATION
- Double-layer sealing of the inner and outer cavities ensures the uniformity of the coating film

PECVD

- 5TH GENERATION
- ＞600 machines delivered
- Larger production capacity, and can reduce costs

EQUIPMENT PORTFOLIO FOR TBC CELL LINE

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Polish	LPCVD	B Diffusion	Laser n area	LPCVD	Polish	P Diffusion	Laser P & Gap area	Texture	Double ALOx	Front SINx	Rear SINx	SP & Firing

LASER and EPD

Poly Thickness Removal via Laser Ablation

- Reduce parasitic absorption,
- increase conversion efficiency and bifaciaity factor

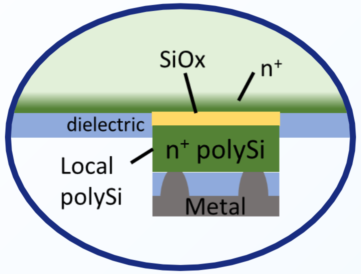
Laser induced Metalization (LIM)

- Improve contact resistivity
- Large production capacity, low commissioning difficulty, and low operation cost

Atomic Edge Passivation Deposition Complete Solution

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

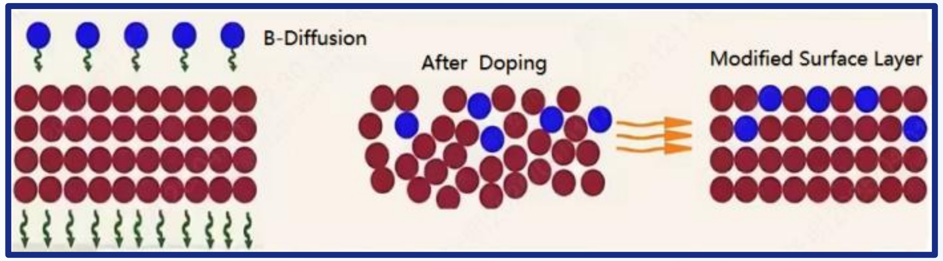
KEY ELEMENTS FOR XBC



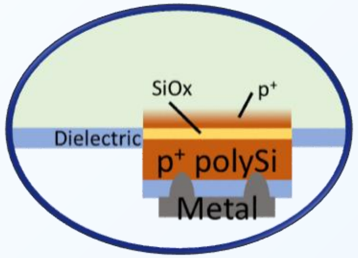
Most important demand for all XBC cells:

Stable, reproducible, uniform, thermal SiOx layer

→ Implementation to XBC requires the use of **LPCVD** for the deposition of both the tunnel SiOx and polysilicon layers



Strong, uniform BSG/PSG film layer for good masking effect and laser opening window achieved through an independent temperature control program and uniform gas precursor availability



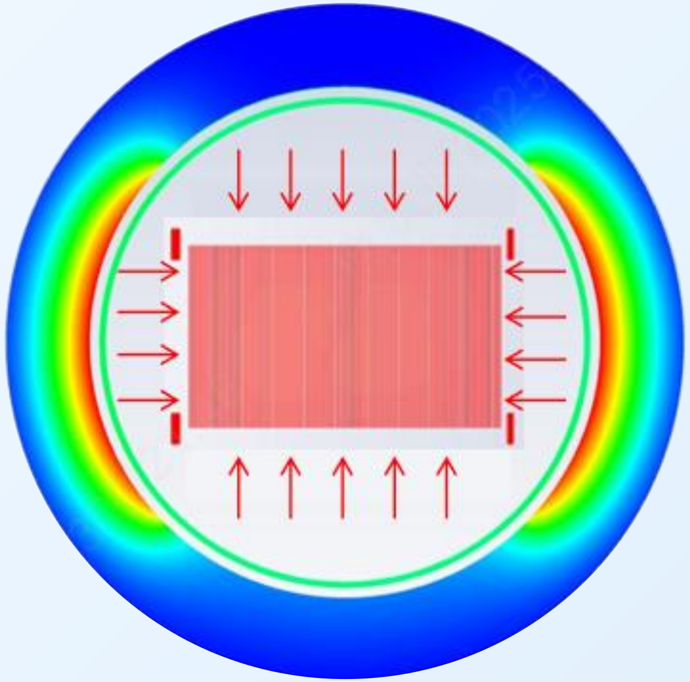
Strong performing **p-poly** through optimized interplay between LPCVD, boron diffusion and the full cell process

Optimized tool capacities to **maximize full line output and yield** and to achieve better production rhythm, greatly reducing investment cost

NOVEL TOOL IMPROVEMENTS FOR XBC

Temperature control system:

- **Increased homogeneity** thanks to 4-section thermal fields
- **Improved temperature control** with up to 3 temperature control points
- New temperature control module for **faster temperature changes** and **minimizing fluctuations**
- **New structural design** and insulation scheme



NOVEL TOOL IMPROVEMENTS FOR XBC

Gas precursor availability

- **Optimized source- connected gas path and implementation of gas compensation points**
  - Increased uniformity
  - Solving white edge and powder formation
  - extended lifetime for consumables.
- **Adjusted pressure detection and control design** for reduced acid accumulation, powder formation or blockages.
- **Novel structural design** and insulation scheme improving uniformity
- **Adjusted exhaust structure** for improved uniformity and tool parts lifetime

Airflow control optimization

EQUIPMENT PORTFOLIO FOR TBC CELL LINE

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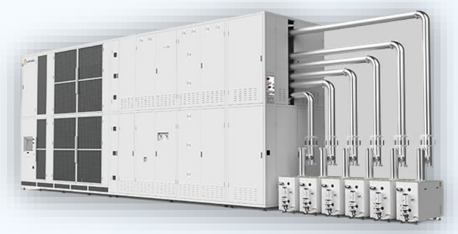
Polish | LPCVD | B Diffusion | Laser n area | LPCVD | Polish | P Diffusion | Laser P & Gap area | Texture | Double ALOx | Front SINx | Rear SINx | SP & Firing

Laplace has a critical edge in developing new manufacturing tools for all BC cell technologies

LPCVD

Critical for integrity of the SiOx tunnel layer

- 5TH GENERATION
- Almost 100% market share for XBC

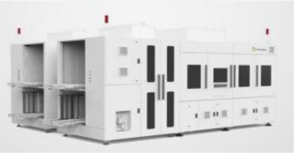


Laser

We possess advanced BC laser technology capable of meeting all our customers' needs

Laser Induced Oxidation

Poly Thickness Reduction via Laser Ablation



XBC Cell Laser Contact Opening

Laser Induced Metallization

LAPLACE'S SOLAR CELL SOLUTIONS

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Long term support

- Continuous support that includes upcoming new technologies
- Vision of the future with Cell Fabs adaptable and compatible for integrating future technologies such as TOPCon+ and XBC cells

Setup

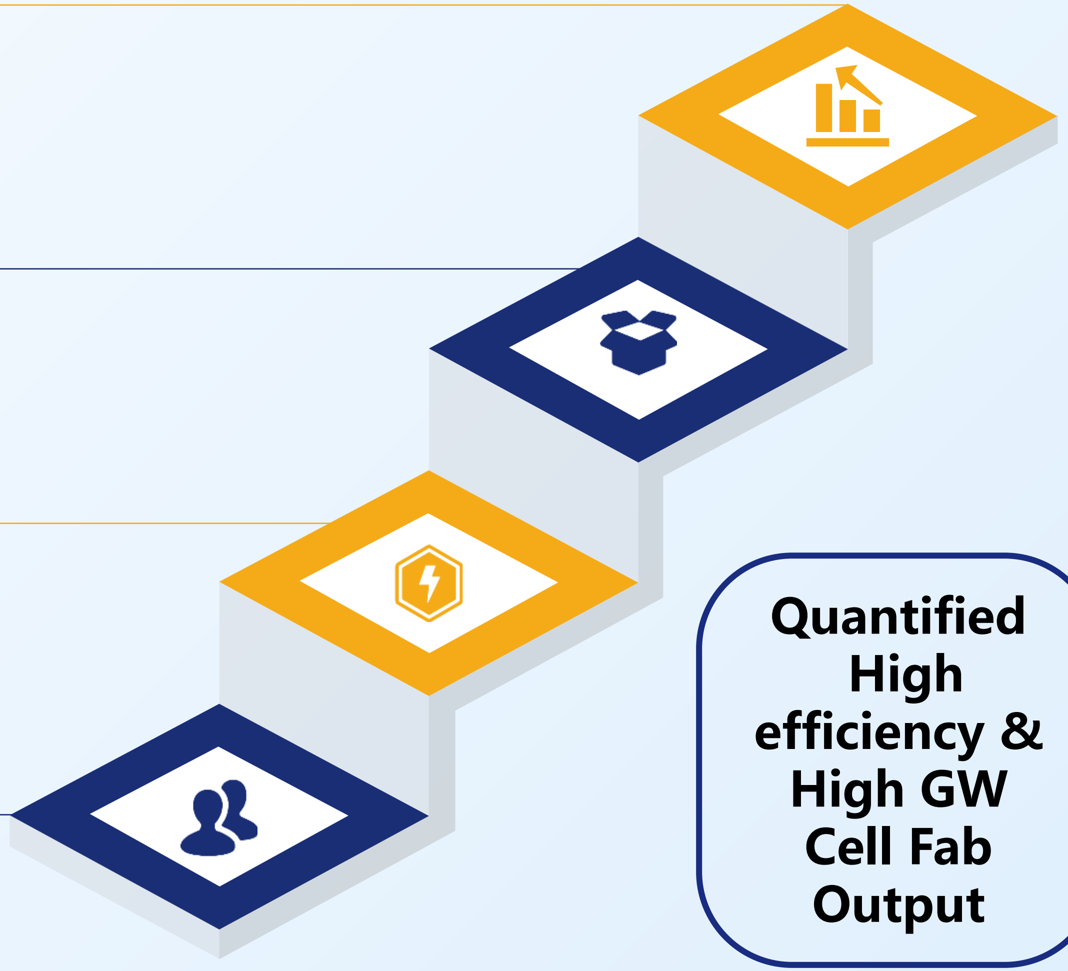
- Support from day one until Fab Up and Running
- Extended training program
- Long term on-site support for continuous improvements

Equipment

- High-end Laplace equipment
- Unified and proprietary automation throughout the entire cell line
- Track-record of strong and close partnership with other equipment makers for a complete cell line

Planning

- Detailed support based on operating Cell Fabs
- Customized optimized layout
- Propose best in class solutions with vision of future improvements



Quantified High efficiency & High GW Cell Fab Output

AI-POWERED SMART FACTORY INTEGRATION

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LAPLACE is driving the next generation of intelligent PV manufacturing through AI-powered factory integration
→ Allows better product and lower skilled manpower, especially critical for XBC integration

AI Factory Integration : Unified platform connecting all production equipment, sensors, and data streams.

Smart Process control : Real-time monitoring and adaptive optimization of each process step: Wet processes, diffusion, passivation, metallization, and testing.

Predictive Maintenance : Machine learning models anticipate equipment anomalies, reducing unplanned downtime.

Yield & Energy Optimization : Continuous data analysis improves conversion efficiency while lowering energy and material consumption.

Summary

01

Experience

Pioneers of TOPCon for mass production with **>500 GW** equipment delivered (**>100 GW XBC)**

02

Innovation for TOPCon

Double-loading for LPCVD
→ Highest throughput in the market:
Proprietary coated quartz tube
→ Double the lifetime of quartz tubes

03

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 master mass production
- **New equipment:**
  New laser tools for TOPCon+ and BC, facilitating the process flow with local openings


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THANKS