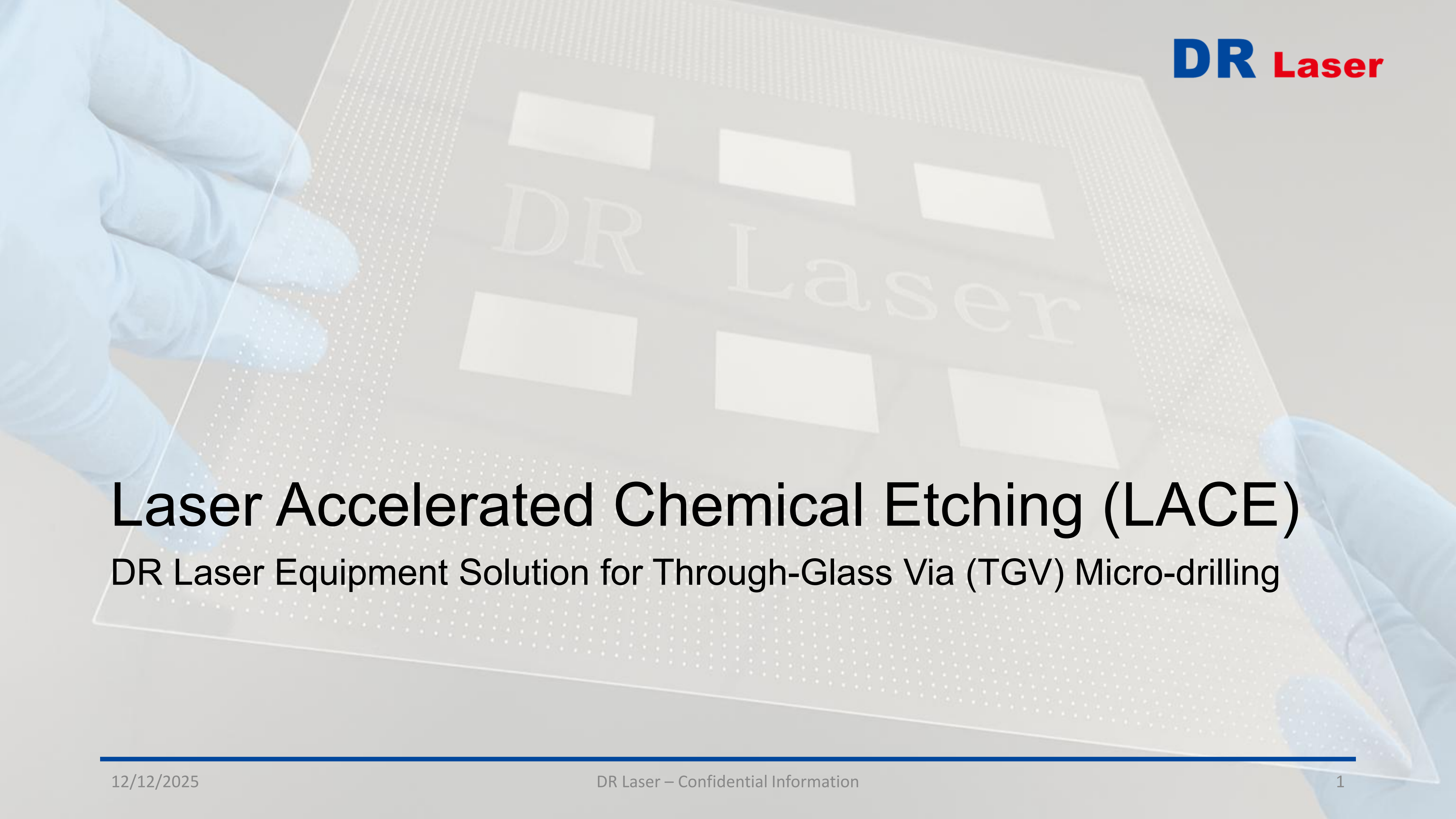


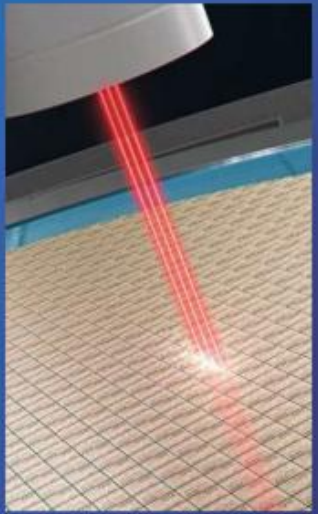
Laser Accelerated Chemical Etching (LACE)

DR Laser Equipment Solution for Through-Glass Via (TGV) Micro-drilling

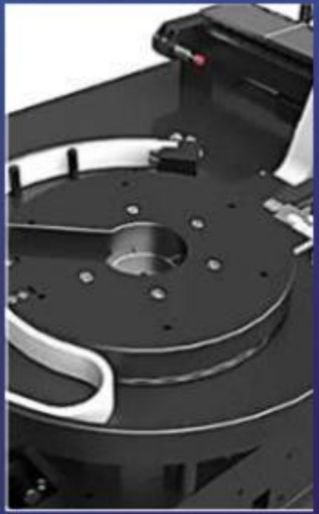
LACE Technology

DR Laser has developed our **LACE** technology to meet the needs of Through-Glass Via (TGV) fabrication. The **Laser Accelerated Controlled Etching technology** is a two-step process:

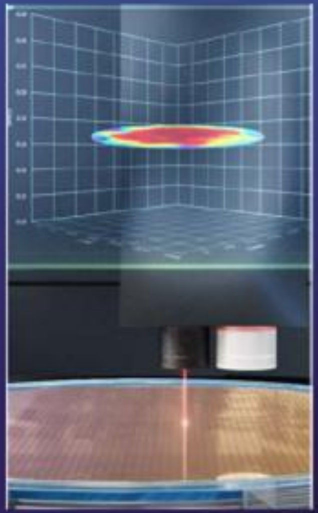
1. A customized laser is used to induce the phase-change of glass material properties based on design requirements. This enables specific regions to exhibit accelerated chemical etching efficiencies.
2. The entire glass undergoes a wet etching process to complete the controlled formation of precise and high-quality TGVs.



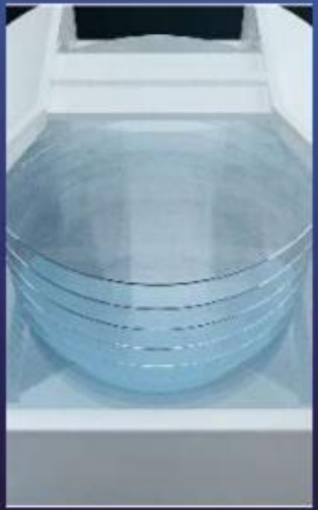
Strong expertise in the bespoke integration of customised laser, using in-house developed optics to create designs based on the customer's choice of glass material.



The specially ordered high-precision XY platform is designed to support the fast, precise, and efficient processing of glass wafers and panels.



The automatic focusing function adapts to substrate surface and height changes during moving, ensuring the processing effect of the product's modified layer.



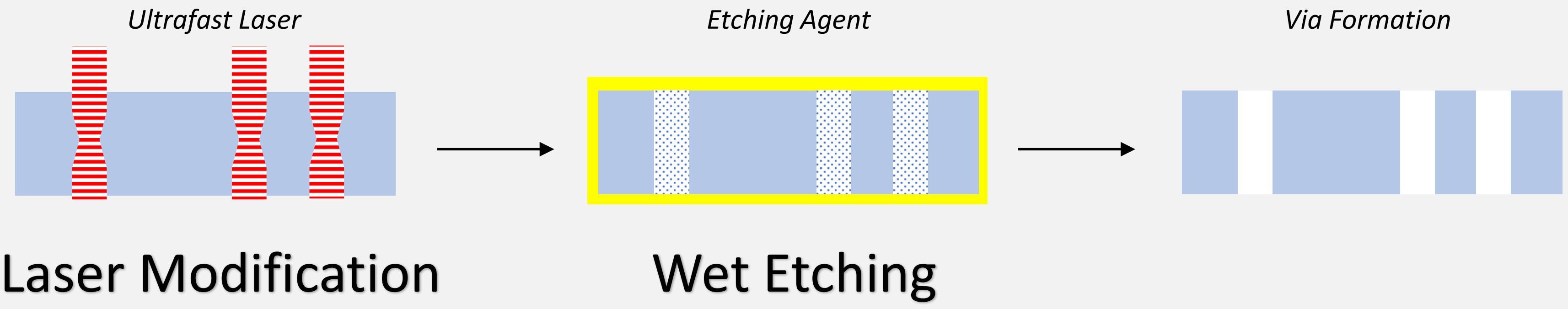
Wet chemical etching is available in the single-chamber or multi-tank models. The design is made to fulfil the needs of actual manufacturing conditions.

The DR laser proprietary software algorithm is developed to plot efficient laser processing paths, enabling it to handle complex designs.

Automated loading and unloading of cassette enables the seamless transfer of glass material during the laser and etching process.

DR Laser – TGV micro drilling solution

Working principle



This is a two-step subtractive fabrication process: (1) Laser Modification, followed by (2) Wet Etching.

(1) An ultrafast laser bessel beam is used to induce the phase-change of glass material properties within designated regions.

(2) The entire glass undergoes a wet etching process. The regions that received laser treatment are etched faster than surrounding areas, thereby completing the controlled formation of precise and high-quality micro-vias.

DR Laser – TGV micro drilling solution

Product development	Year 2019 – Glass micro via drilling R&D project was established.
	Year 2020 – Prototype equipment was developed based on laser modification and wet etching techniques.
	Year 2021 – Wafer-level TGV processing solution achieved successful applications.
	Year 2022 – Developed 1st generation Wafer-level TGV processing equipment.
	Year 2023 – Launched *ThruGlas* product line based on in-house *LACE* technology.
	Year 2024 – Developed 2nd generation Panel-level TGV processing equipment.
	Year 2025 – Currently developing 3rd generation TGV processing equipment for semiconductor applications.
Track Record	Year 2022 – Sale of Wafer-level TGV processing equipment (non-semiconductor customer).
	Year 2023 – Sale of Wafer-level TGV processing equipment (semiconductor customer).
	Year 2024 – Sale of Panel-level TGV processing equipment in Mainland China.
	Year 2025 – Received order for Panel-level TGV processing equipment in Taiwan. (Ship-out date: July 2025)

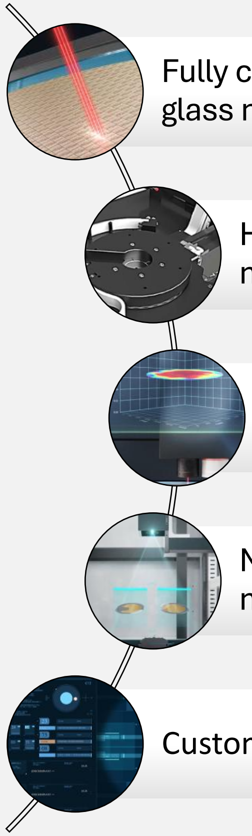
Product Lineup: ThruGlas series

Processing equipment for the TGV micro-drilling applications

	ThruGlas LA-300	ThruGlas CE-300	ThruGlas INS-300	Core Specifications
Wafer-level **(300x300mm, up to 12-inch)**				@300 mm range, 800 mm/s speed • Positioning accuracy: ≤ ±1 μm • Repeatability: ≤ ±0.75 μm • Pattern placement accuracy: ≤ ±3 μm
	ThruGlas LA-510	**ThruGlas CE-510**	**ThruGlas INS-510**	**Core Specifications**
Panel-level **(510x515mm, up to 650x750mm)**				@600 mm range, 1000 mm/s • Positioning accuracy: ≤ ±1 μm • Repeatability: ≤ ±0.75 μm • Pattern placement accuracy: ≤ ±5 μm @300 mm range, 800 mm/s: • Positioning accuracy: ≤ ±1 μm • Repeatability: ≤ ±0.75 μm • Pattern placement accuracy: ≤ ±3 μm

Wafer-level, Laser modification

ThruGlas LA-300



Fully customized laser optical system is designed to be suitable for a wide variety of glass materials, with stable and reliable processing effects.

High-precision platform tracks motion in real-time using fast-response control module, to enable accurate and efficient glass processing.

DR Laser developed software with thoughtful UI/UX considerations to provide a user-friendly human-machine interface in both English & Chinese operation.

Multiple vision alignment modes can be employed, such as based on unique marks, or material contours.

Custom configuration is available. Please consult our R&D team for discussion.

ThruGlas LA-300 (Wafer-level, Laser modification)

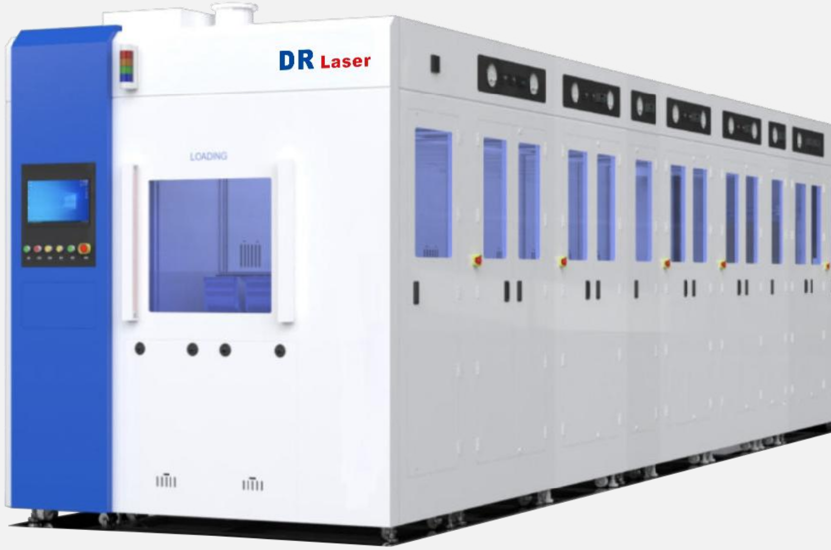
- Specifications

Laser source	**Customised Ultrafast Laser**	**Footprint**	**2800（L）*2300（W）*2300（H）**
Substrate size	4~12” wafer & panel	Weight	≤5tons
Substrate thickness	0.1~1.1mm	Drawing file format	DXF
Loading / Unloading	4~12”（cassette）automated	Repeatability	≤±1um
Processing Method	Fixed laser + High-precision mechanical platform	Positional Accuracy	≤±2um
Processing Speed	800mm/s	Variation (from drawing)	≤±3um across 300mm area

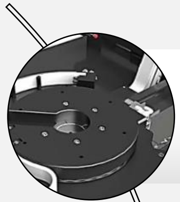
- **Operation Flow**

Load cassette → **Scan dimensions & contours** → **Mechanical arm transfer (in)** → **Vision alignment of target** → **Laser modification** → **Mechanical arm transfer (out)** → **Unload cassette**

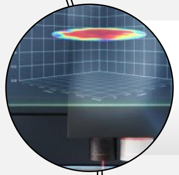
Wafer-level, Wet etching



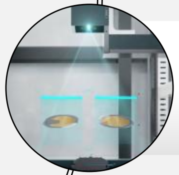
ThruGlas CE-300



Multi-rinsing removes impurity to ensure maximum material cleaning, leading to enhanced uniformity of micro-hole fabrication effects.



DR Laser developed software with thoughtful UI/UX considerations to provide a user-friendly human-machine interface in both English & Chinese operation.



Chemical formulation is developed based on DR Laser's LACE technology to optimise etching efficacy for different glass materials.

Custom configuration is available. Please consult our R&D team for discussion.

ThruGlas CE-300 (Wafer-level, Wet etching)

- Specifications

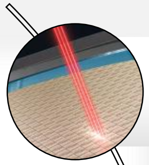
Substrate material	Quartz/Schott BF33/AF32/Corning/others	**Footprint**	6000（L）*2000（W）*2200（H）（Customisable based on request）
Substrate size	4~12" Wafer / Panel	**Pass-line**	1000±20mm
Substrate thickness	0.1~1.1mm	**Electrical**	3-phase 380V 50HZ
Loading / Unloading	4~12" Cassette, Automated	**Waste discharge**	Can be connected to facilities, or stored in tanks independently
Main build	High Strength SUS304 Frame Acid & Akali Resistant PP cover	**Discharge / Refill**	Automatic mode available
Operation mode	Semi-automatic; up to 1000 sets of recipe	**Material transfer**	XYZ-axis mechanical arm module
Etching chamber	Circulation, overflow, automatic refilling (at low fluid level)	**Rinsing module**	QDR: top-spray, base water submerge
Wetting module	Ultrasonic + Vacuum + Overflow	**FR Module**	80/120KHz， adjustable power

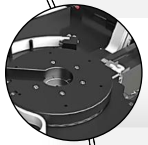
- **Operation Flow**

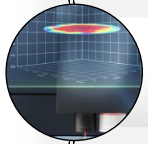

Load cassette → **Vacuum operation & Wetting** → **Single chamber etching & QDR rinsing** → **FR Ultrasonic cleaning** → **Heated drying using N2 gas** → **Unload cassette**

Panel-level, Laser modification

ThruGlas LA-510


Fully customized laser optical system is designed to be suitable for a wide variety of glass materials, with stable and reliable processing effects.


Specially designed large high-precision platform tracks motion in real-time using fast-response control module, to enable accurate and efficient glass processing.


DR Laser developed software with thoughtful UI/UX considerations to provide a user-friendly human-machine interface in both English & Chinese operation.


Multiple vision alignment modes can be employed, such as based on unique marks, or material contours.


Custom configuration is available. Please consult our R&D team for discussion.

ThruGlas LA-510 (Panel-level, Laser modification)

- **Specifications**

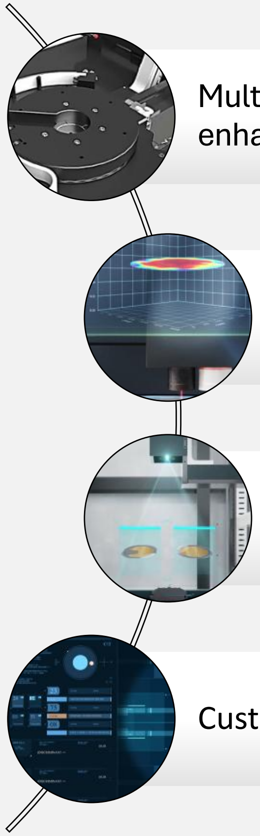
Laser source	**Customised ultrafast laser**	**Footprint**	**3700（L）*2500（W）*2300（H）**
Substrate size	< 650x650mm	Weight	≤10tons
Substrate thickness	0.1~1.1mm	Drawing file format	DXF
Loading / Unloading	Mechanical arm / FOUP	Repeatability	≤±1.5um
Processing Method	Laser + High-precision mechanical platform	Accuracy	≤±3um
Processing Speed	1000mm/s	Variation (from drawing)	≤±3um across 300mm area ≤±5um across 600mm area

- **Operation Flow**

Load cassette → **Mechanical arm / FOUP (in)** → **Vision alignment of target** → **Laser modification** → **Mechanical arm / FOUP (out)** → **Unload cassette**

Panel-level, Wet etching

ThruGlas CE-510



Multi-rinsing removes impurity to ensure maximum material cleaning, leading to enhanced uniformity of micro-hole fabrication effects.

DR Laser developed software with thoughtful UI/UX considerations to provide a user-friendly human-machine interface in both English & Chinese operation.

Chemical formulation is developed based on DR Laser's LACE technology to optimise etching efficacy for different glass materials.

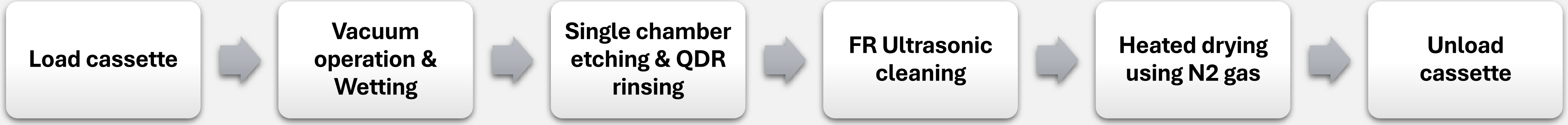
Custom configuration is available. Please consult our R&D team for discussion.

ThruGlas CE-510 (Panel-level, Wet etching)

- Specifications

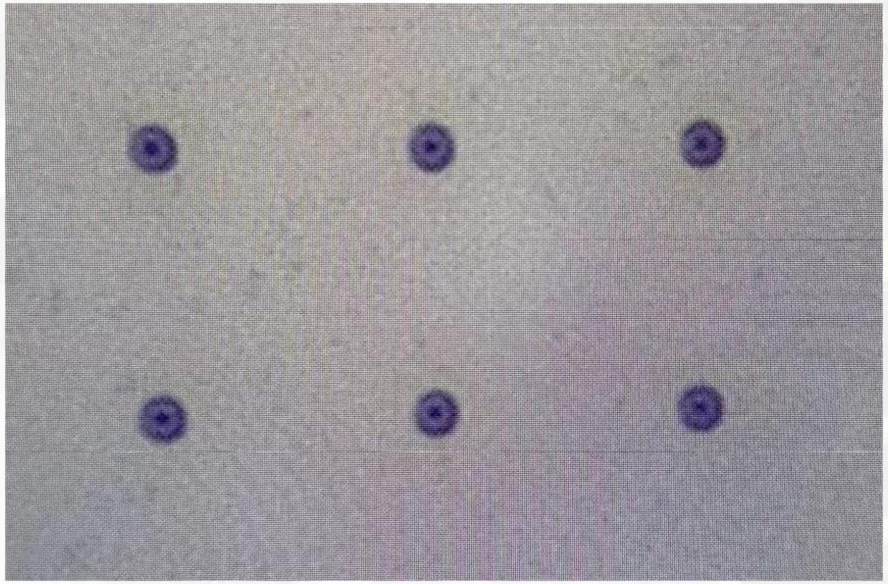
Substrate material	Quartz/Schott BF33/AF32/Corning/others	**Footprint**	4300（L）*2300（W）*2700（H） （Customisable based on request）
Substrate size	**650x650mm**	**Pass-line**	1000±20mm
Substrate thickness	0.1~1.1mm	**Electrical**	3-phase 380V 50HZ
Loading / Unloading	Manual, trolley/cart	**Waste discharge**	Can be connected to facilities, or stored in tanks independently
Main build	High Strength SUS304 Frame Acid & Akali Resistant PP cover	**Discharge / Refill**	Automatic mode available
Etching chamber	Circulation, overflow, automatic refilling (at low fluid level)	**Rinsing module**	QDR: top-spray, base water submerge
Wetting module	Ultrasonic + Vacuum + Overflow	**FR Module**	80/120KHz，adjustable power

- **Operation Flow**

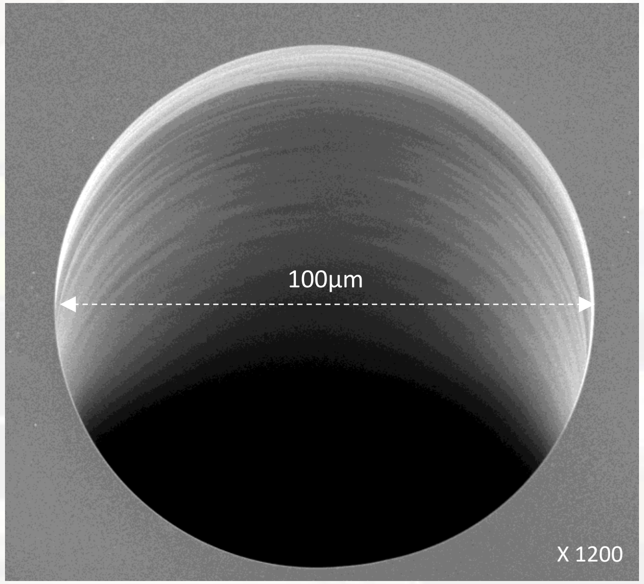


Load cassette → **Vacuum operation & Wetting** → **Single chamber etching & QDR rinsing** → **FR Ultrasonic cleaning** → **Heated drying using N2 gas** → **Unload cassette**

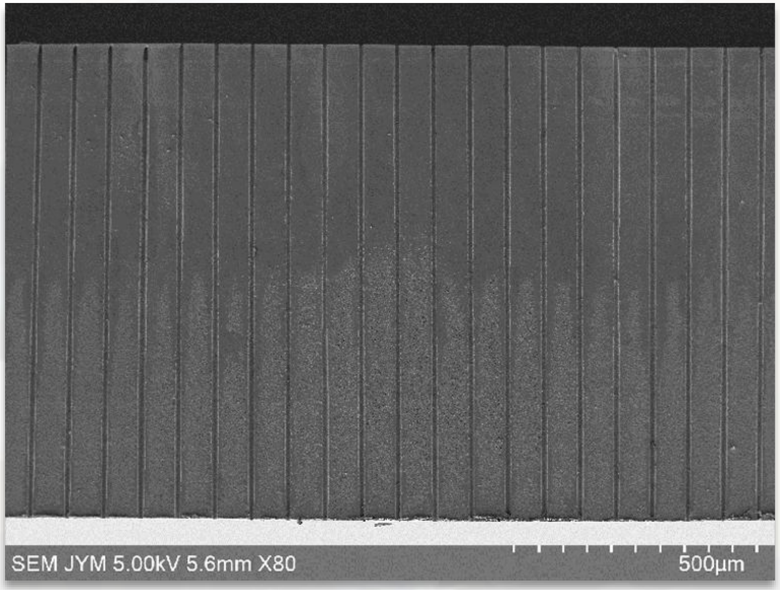
DR Laser TGV Capabilities



Laser modification using circular beam spot

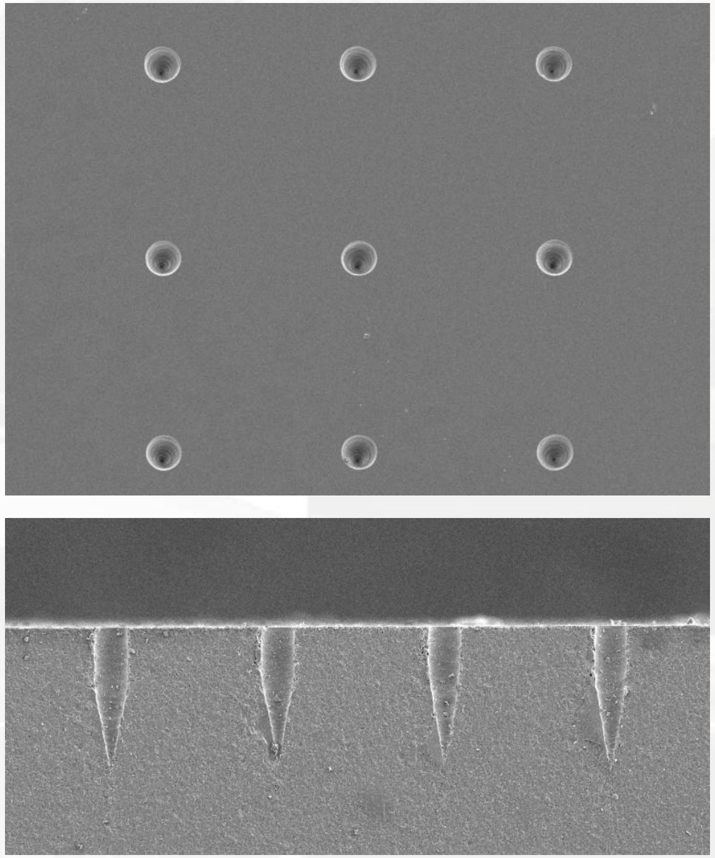


Wet etching process to create via holes with good surface quality

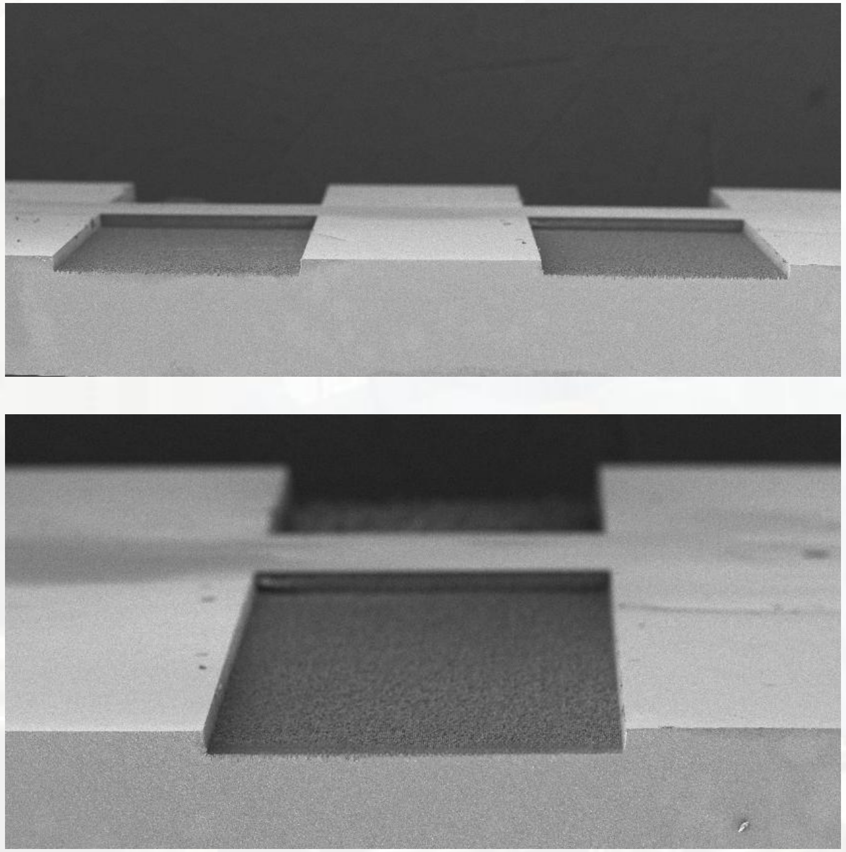


Maximum aspect ratio of 100:1
1mm thickness, 10um hole size
***varies depending on material**

DR Laser TGV Capabilities

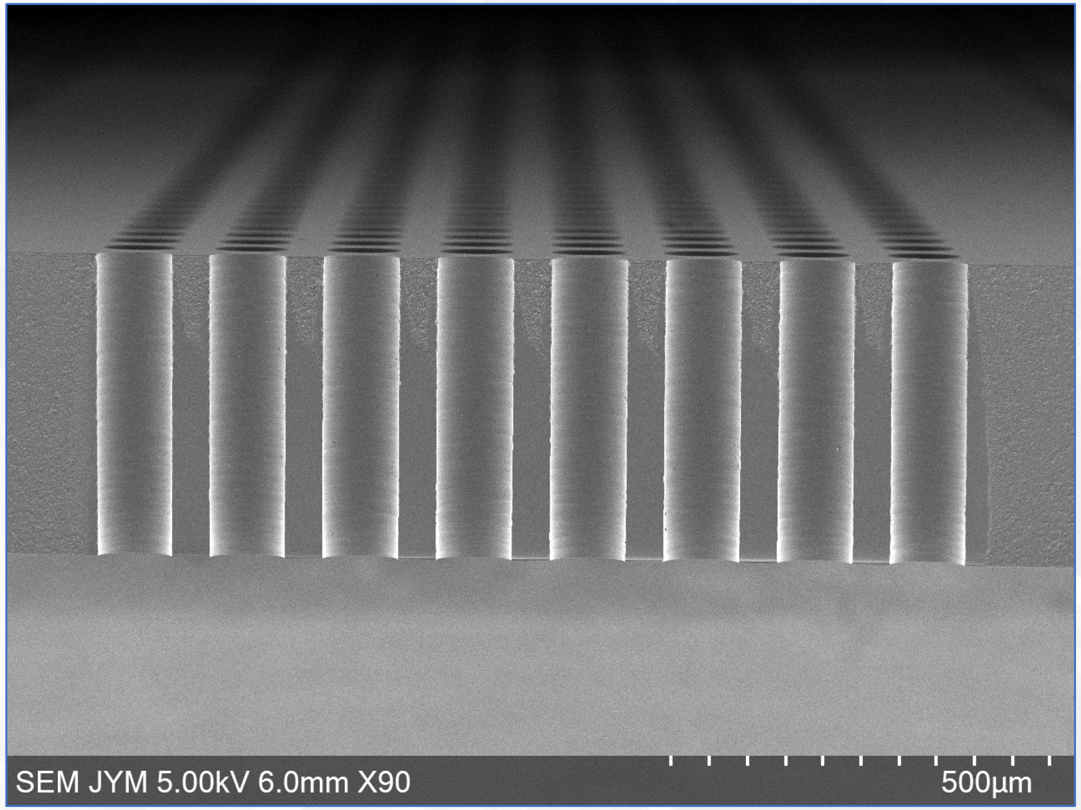


Blind hole
(BF33, 0.5mm thickness, 80μm depth, 20μm diameter)

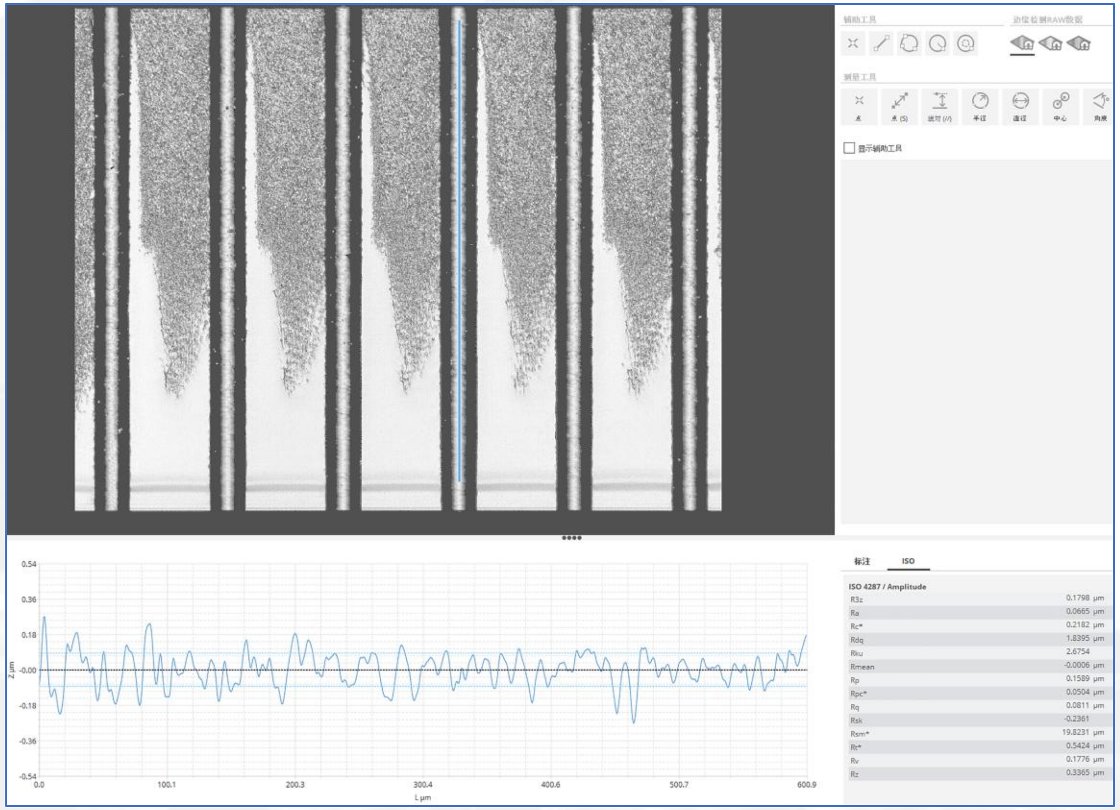


Blind trench
(BF33, 0.5mm thickness, 40μm depth, 1mm width)

DR Laser TGV Capabilities



Taper angle* < 0.1°
***varies depending on material**

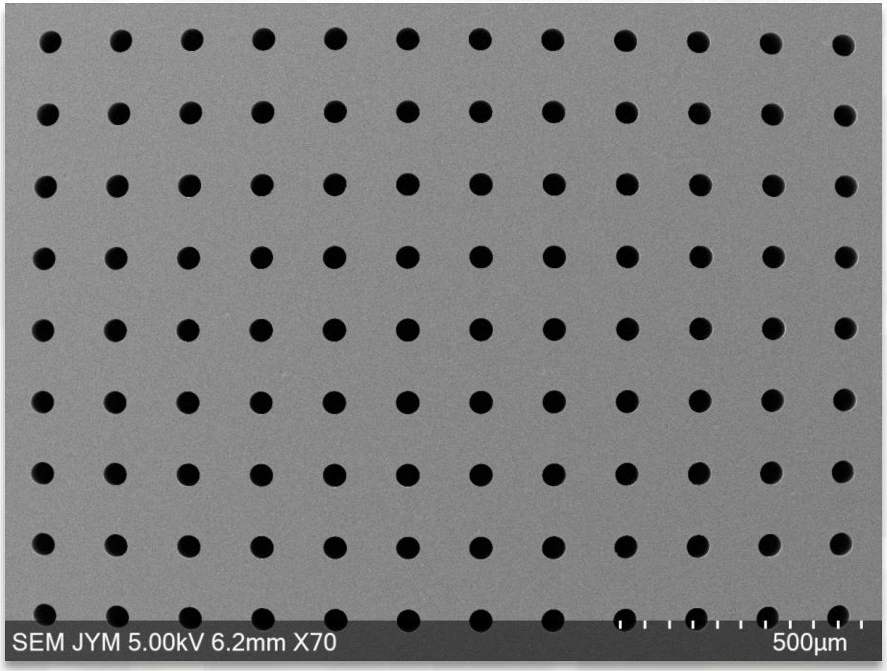


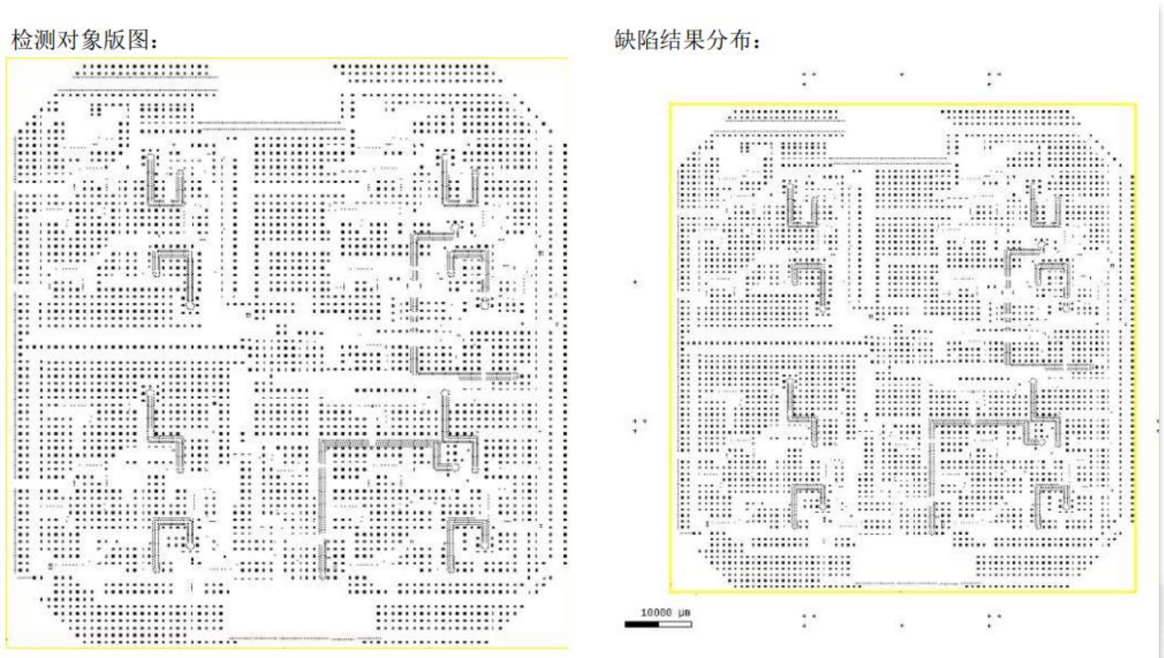
ISO 4287 / Amplitude

R3z	0.1798 µm
Ra	0.0665 µm
Rc*	0.2182 µm
Rdq	1.8395 µm
Rku	2.6754
Rmean	-0.0006 µm
Rp	0.1589 µm
Rpc*	0.0504 µm
Rq	0.0811 µm
Rsk	-0.2361
Rsm*	19.8231 µm
Rt*	0.5424 µm
Rv	0.1776 µm
Rz	0.3365 µm

Hole cross-section line roughness
Ra < 100nm

DR Laser TGV Capabilities





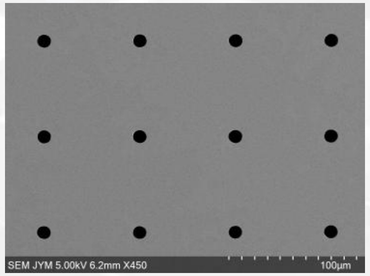
Circularity > 95%

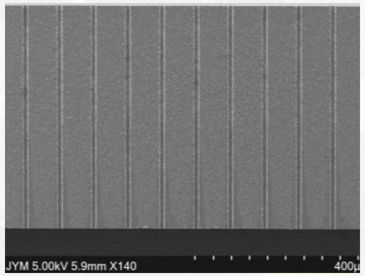
Built-in detection module to ensure 100% through-hole penetration yield

DR Laser TGV Capabilities

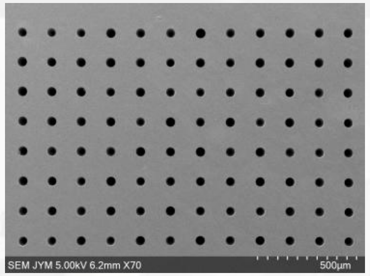
BF33 (0.5mm thickness)

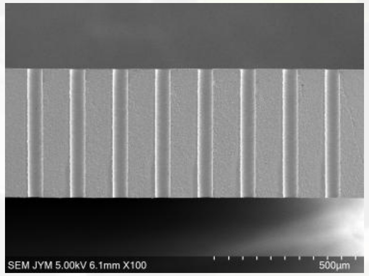
10um



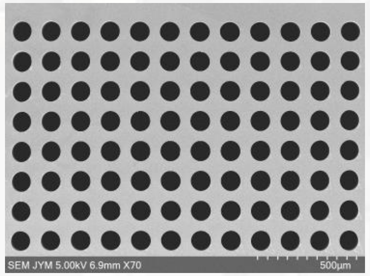


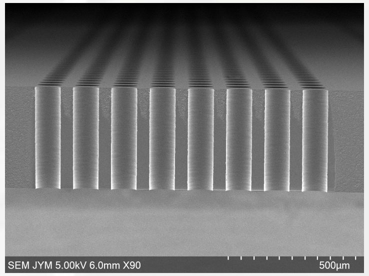
50um





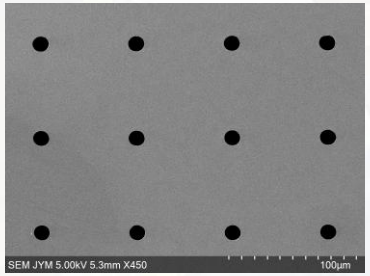
100um

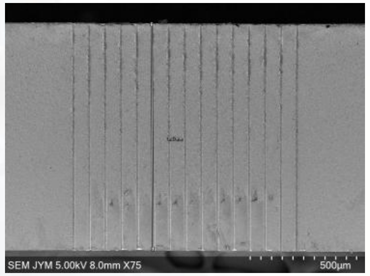




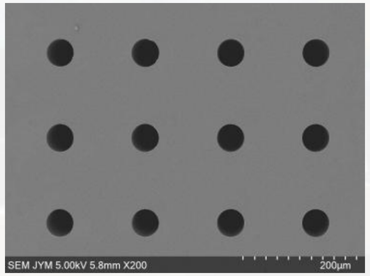
BF33 (1.1mm thickness)

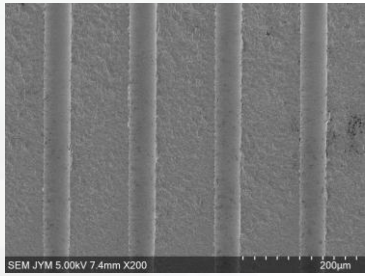
10um



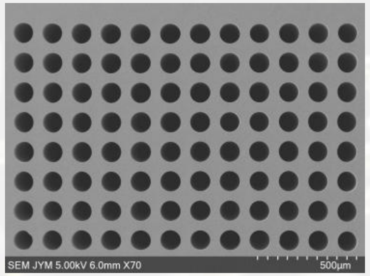


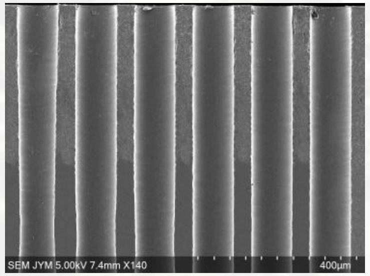
50um





100um

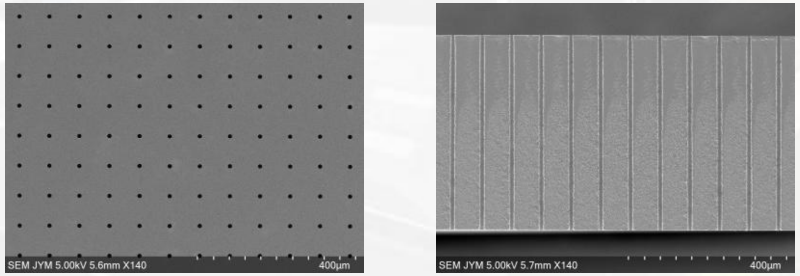




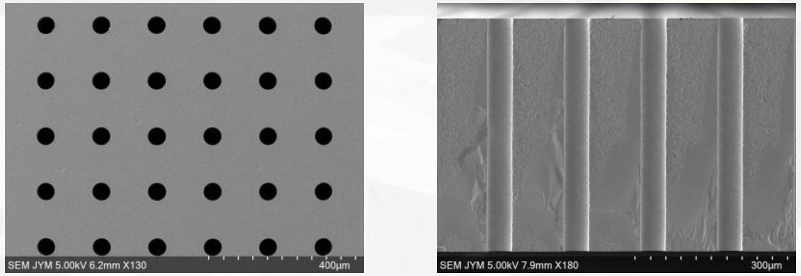
DR Laser TGV Capabilities

Quartz (0.5mm thickness)

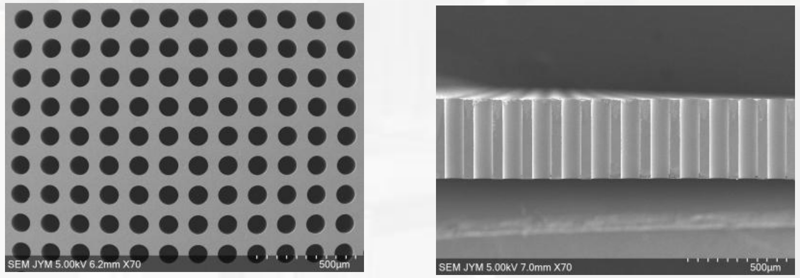
10um



50um

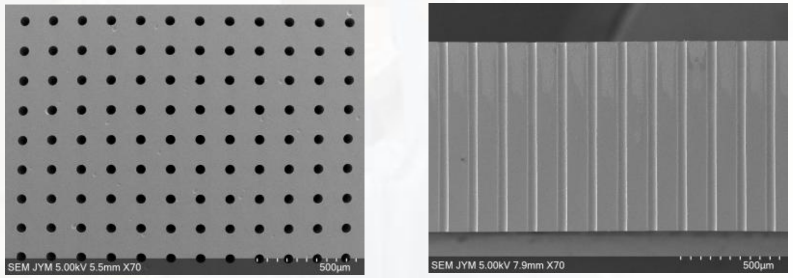


100um

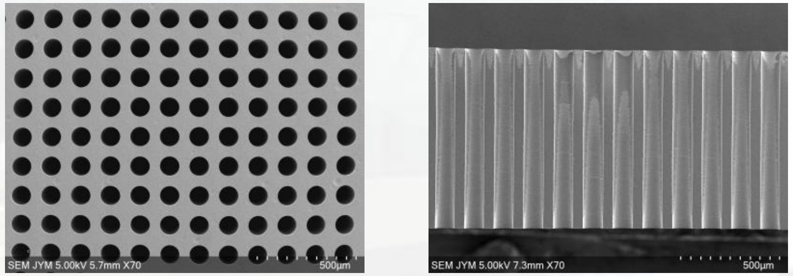


Quartz (1mm thickness)

50um



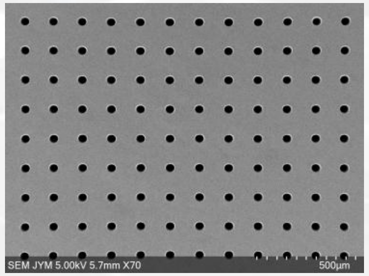
100um

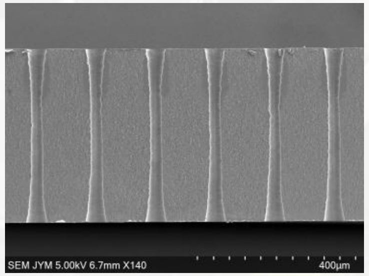


DR Laser TGV Capabilities

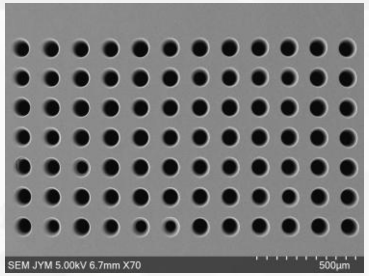
Corning EXG (0.5mm thickness)

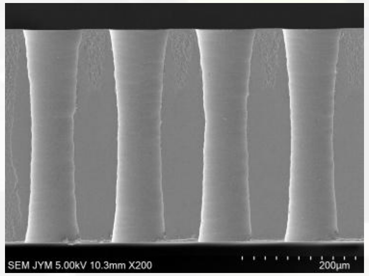
50um





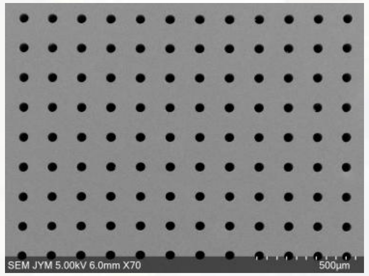
100um

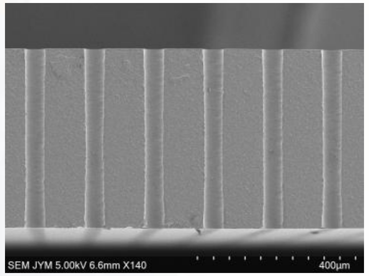




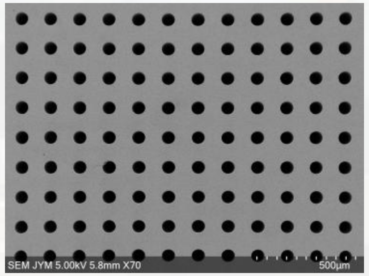
Corning SG3.4 (0.5mm thickness)

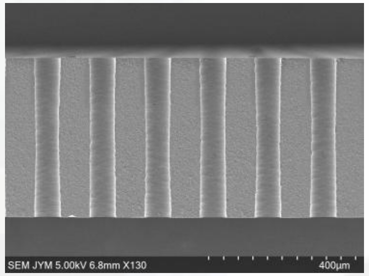
50um





70um





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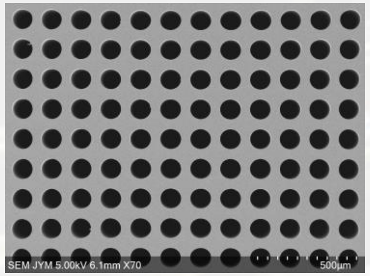
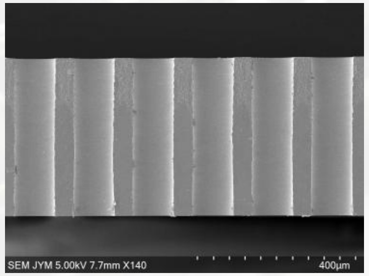


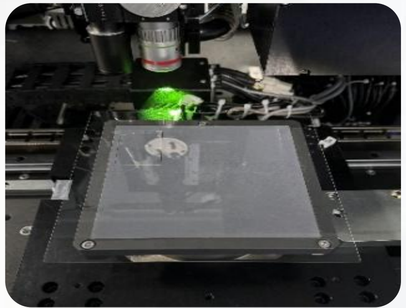


DR Laser TGV Prototyping Lab

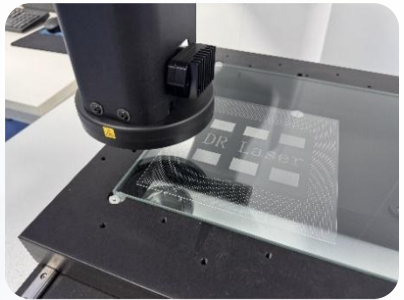
Sample cleaning & verification

Laser processing

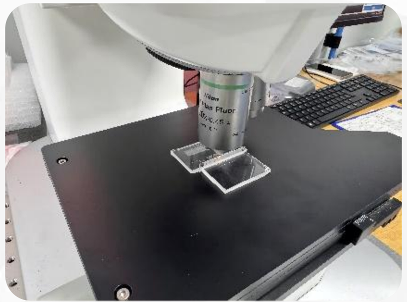
Chemical etching



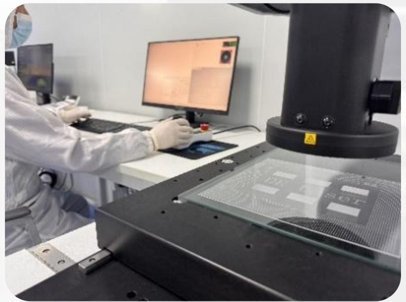
Cross-section cutting



Vision inspection of through-hole penetration



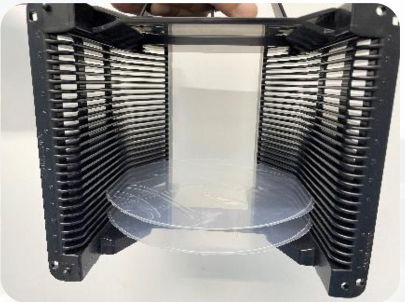
Cross-section roughness measurement



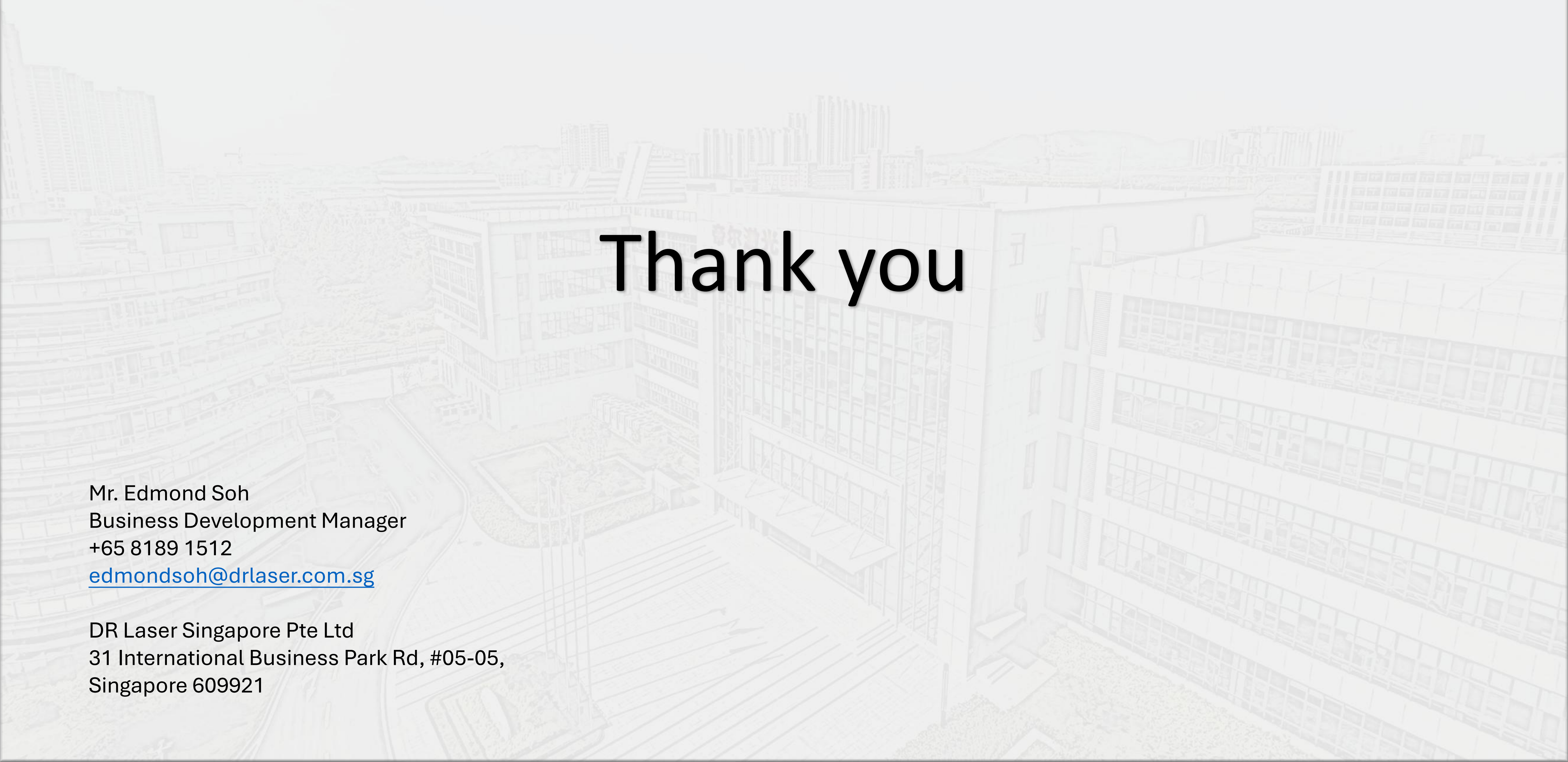
Hole dimensional measurements

Circularity measurement

Chemical formulation optimisation



Batch processing for small-scale manufacturing validation



Thank you

Mr. Edmond Soh
Business Development Manager
+65 8189 1512
edmondsoh@drlaser.com.sg

DR Laser Singapore Pte Ltd
31 International Business Park Rd, #05-05,
Singapore 609921