



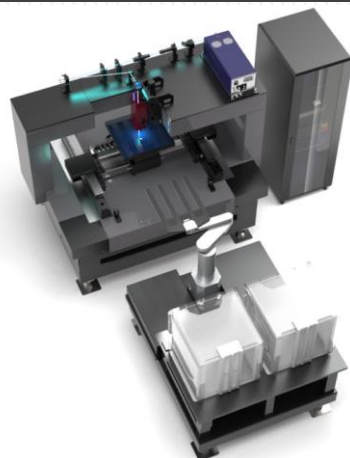
u-Lab.



Laser Patterning Machine based on Gantry Sys.



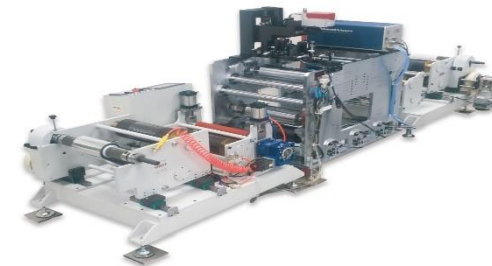
Laser scriber with wafer rotary unit



Maskless Laser Lithography



u-Fab.



Laser Patterning Machine based on R2R

Established in 1999
(주)코셈사이언스
 A.I. Deep Learning

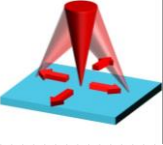
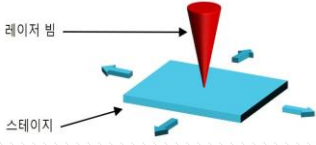
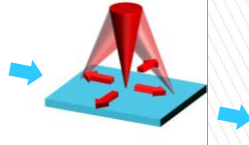
레이저 Patterning 장비 소개



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※ Operation Mode

작동 방식	Dual Mode		IFOV	R2R	Remark	
	Scan Mode	Direct Writing(Fixed Optics)		MOTF		
		Objection Lens + Motion Stage				Scanner + Motion Stage
Model	μ -Lab, μ -Fab	μ -Fab		μ -R2R		
개념도						
Laser	355nm, 532nm	355nm, 532nm, 1064nm		355nm, 532nm, 1064nm(1 selection)		
특징	레이저 빔 이동 (거울이용) 가공물(stage) 고정	레이저 빔 고정 가공물(Stage) 이동		레이저 빔 이동 가공물(stage) 단방향(x축) 이동		
Travel Range	≤ 200mm X 200 mm (小)	≤300x500mm (中)		≤500x500 ~ 1000X 1000mm (大)	Web width (200~300mm)	
가공속도	5~7m/s 까지 가능	1~ 1.5 m/s 이하		1~ 1.5 m/s 이하	3M / min	
곡선	○	△		○	△	
직선	○	○		○	○	
동영상	www.kortherm.com					
Applications	Glass / Polymer / Wafer / Thin metal/ Film / Silicon wafer DISPLAY (FPD, AMLCD) / Solar Cell (Perovskite, OPV, CIGS등) / Bio sensor					
Option	<ul style="list-style-type: none"> - Beam Profile(Tophap, Bessel Beam) - IFOV 					

※ Beam profile

<p>Gaussian Beam</p>	<ul style="list-style-type: none"> • Typical shape of Laser Beam • Energy is concentrated in center 			<p>Wavelength : 532nm</p>
<p>Tophat Beam (Flat top Laser Beam)</p>	<ul style="list-style-type: none"> • Modulated Beam of Gaussian • It have constant energy density • It make uniform Laser Processing result • Power is lower than Gaussian 			
<p>Bessel Beam</p>	<ul style="list-style-type: none"> • Beam have long focus position • It use process of Transparent material like glass, sapphire, quartz. 			<p>Wavelength : 1064nm</p>
		<p>Bessel Beam Diameter 2-3μm by Axicon Lens</p>	<p>Energy distribution of Bessel Beam</p>	

※ Beam profile

<p>Line Beam</p>	<ul style="list-style-type: none"> • Modulated Beam of Gaussian to narrow line • It use lower power, make same power density in a thin line by lower cost. 	<p>The image shows a cross-section of a line beam with a multi-colored intensity profile. To the right, a photograph shows a flexible display being scanned by a line beam. A schematic diagram labels the 'Flexible display', 'Transport glass', and 'Line beam scan'.</p>
<p>Maskless Beam by SLM</p>	<ul style="list-style-type: none"> • Light transmitted by SLM can be reshaped to desired shape • It make single laser beam to split multi beam 	<p>Five images showing different beam profiles created by SLM: a grid of dots, a crosshair, a diagonal line, a square frame, and a series of vertical lines.</p>
<p>Annualr Beam</p>	<ul style="list-style-type: none"> • High efficiency and flexibility • Apparent bright spot at the center 	<p>A detailed diagram showing the propagation of an annular beam through four stages: 1. Annular Fresnel FZP (with wavelength λ and radius R_1), 2. Projection area (forming an annular beam), 3. Fresnel diffraction area (forming a central spot), and 4. Fronhoffer diffraction area (forming a central spot). A separate diagram shows the Fresnel zone plate with radii R_1, R_2, and $2r_{01}$.</p>

01

μ-Lab1

02

μ-Lab-S2

03

μ-Fab-D2 (Dual Mode : Fixed Optics / Scan)

05

μ-Fab-I [IFOV (Synchronization)]

05

μ-Gan (Laser Patterning Machine based on Gantry System)

06

μ-WTU (Laser Scribe with Wafer Rotary Unit)

07

μ-R2R (Laser Patterning Machine based on Roll to Roll)

08

μ-Slot Die (Slot die Coating system)

09

Glass Hole Drilling Machine (LIDE, Laser Induced Deep Etching)

10

Maskless Laser Lithography (DMD: Digital Micro-mirror Display)

11

주요 기능 소개

12

보유 기술

13

고객 리스트

14

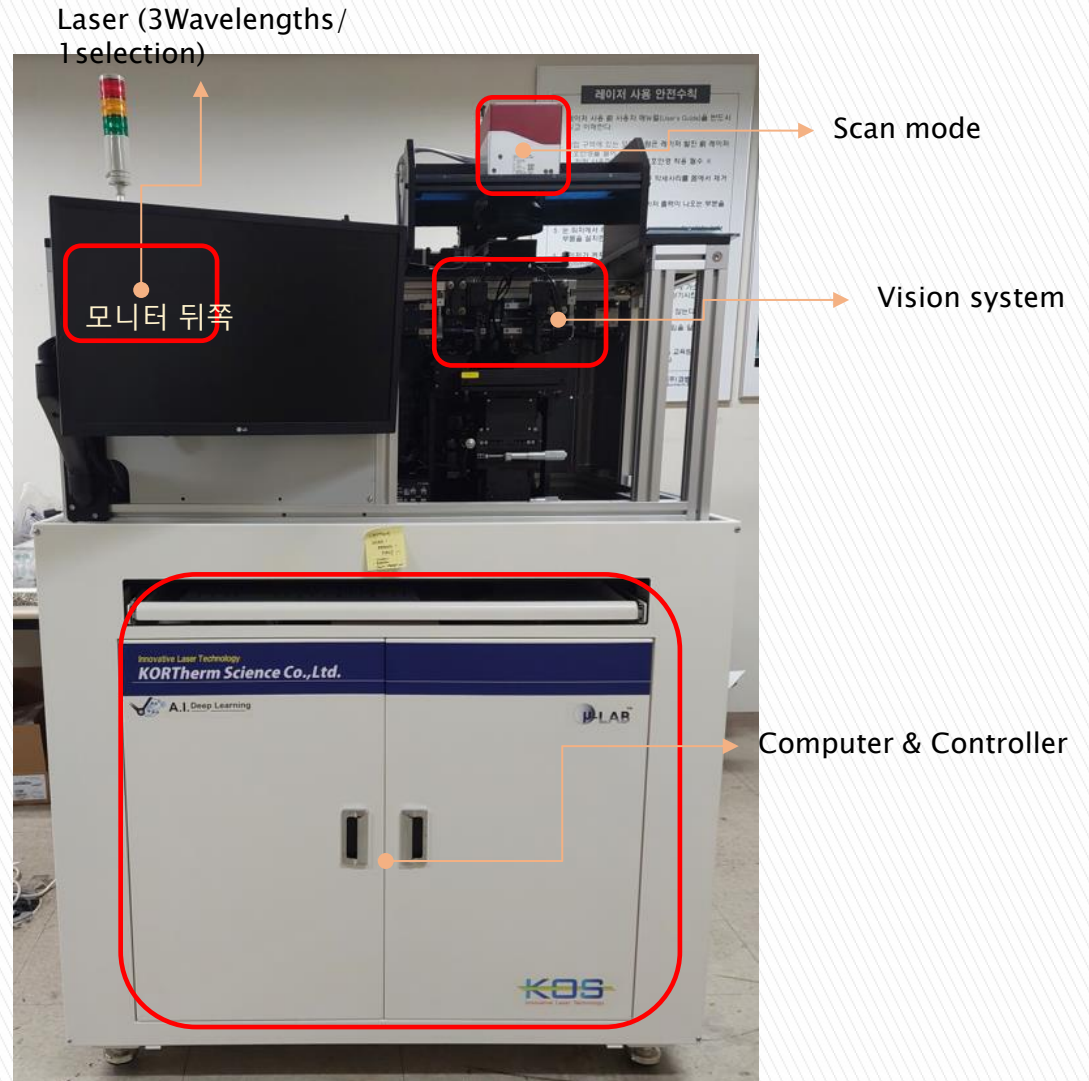
ZEUS(장비 활용 종합 포털)

❖ Specification

Laser pulse width	NANO / PICO / FEMTO
Wavelength	355nm(UV)/ 532nm(Green)/ 1064nm(IR) : 1 Wavelength
Operating mode	Scan mode
Traveling range	200mm x 200mm
Dimension (W/D/H)	1,600mm x 1,200mm x 1900mm
Accuracy	$\leq \pm 0.5\mu\text{m}$
Reliability	$\leq \pm 0.5\mu\text{m}$
Working type	Patterning / Scribing / Cutting / Drilling
Application	Glass / Polymer / Wafer / Thin metal/ Film / Silicon wafer
	DISPLAY (FPD, AMLCD) / Solar Cell (Perovskite, OPV, CIGS등)
	Bio sensor

* 핵심 기술 :

- 1) Vision Alignment 를 통한 패턴 인식 및 정렬
- 2) Multi 기능이 가능한 강력한 소프트웨어 구성
 - Measure Function
 - Laser Spot Overlap & Fluence Calculation
 - Control Laser Parameter
 - A.I adoption

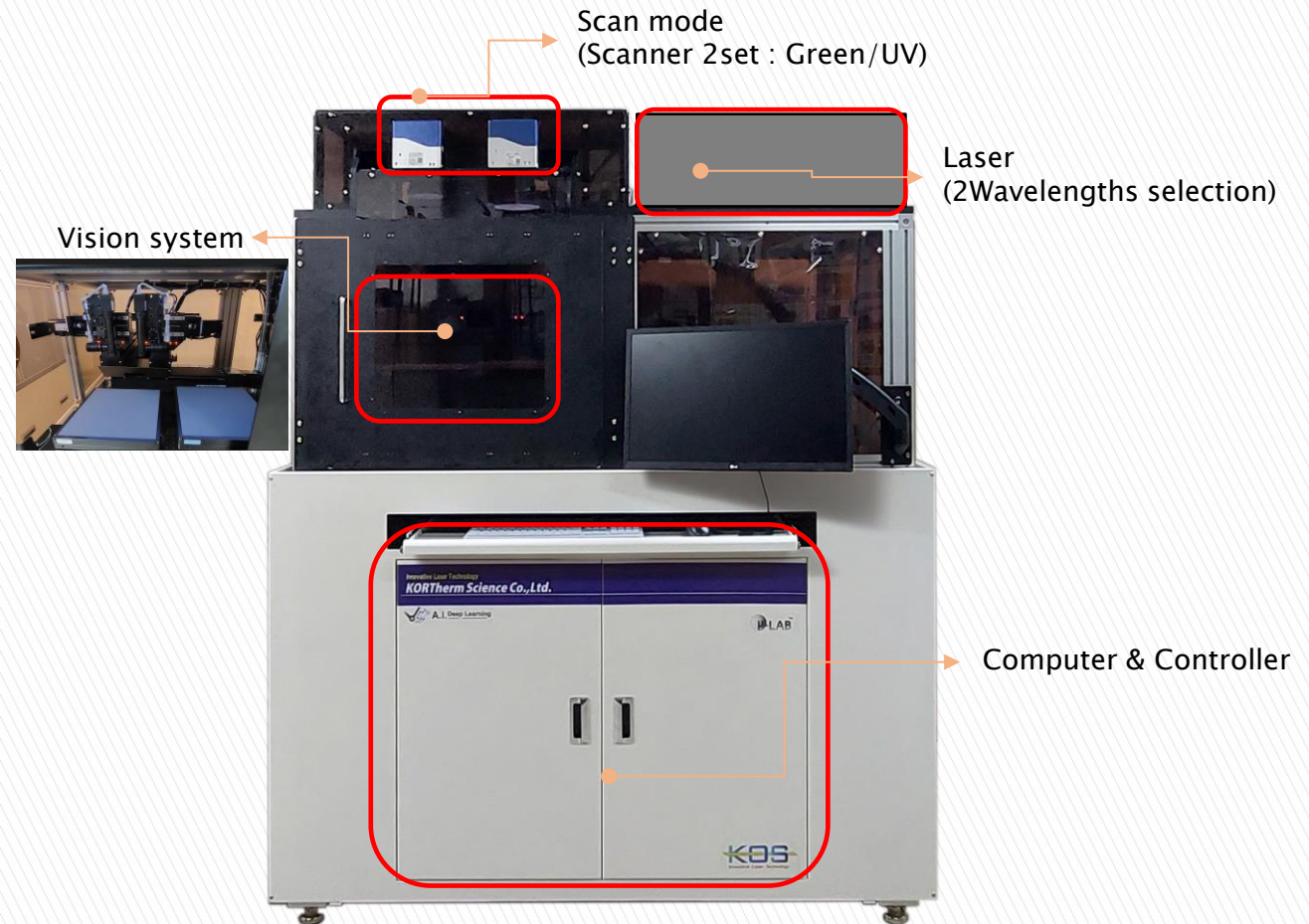


❖ Specification

Laser pulse width	NANO / PICO / FEMTO
Wavelength	355nm(UV)/ 532nm(Green)/ 1064nm(IR) : 2 Wavelengths
Operating mode	Scan Mode (Scanner 2set : Green / UV)
Traveling range	200mm x 200mm
Dimension (W/D/H)	1,600mm x 1,200mm x 1900mm
Accuracy	$\leq \pm 0.5\mu\text{m}$
Reliability	$\leq \pm 0.5\mu\text{m}$
Working type	Patterning / Scribing / Cutting / Drilling
Application	Glass / Polymer / Wafer / Thin metal/ Film / Silicon wafer DISPLAY (FPD, AMLCD) / Solar Cell (Perovskite, OPV, CIGS 등)

• 핵심 기술 :

- 1) 2 Wavelength 적용으로 선택적으로 사용



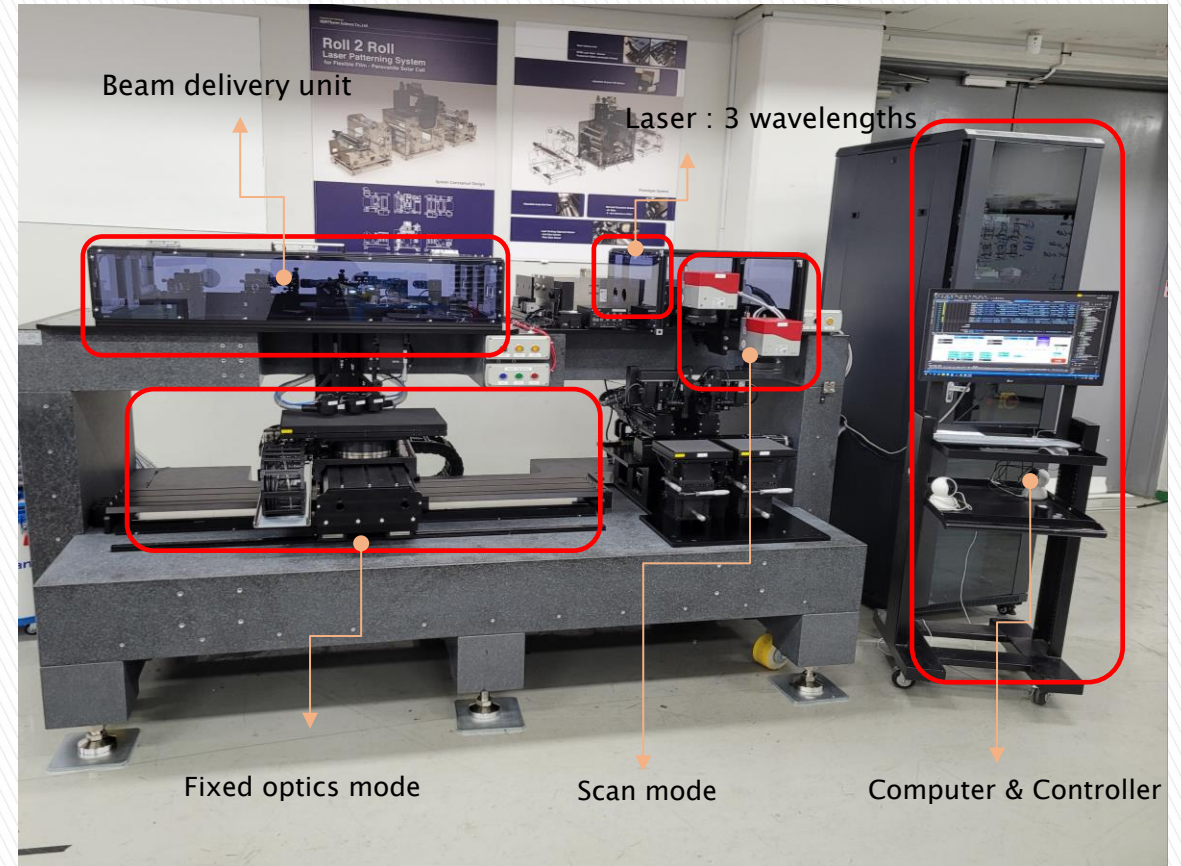
3. μ -Fab-D2 (Dual Mode : Fixed Optics / Scan)

❖ 주요 구성품

Laser	355nm(UV)/ 532nm(Green)/ 1064nm(IR) : 3 Wavelengths
Fixed optic mode	355nm, 532nm, 1064 nm 사용 가능
Scan mode	2 set (355nm, 532nm 사용 가능)
Option	Bessel beam, Tophap beam

❖ 주요 spec.

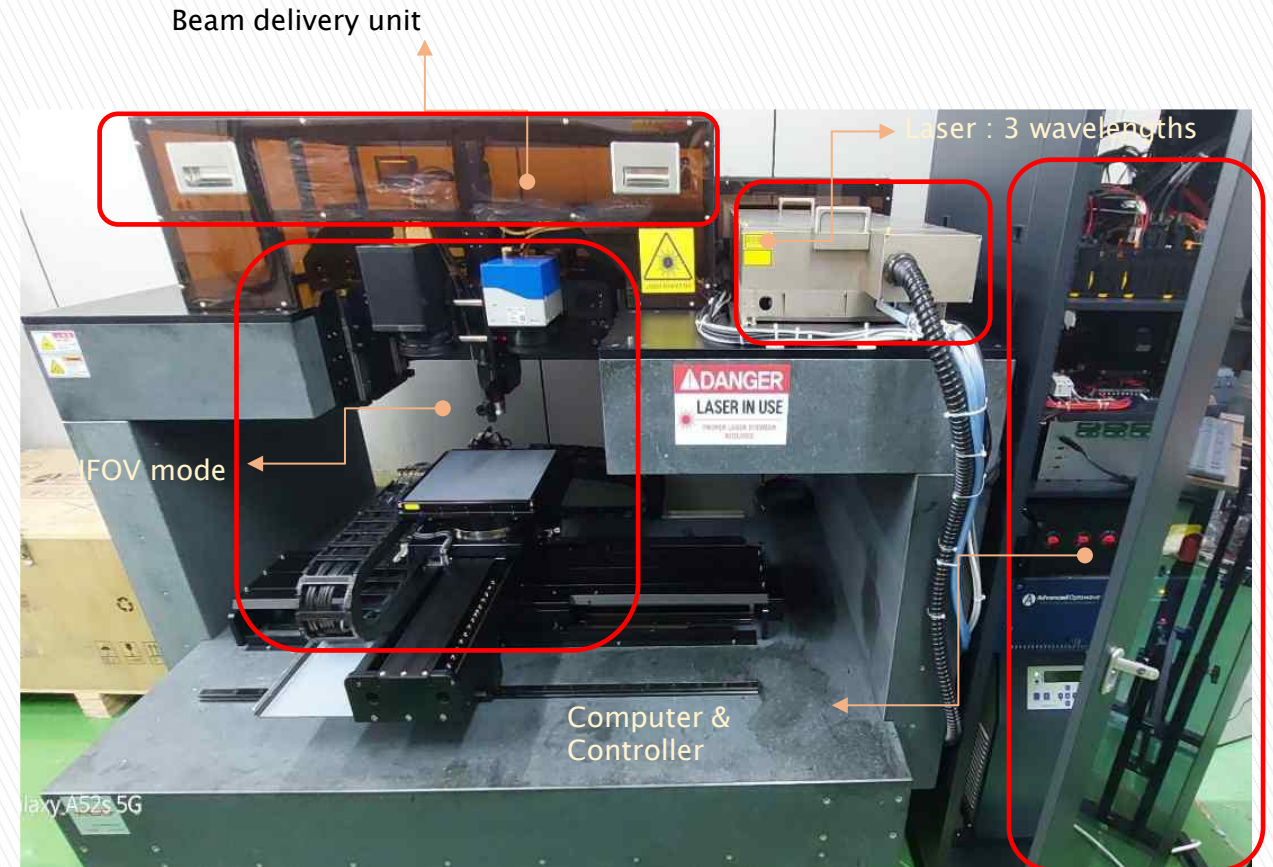
Laser	40W(1064nm)/ 20W(532nm)/ 10W (355nm) Repetition rate : 0.2 ~ 1MHz
spot size	$\leq 25\mu\text{m}$ (1064nm), $15\mu\text{m}$ (532nm), $12\mu\text{m}$ (355nm)
Substrate size	Motion stage : $\leq 500\text{X}300\text{mm}$ Scanner : $\leq 180\text{X}180\text{mm}$
Speed	Fixed optics mode : $\leq 1.5 \text{ m/s}$ Scan mode : $\leq 7 \text{ m/s}$
Accuracy	$\leq \pm 0.5\mu\text{m}$
Reliability	$\leq \pm 0.5\mu\text{m}$
Dimension(W/D/H)	2700X1500X2100mm



4-1. μ -Fab-I [IFOV (Synchronization)]

❖ 주요 spec.

Laser pulse width	Nano / Pico / Femto
Wavelength	355nm(UV)/532nm(Green)/1064nm(IR) / 2 Wavelengths
Operating mode	Dual mode (Fixed Optics / Scan) IFOV (Synchronization : Scan + Fixed Optics)
Traveling range	Max 600mm x 600mm
Working type	Patterning / Scribing / Cutting / Drilling
Application	Transparent material(Quartz, Sapphire, Glass wafer 등)
	TGV(Through Glass Via), TSV(Through Silicon Via)
	3D Micro/Nano Structures
	박막 유리 가공
	Polymer / Wafer / Thin metal/ Film / Silicon wafer
	DISPLAY (FPD, AMLCD) / Solar Cell (Perovskite, OPV, CIGS 등)

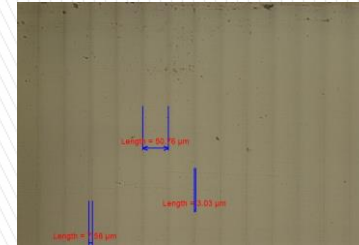


※ IFOV : Infinite Field Of View

4-2. μ -Fab-I [IFOV (Synchronization)]

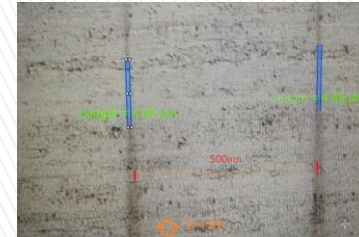
❖ Glass Hole Drilling Machine 적용시 성능(LIDE, Laser Induced Deep Etching)

Attribute	Capability
Processing type	TGV, Open and closed cavities, Trenches, Blind Vias
Outer Diameter (OD)	10~100 μ m
TGV Drilling rate	~10,000 TGV / s
Min. Pitch	5 μ m
Taper angle	0° ~ 10°
Sample Size	Wafer-Level Proccesing (~12")
Material type	All of Transparent material (Sappahire, Borosilicate, Quartz, etc)
Accuracy	$\pm 1 \mu$ m
Thickness	50~1000 μ m
Remark	No Burr/ Microcracks /Debris/ Chipping



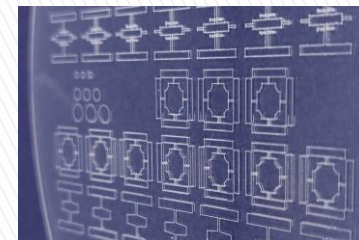
Modification Inside Glass

Wavelength : 1030nm
Thickness : 1mm



Borosilicate Glass (Bessel beam)

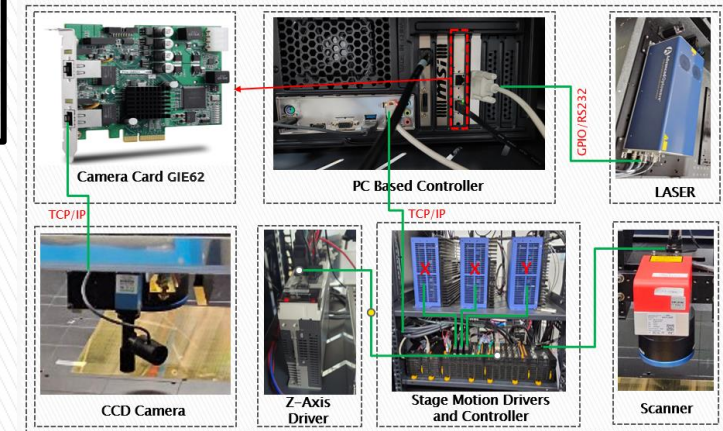
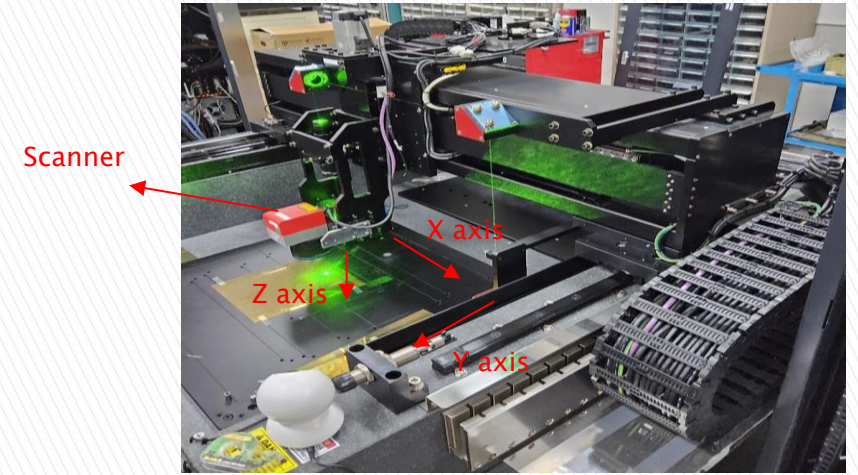
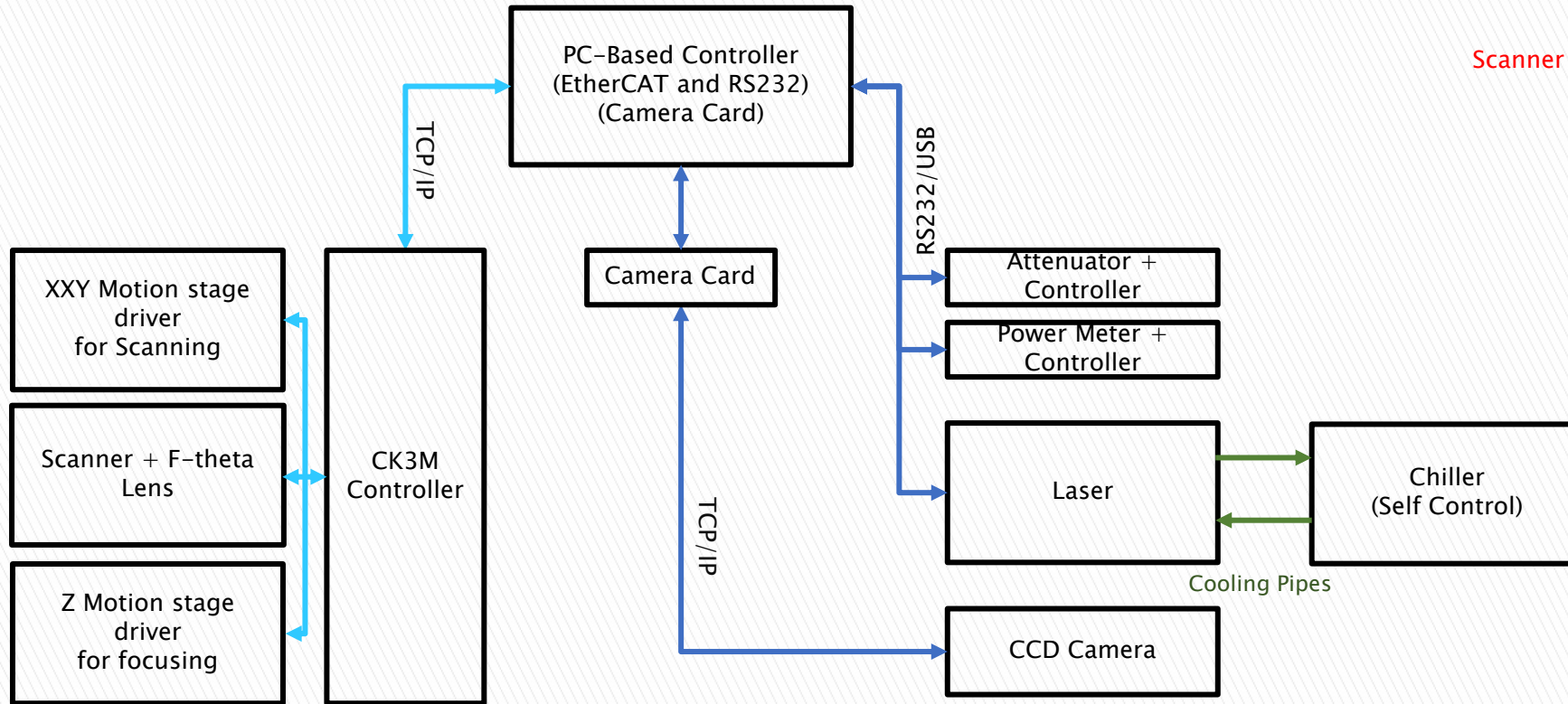
Wavelength : 1030nm
Thickness : 1mm



Borosilicate Glass 3.3(Dia 6", 웨이퍼)

Wavelength : 1030nm
Thickness : 1mm

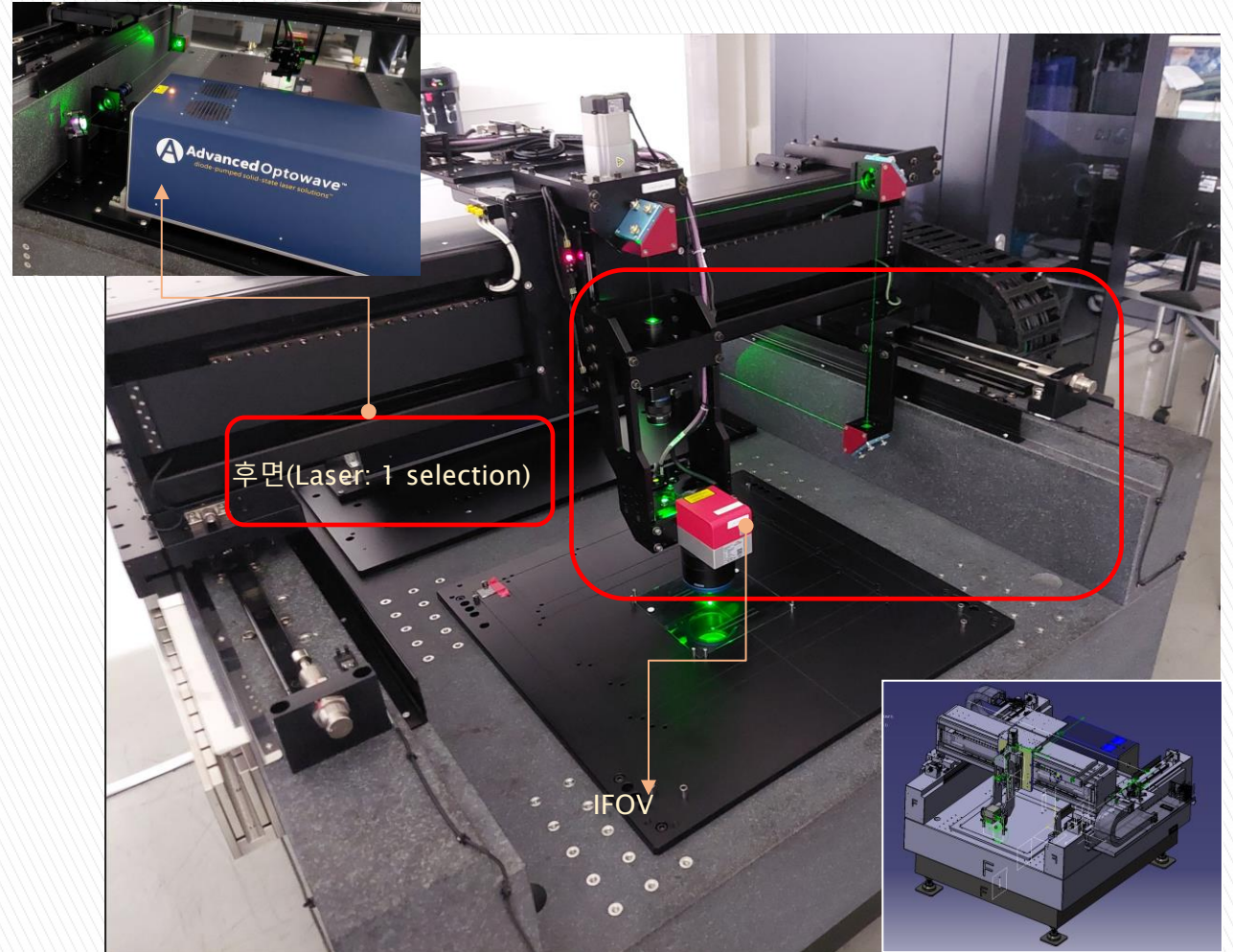
4-3. μ -Fab-I [IFOV (Synchronization)]



5-1. μ -Gan (Laser Patterning Machine based on Gantry System)

❖ 주요 spec.

Laser pulse width	Nano / Pico / Femto
Wavelength	355nm(UV)/532nm(Green)/1064nm(IR) / 1 Wavelength
Operating mode	Fixed Optics mode / IFOV
Traveling range	1000 mm(X) X 1000 mm(Y)
Working type	Patterning / Scribing / Cutting / Drilling
Application	Glass, Polymer / Wafer / Thin metal / DISPLAY (FPD, AMLCD) / Solar Cell (Perovskite, CIGS등)



5-2. μ -Gan (Laser Patterning Machine based on Gantry System)

❖ Glass micromaching system feature

Attribute	Capability
Processing type	TGV, Open and closed cavities, Trenches, Blind Vias
Outer Diameter (OD)	10~100 μ m
TGV Drilling rate	~10,000 TGV / s
Min. Pitch	5 μ m
Taper angle	0° ~ 10°
Sample Size	Panel-Level Proccesing (515mm x 510mm)
Material type	All of Transparent material (Sappahire, Borosilicate, Quartz, etc)
Accuracy	\pm 1 μ m
Thickness	50~1000 μ m
Remark	No Burr/ Microcracks /Debris/ Chipping

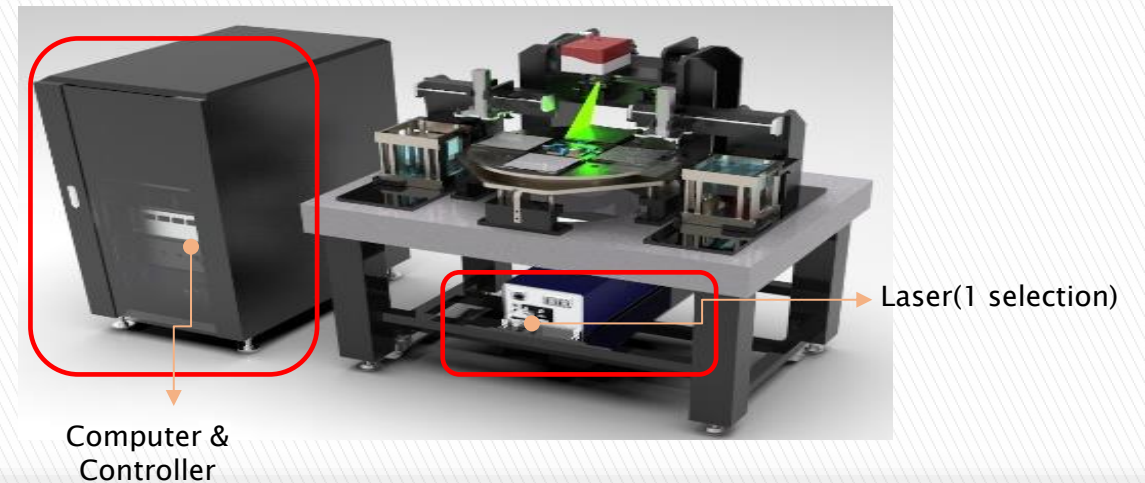
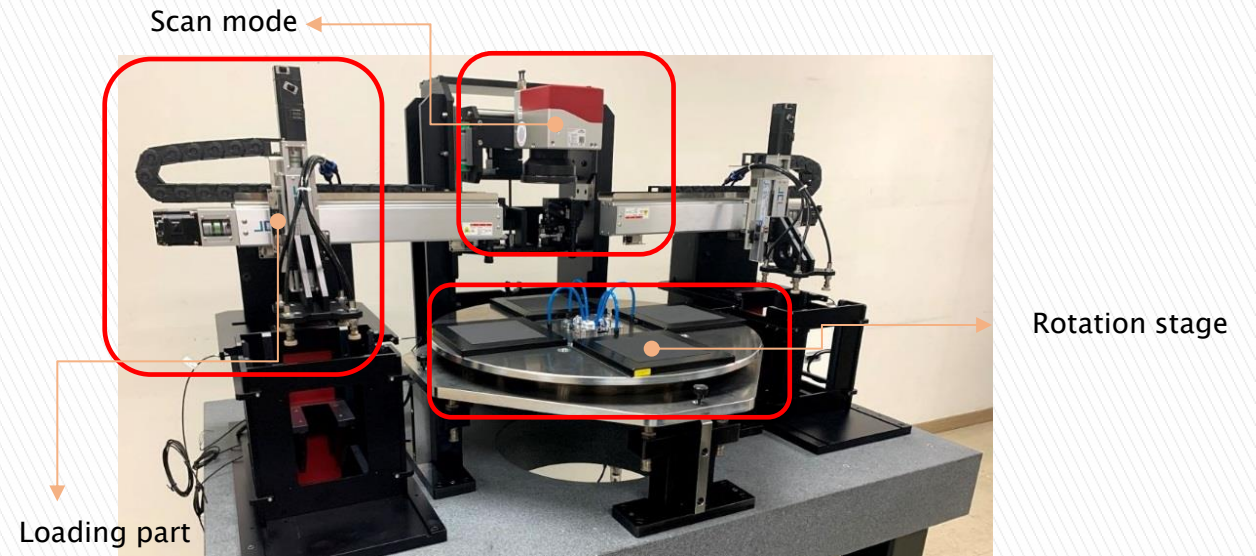
6. μ -WTU (Laser Scriber with Wafer Rotary Unit)

❖ 주요 구성품

Wavelength	355nm(UV)/532nm(Green)/1064nm (IR) / 선택 가능
Scanner	180mm X 180mm
Rotation stage	Wafer 4개 장착
Loading/unloading Part	Cassette (공정 ~이송)

❖ 주요 spec.

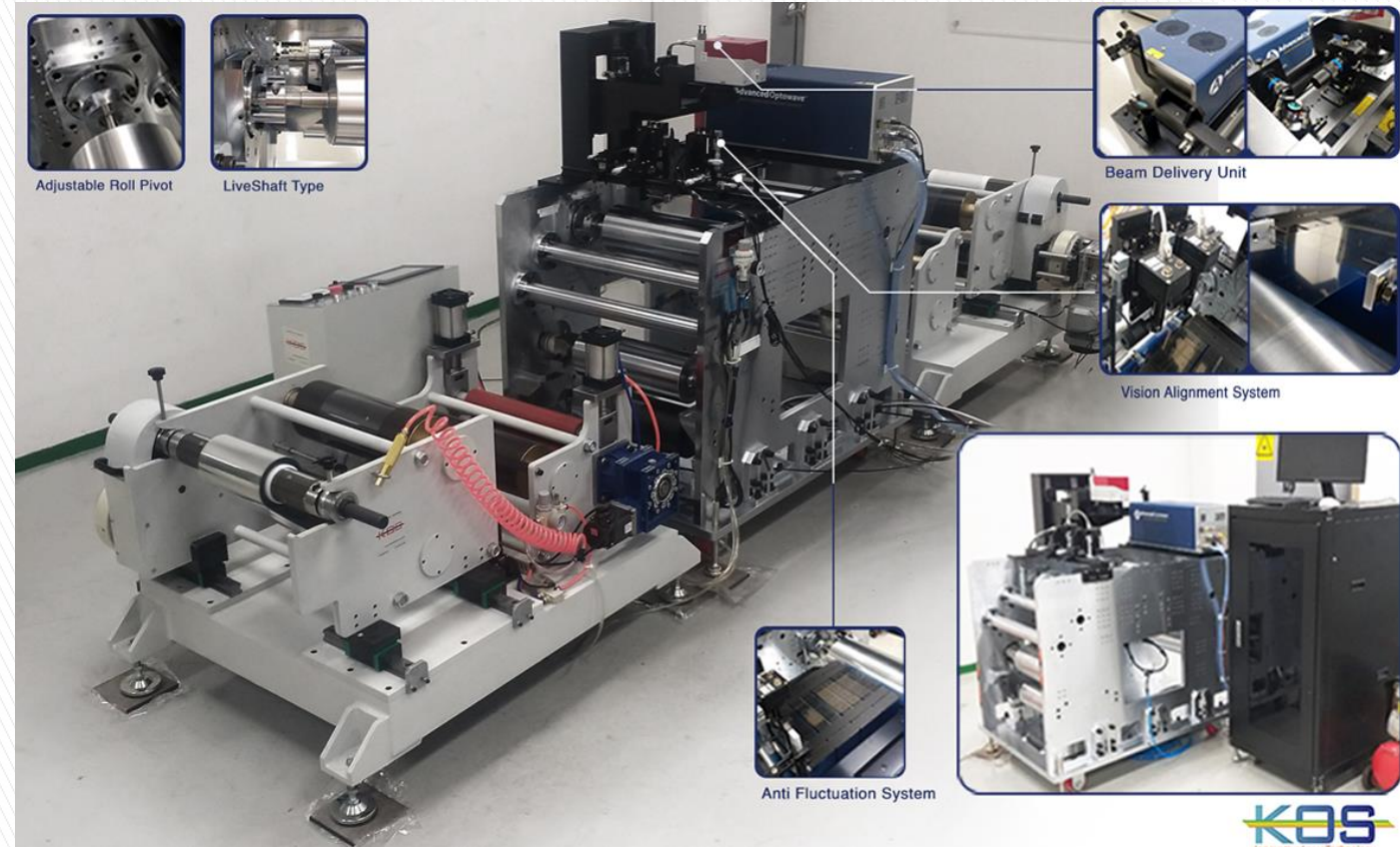
Laser	10W (532nm) Repetition rate : 0.2 ~ 1MHz
Substrate size	$\leq 200 \times 200$ mm(변경 가능)
Substrate thickness	0.05 ~ 3t (mm)
Speed	7 m/s
선폭	$\leq 15 \mu\text{m}$
Accuracy	$\leq \pm 0.5 \mu\text{m}$
Dimension(W/D/H)	3000 X 1500 X 1700 mm
Throughput	-



7. μ -R2R (Laser Patterning Machine based on Roll to Roll)

❖ 주요 spec.

Laser pulse width	Nano / Pico / Femto
Wavelength	355nm(UV) / 532nm(Green) / 1064nm(IR) / Single only
Operating mode	MOTF
Traveling range	200mm / 공정속도 Minimum 3M / min
선폭정밀도	2 μ m 이하
위치정밀도	$\leq \pm 50\mu$ m at 3M/Min
Application	Pevrovskite Composite / Film 등 유연 소재 Printed Electronics(인쇄 전자)
Dimension(W/D/H)	4500 X 2000 X 2000 mm



※ MOTF : Marking On the Fly

8. μ -Slot Die (Slot die Coating system)

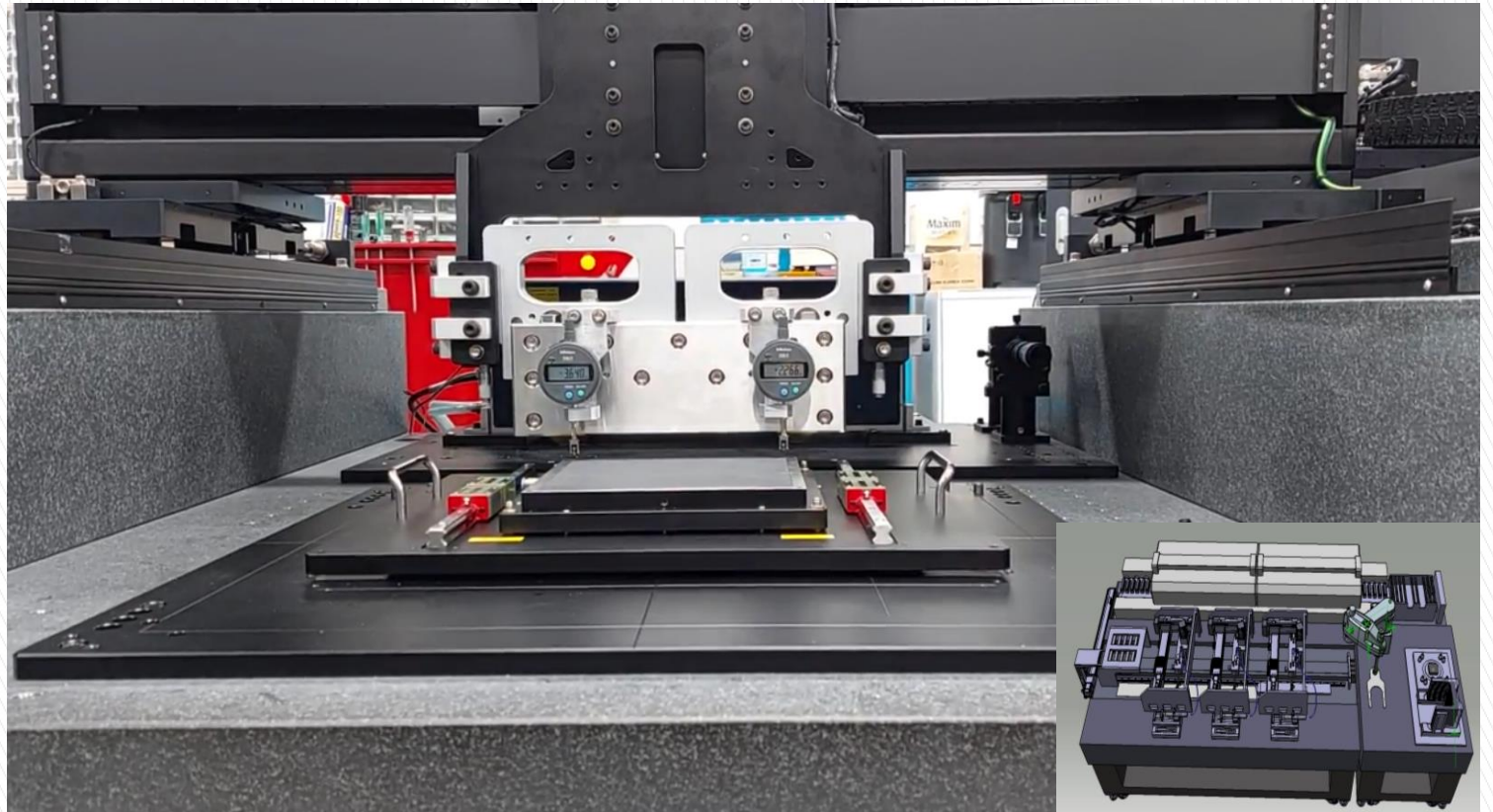
❖ 주요 구성품

Slot die coater	3 set (lip cleaner 3set 포함)
Syringe pump	3 set (사용량에 따라 변경 가능)
Semi dry zone	Air knife dryer
IR dryer	Convey 기능 포함
Automation system	Wafer Cartridge 10 sheet Loading / unloading Robot Transfer stage (Coating -> Dryer)

❖ 주요 spec.

Substrate size	200X200mm Glass(0.7~ 3mm)
Coating area	~ 160x160mm
Coating Speed	1~ 200mm/s
IR zone	2mm ($\leq 150^{\circ}\text{C}$)
Outline Dimension	3,500 X 1,750 X 1600 mm

※ 고객 요청에 따라 spec. 및 구성 변경 가능



◆ Specification

Laser Pulse Duration	PICO / FEMTO
Wavelength	532nm(Green)/ 1064nm(IR) - 1 종류 적용
Operating Mode	IFOV
Traveling range	300~600 mm (X) x 300~600 mm (Y)
Working Dimension	1000 mm (X) x 1000 mm (Y) x 50mm (Z)
Working Type	Modification Inside Glass / Drilling
Application	Transparent Material (Quartz, Borosilicate, Sapphire, Glass, wafer 등)

* 핵심 기술 :

- 1) Axicon – Convex 구성으로 Bessel beam 을 구현
- 2) 멀티 Beam을 통한 Material에 따른 파장 선택 가능

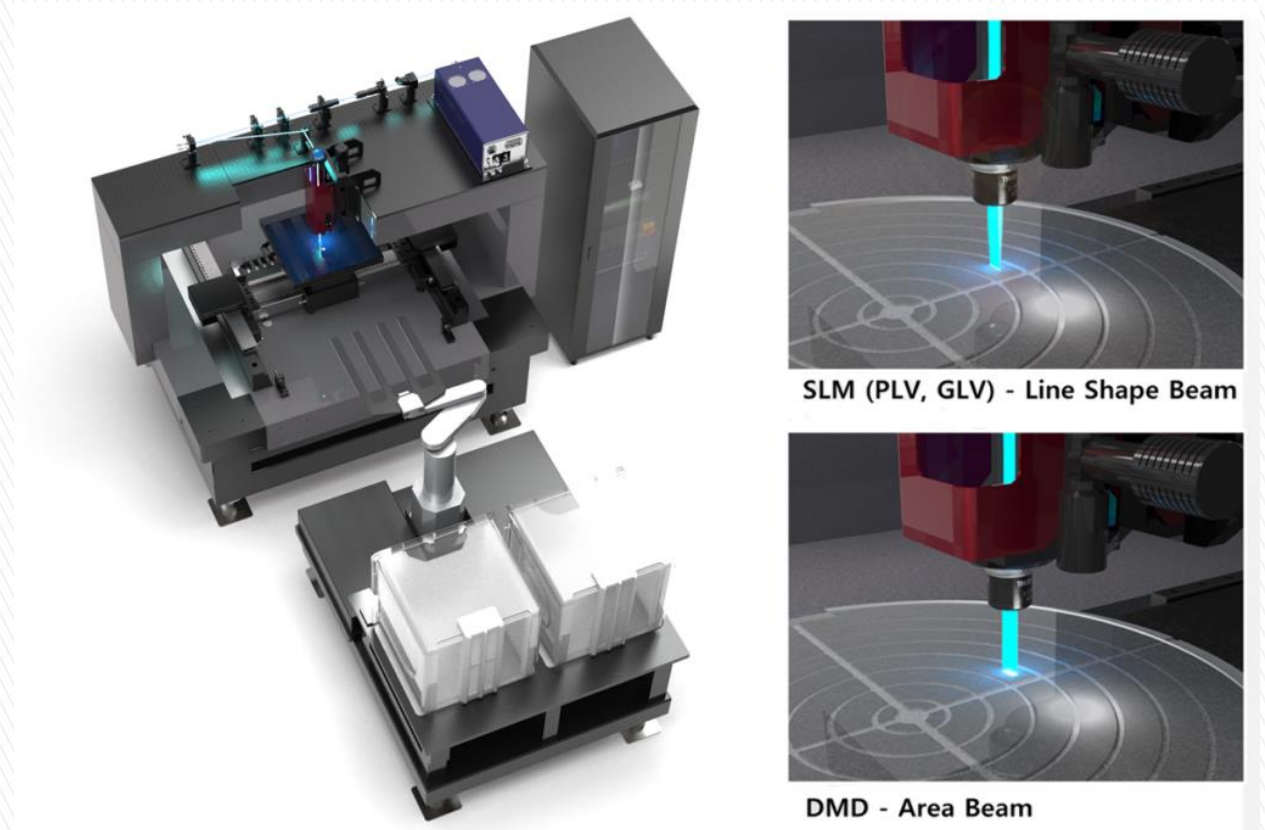


◆ Specification

Wavelength	355nm(UV-A)/ 365nm(UV-A) / 248nm(UV-C) - 1 종류 적용
Operating Mode	Direct Writing & DMD
Traveling range	300~600 mm (X) x 300~600 mm (Y)
Working Type	Lithography, Exposer, Patterning
Application	PR(Photo Resist), DFR(Dry Film Resist) Maskless RDL(Redistribution Layer) 제작
Working Dimension	1800 mm (X) x 1600 mm (Y) x 1650 mm (Z)

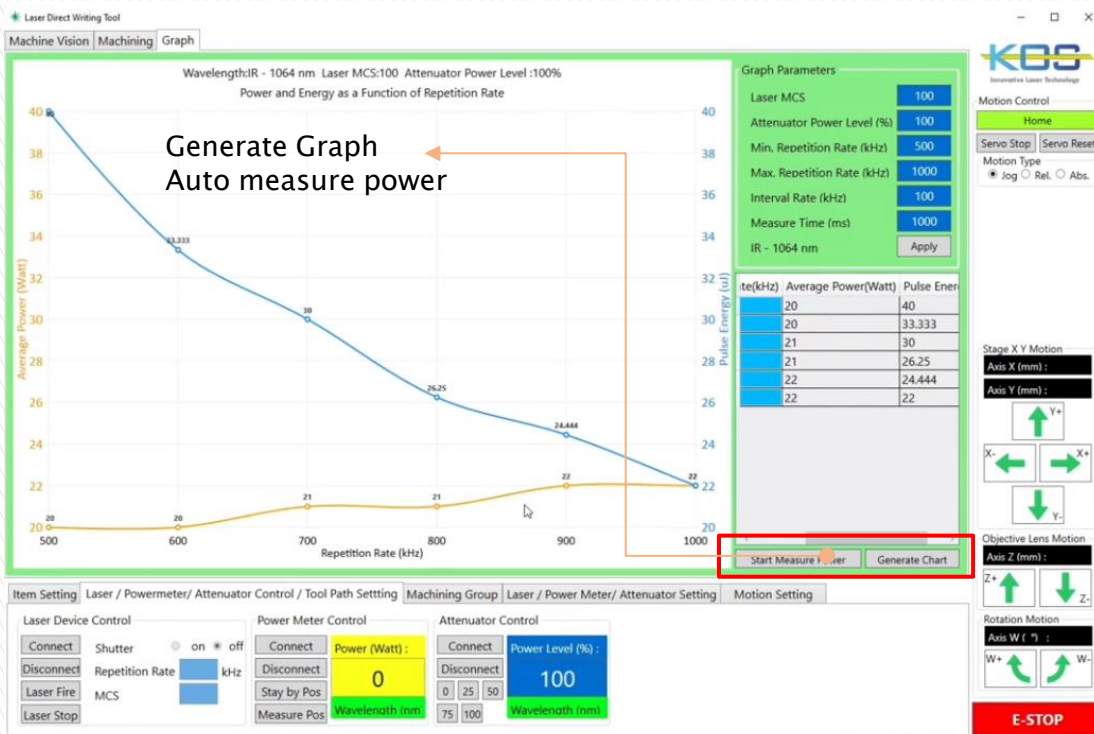
* 핵심 기술 :

- 1) DMD를 적용하여 Circuit Patterning 공정 구현
- 2) Substrate RDL(Redistribution Layer) 공정 가능, TGV Glass, PCB
- 3) Stitching Error 보정



❖ Auto measure power / Generate Graph

- Repetition rate 에 따른 Power와 Pulse Energy
를 자동으로 계산 및 그래프 생성 가능



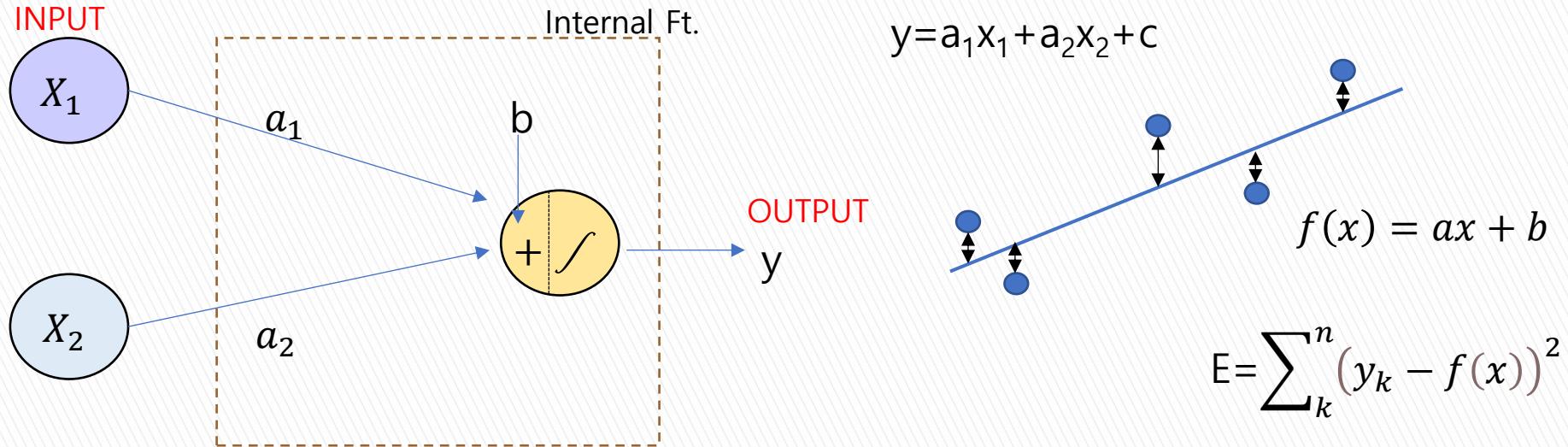
❖ Control Laser Parameter 기능

- 사용자가 최적의 공정 Parameter를 찾기 위하여 여러 번 반복 테스트를 진행 시,
한 번에 서로 다른 여러 Parameter 값을 가공 샘플에 적용하여 작업 효율을 높이는 기능

※ 주요 조정 Parameter: Power, Rep.Rate, Scan Speed, Pass(Repeat), Overlap(%)

Power Level	Spot Dia.(um)	LSO(%)	Power (Watt)	Fluence(J/cm^2)	Attenuator Power Level(%)	Machining Z Offset (mm)	Pass #	Group Delay (s)	Group Note
100	20	99	10	6.36619772367581	60	-1	1	1	
300	20	99	10	6.36619772367581	100	-2	1	1	
300	20	99	10	6.36619772367581	100	0.5	1	1	
300	20	99	10	6.36619772367581	100	-1.56	1	1	
300	20	99	10	6.36619772367581	100	1.55	1	1	

❖ AI adoption을 통한 공정 Parameter 최적화 기능



Input
 Overlapping(%), Repetition Rate(Hz), Scan Speed(M/s), Fluence(J/cm²)
 Training Data(30ea), Test Data(50ea)



Output
 Ra(surface roughness;μm), Line Width(spot μm;)---
 →PCE (Power Conversion Efficiency)

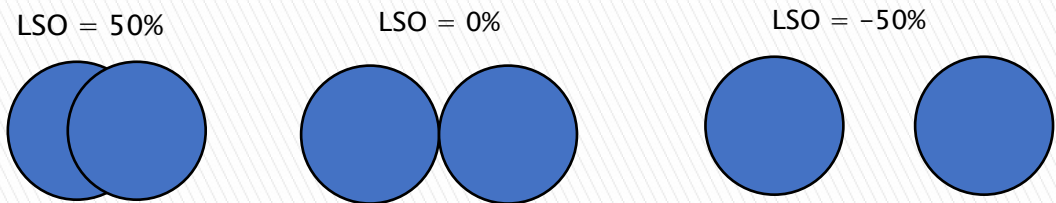
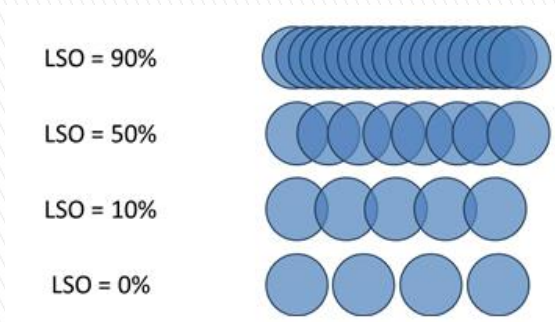
❖ Laser Spot Overlap – LSO(%)

- 3 개 변수(v,f,d)에 따라 LSO 값 결정
- 70%이상 설정으로 가공 품질 향상 가능
- LSO 공식

Laser Spot Overlap

$$LSO (\%) = \left(1 - \frac{v}{f \times d} \right) \times 100\%$$

LSO = Laser Spot Overlap
 v = processing speed(mm/s)
 f = repetition frequency (kHz)
 d = beam spot diameter(um)



no.	Processing Speed (mm/s)	PRF (kHz)	Power Level	Spot Dia.(um)	LSO(%)
1	9600	400	300	20	-20

❖ Fluence

- 단위 면적당 레이저 에너지 (J/cm²)
- 3개 변수(p,f,d)에 따라 Fluence 값 결정
- Fluence 통해 최적 Parameter 선정 가능
- Fluence 공식

Fluence Fluence = 5.427056 J/cm²

$$Fluence (J/cm^2) = p / f / (\pi * (d / 2)^2)$$

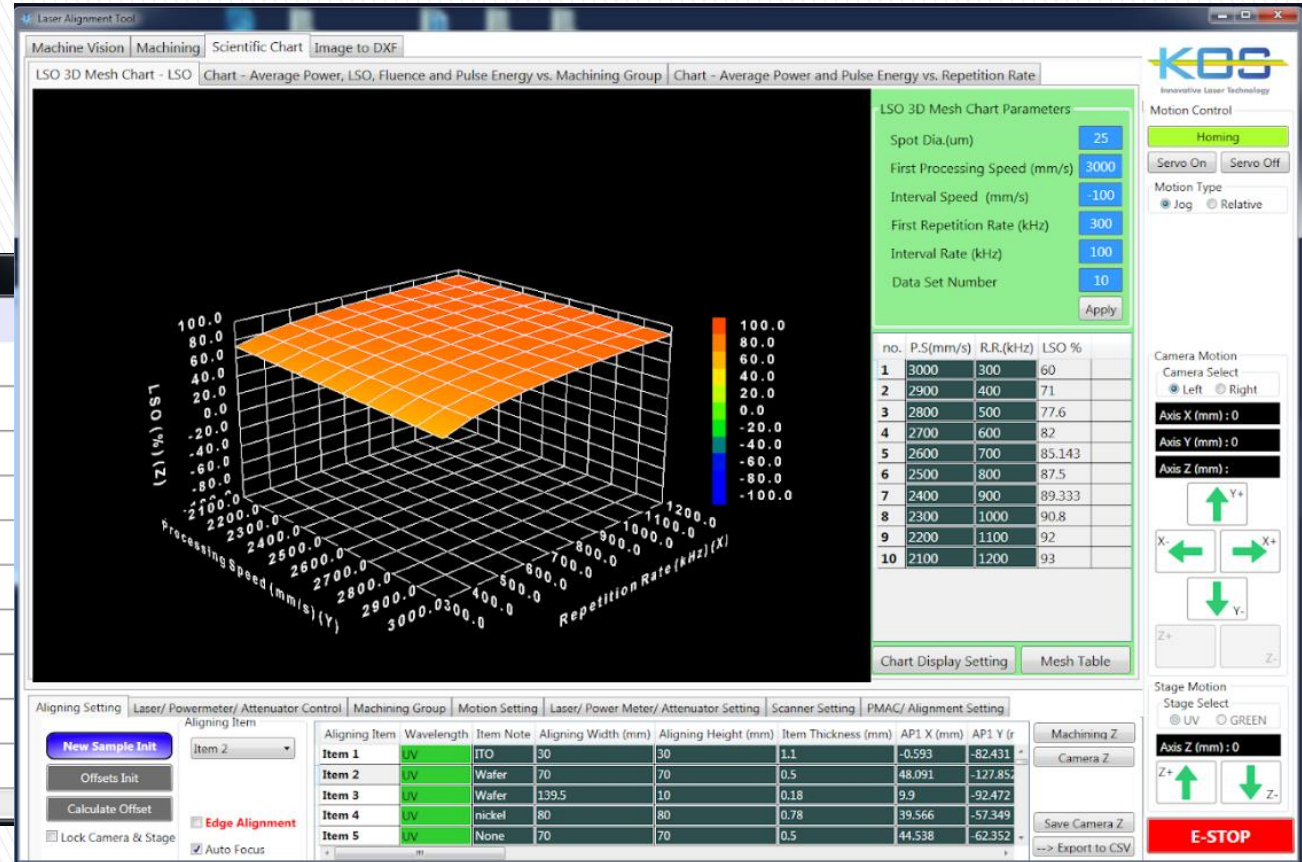
p = laser power (Watt) 13.32 Watt
 f = repetition frequency (kHz) 500 kHz
 d = beam spot diameter (um) 25 um Calculate

PRF (kHz)	Power Level	Spot Dia.(um)	LSO(%)	Power (Watt)	Fluence(J/cm ²)
400	300	20	-20	20	7.95774715459477

❖ LSO 3D Chart

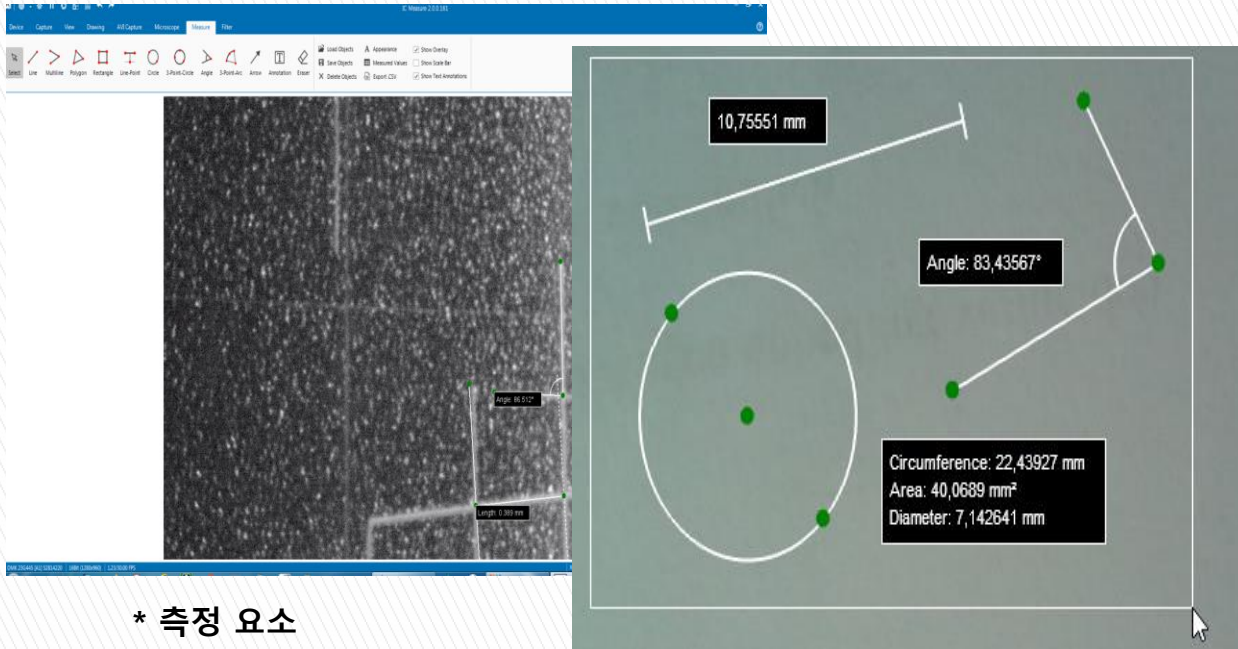
- 2 개 변수(v,f)에 따라 LSO 값을 3D chart로 표현 가능

P.S.(mm/s) /> LSO(%) for 25um /-> R.R.(kHz)	1200	1100	1000	900	800
2100	93	92.364	91.6	90.667	89.5
2200	92.667	92	91.2	90.222	89
2300	92.333	91.636	90.8	89.778	88.5
2400	92	91.273	90.4	89.333	88
2500	91.667	90.909	90	88.889	87.5
2600	91.333	90.545	89.6	88.444	87
2700	91	90.182	89.2	88	86.5
2800	90.667	89.818	88.8	87.556	86
2900	90.333	89.455	88.4	87.111	85.5
3000	90	89.091	88	86.667	85



❖ Measurement Function

- 최적화된 Vision system을 이용하여 미세 가공 데이터를 수치화 가능



* 측정 요소

- Spot Size
- Line width
- Line to Line Space
- Pattern Size

❖ Auto Focus

- 시료 Thickness에 적합한 가공 Z 위치 선정
- ±5mm adjustable by motor



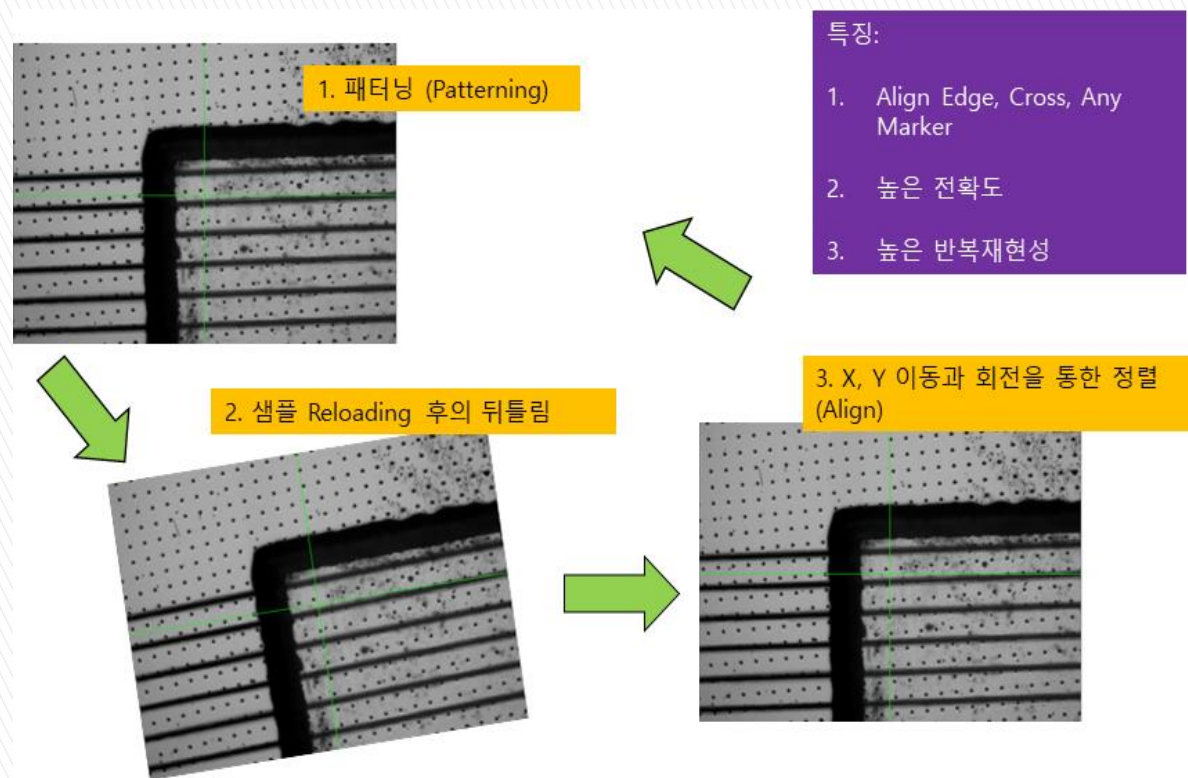
Auto Focus 클릭으로 적합한 가공 Z 위치 선정

❖ Auto Vision Align 기능

- 2대의 카메라를 이용한 Alignment
- 기판 크기 저장 가능(최대 50개)
- Edge, Marker Alignment 기능

Alignment & Offsets Setting

Aligning Item	Custom X1	Custom Y1	Custom X2	Custom Y2	Align Angle Offset	Align X Offset	Align Y Offset	User Angle Offset	User X Offset	User Y Offset	Total Angle Offset	Total X Offset	Total Y Offset
Item 1	-50	50	50	50	0	0	0	0	0	0	0	0	0
Item 2	-50	50	50	50	0	0	0	0	0	-0.1	0	0	0
Item 3	-50	50	50	50	0	0	0	0	0	-0.2	0	0	0

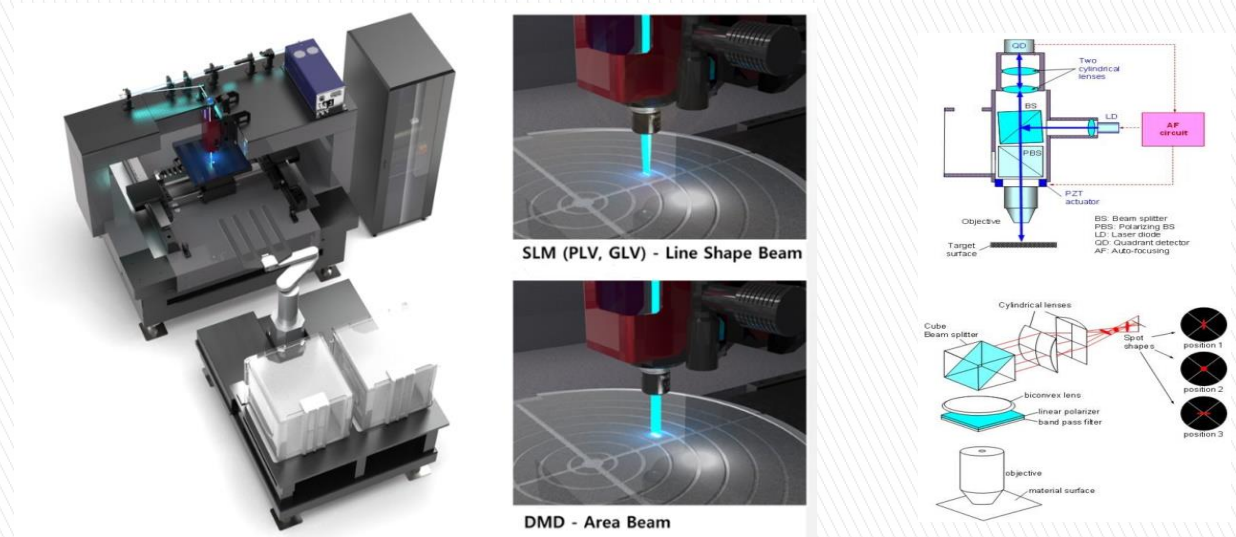


◆ Maskless Laser Lithography(Writer)

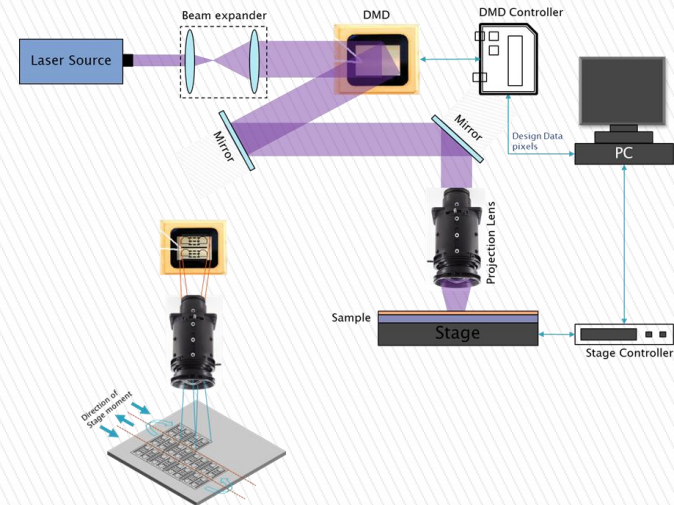
- 응용 분야
 Laser Lithography
 Glass substrate for Advanced Packaging
 Semiconductor(BEOL)
 TGV(Through Glass Via), TSV(Through Silicon Via)

사용 모드: Fixed Optics Mode, Autofocusing

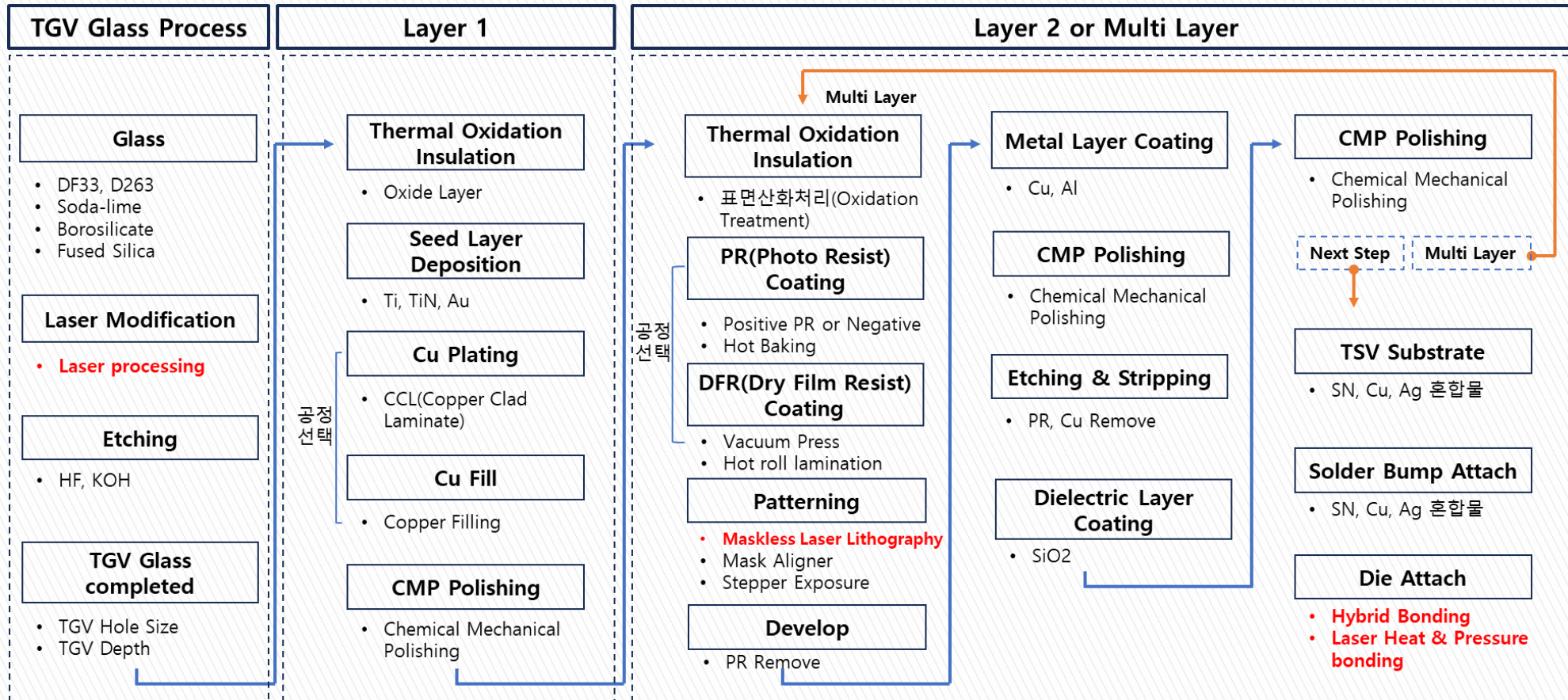
- 가공 면적 : 300~600 mm (X) x 300~600 mm (Y)
- 작업 범위 : PR(Photo Resist), DFR(Dry Film Resist)
 Maskless RDL(Redistribution Layer) 제작
- 적용 소재: Silicon/Glass/PCB



< Autofocusing >

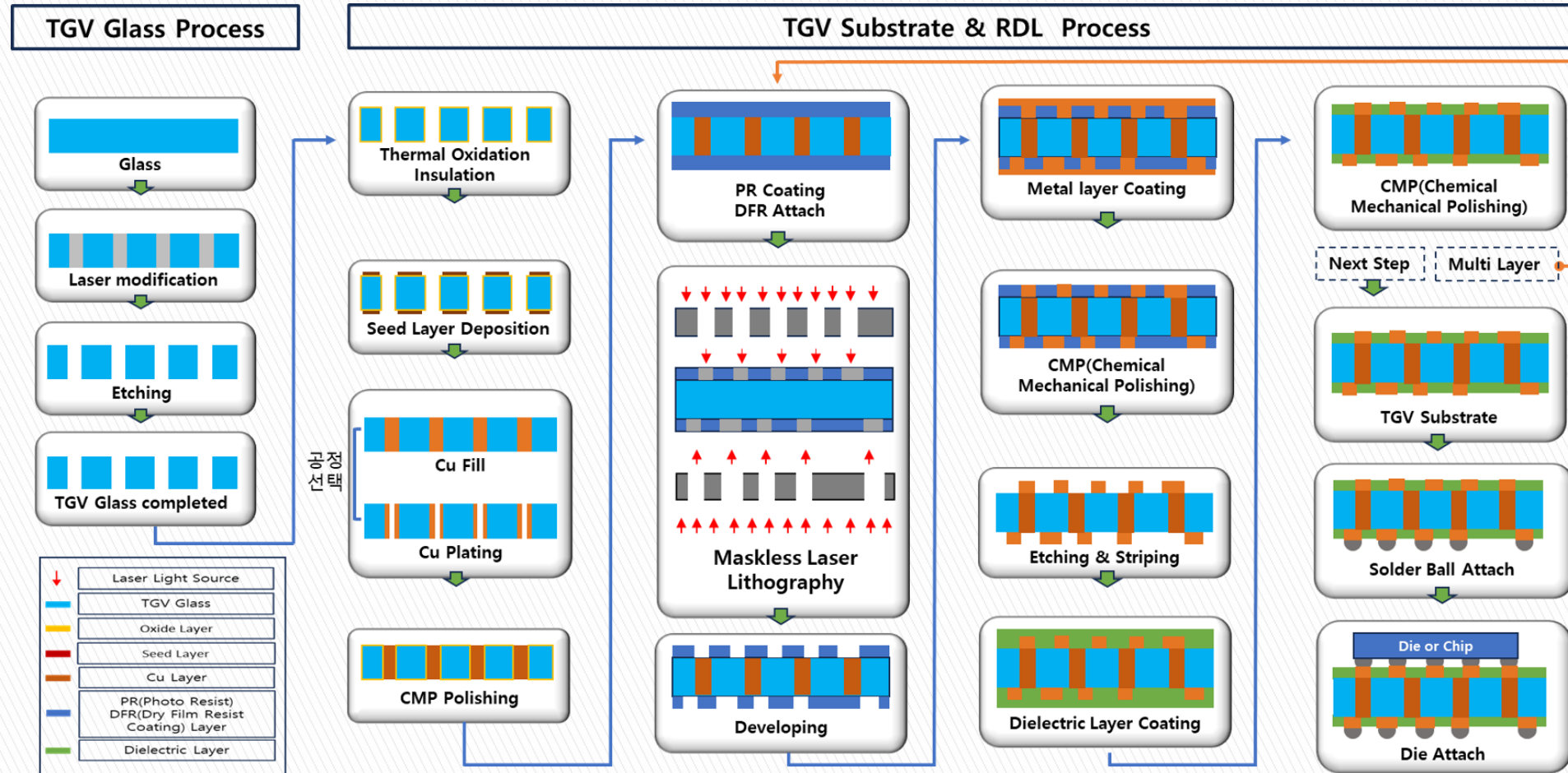


◆ Glass Substrate Fabrication Processes for Advanced Packaging



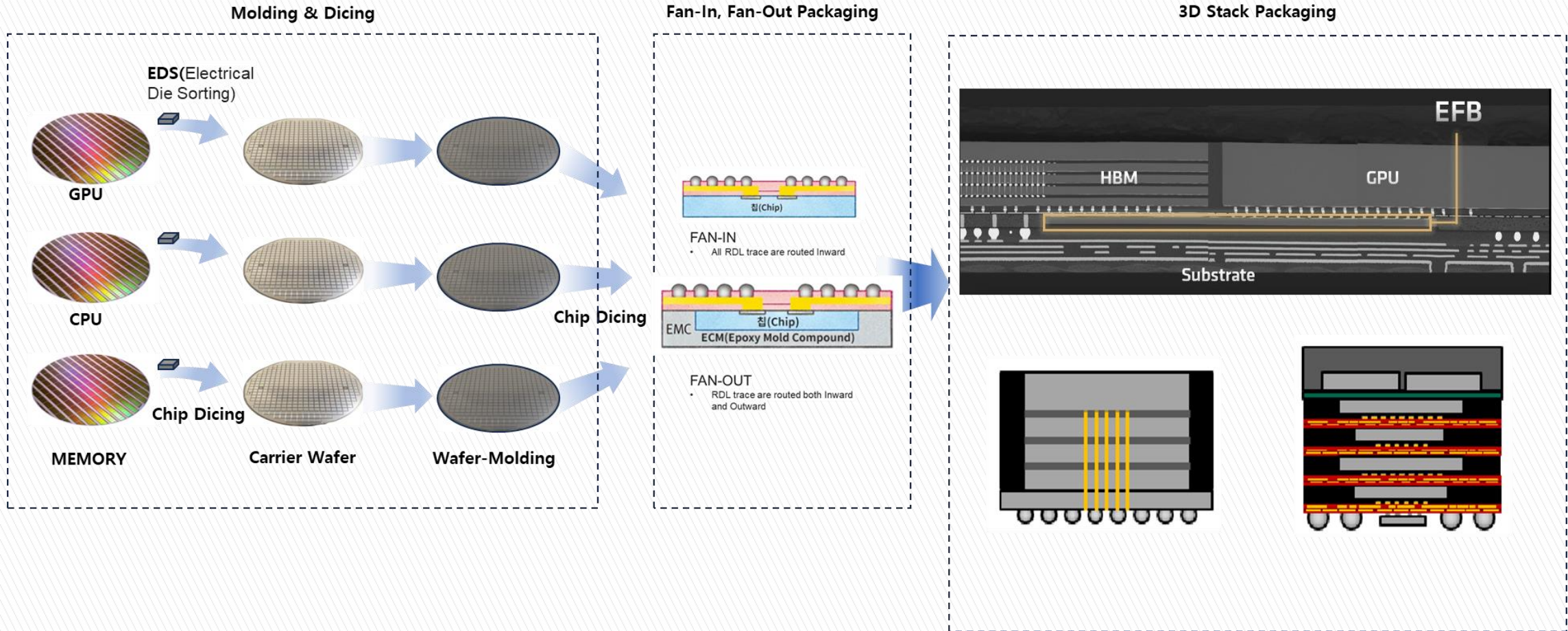
- 장점: TGV Glass와 RDL(Cu Circuit) 층을 주문 제작 방식으로 제작하며 생산 가능

◆ Glass Substrate Fabrication Processes for Advanced Packaging



• TGV Glass Substrate 제작 Illustration

◆ Advanced Packaging – (FAN-IN, FAN-OUT)



Applications

1.Solar Cell
(PSC/OPV/CIGS)

2.Display
(Flat Panel Display)

3.Semiconductor
(MEMS/Bio Sensor)

4.Transparent
Materials
(Glass, Polymer,
4H SiC)

▶ 국내 기업



▶ 정부산하 연구센터

- KIST (한국과학기술연구원), 한국생산기술연구원, 대구 나노팩
- 한국재료연구원, KERI(한국전기연구원)
- ETRI(한국전자통신연구원), 한국화학연구원, 한국에너지기술원
- GIST(광주과학기술원), UNIST(울산과학기술원), DGIST(대구경북과학기술원)

▶ 국내대학 연구소

- 성균관대학교, 충남대학교, 연세대학교, 서울대학교, 고려대학교, 부산대학교

❖ 납품 장비 : u-Fab. System, u-Lab. System

14. ZEUS(장비 활용 종합 포털)

❖ ZEUS (장비 활용 종합 포털) <https://www.zeus.go.kr/main>

