

LASER SAMPLE TEST 안내

2024. 04.

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1. 개요

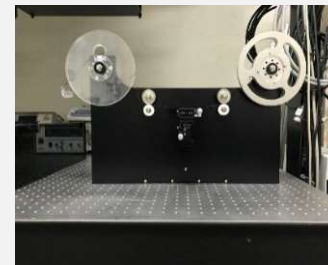
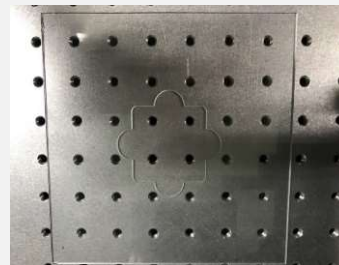
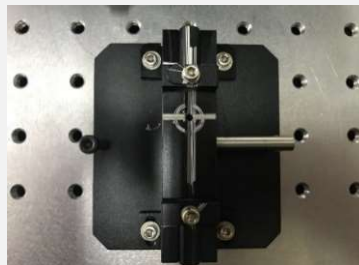
LASER SAMPLE TEST (레이저 가공의뢰)

초미세 레이저 장비의 도입을 검토 중인 기업 또는
레이저를 이용한 가공 공정이 필요한 기관이나 개인의 의뢰로 진행되는
당사 보유 레이저를 이용한 테스트 작업.

2. Sample Test 규정

1. 계약 최소단위는 10시간이며, 상황에 따라 협의 가능합니다.
2. 작업은 고객이 의뢰한 시간에 **작업지시서(도면)**를 따라 진행합니다.
(작업진행: 경력 5년 이상 숙련자)
3. 가공을 위한 레이저 셋업(Alignment, Parameters 등)은 4시간이 기본입니다.
4. **작업의 난이도**에 따라 기본비용 및 단가는 달라질 수 있습니다.
5. 작업에 필요한 지그(JIG) 제작, 소모품 구입 등 부대비용은 추가 청구합니다.

* 작업에 필요한 지그(JIG) 예시사진



2. Sample Test 규정

6. 기본 작업 시간 이전에 가공 종료 시, 잔여 시간은 **시작일** 기준으로 1년 이내로사용 가능합니다. (단, 동일 재료에 한함.)
7. **고객이 제공한 도면 및 작업지시에 따라 정상적으로 이루어진 테스트의 결과는 당사가 보증하지 않으며 단, 외부에 대하여 기밀을 유지합니다.**
8. **당사는 2D 촬영을 위한 현미경을 보유하고 있으므로 2D관측만 당사에서 제공합니다. 3D 관찰을 위한 장비 및 관련 Data는 의뢰자 측에서 부담함을 원칙으로 합니다.**
9. 신규 가공의뢰자는 반드시 서명이 기재된 「가공의뢰서」를 작성하여 샘플과 함께 제출해야 합니다. (양식 다운로드: **변경중**)

2. Sample Test 규정

10. 작업시간당 기본금액

- 1) Nano Second Laser (UV, GREEN, IR): 25만원 * 10시간 = 250만원 (VAT별도)
- 2) Pico Second Laser(UV, GREEN, IR): 25만원 * 10시간 = 250만원 (VAT별도)
- 3) Femto Second Laser(UV, GREEN, IR): 40만원 * 10시간 = 400만원 (VAT별도)
- 4) CO2 LASER: 25만원 * 10시간 = 250만원 (VAT별도)
- 5) F-πShaper 필요한 경우 alignment, system setting 등 추가 작업이 필요
(10시간 비용 추가)
- 6) 대면적(200mm x 200mm ~ 600mmx600mm) 가공은 별도 협의

11. 당사의 미세가공 서비스는 Parameter Data를 제공하지 않습니다.

연구 목적으로 이용하기 위하여 Laser Processing Report를 요청하시면
협의 후 추가 비용으로 제공하고 있습니다.

레이저 셋업 _ Alignment

Close



Alignment

Stage

X

Y

Z

Velocity

100

mm/s

Position

Current Pos

0,00

Move Vision Pos

Vision Pos

841,70

Home

Wasting Pos

55,01

Mark _ Material

Material Size

160 x 160

mm

Align Type

Mark_Cross

Mark Distance

129,7

mm

LED Control

CH1

25

CH2

25

COM

COM4

Set



Profile

Vision & Alignment

Servo & Parameters

Marking Profiles

Adjust the mark quality with the Profile parameters.

Marking Profiles

Filling Profiles

Mode:

mark once

Current Profile:

All passes

Passes

1

Laser power

50,000

%

Mark speed

1831,1

mm/s

Frequency

5,00

kHz

Pulse width

100

μs

Pulsed mode

CW mode

LaserOn delay

200

μs

Jump speed

1831,1

mm/s

LaserOff delay

300

μs

Jump delay

300

μs

Mark delay

300

μs

Vari. jump length

300

mm

Poly delay

50

μs

Vari. jump delay

50

μs

Spot Offset

0,000

mm

Wobble frequency

0,000

Hz

Wobble width

0,000

mm

OK

Cancel

Apply

Help

레이저 셋업 _ Parameters

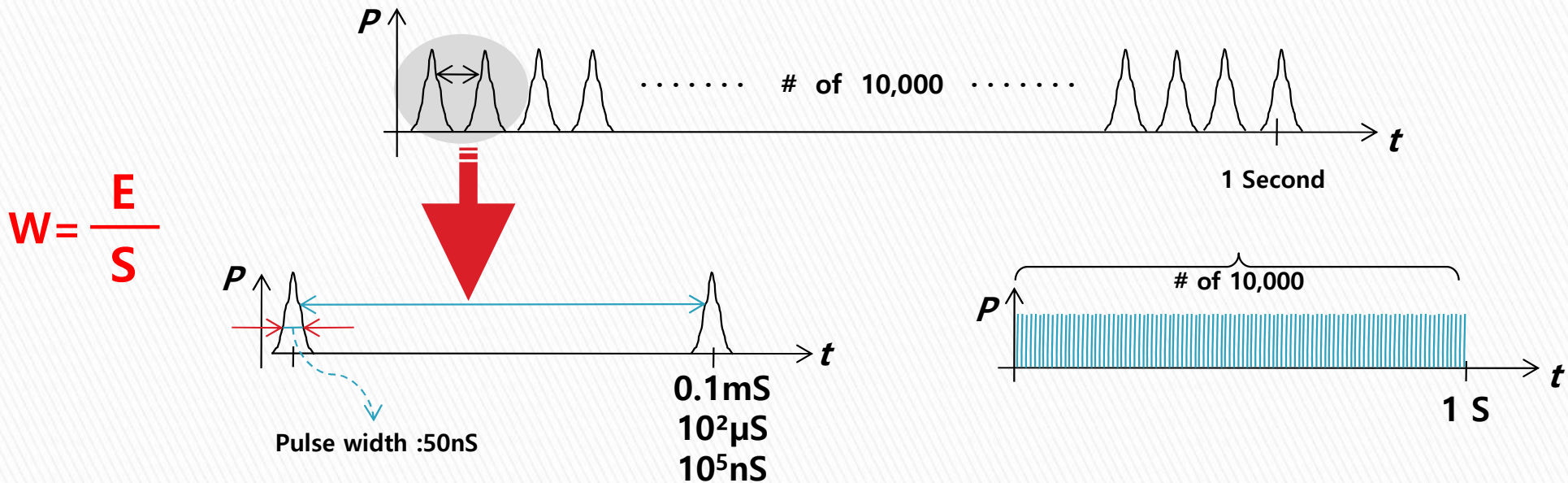
Wavelength Selection : UV, Green, IR and Nano, Pico

1. Pass [가공 위치를 Laser가 통과하는 횟수(#)]
2. Scanning Speed [가공 부위를 통과하는 속도(mm/S)]
3. Focal Point [Beam Spot이 가장 작은 위치]
4. Pulse Energy [하나의 Pulse 가지고 있는 에너지(E/Pulse)]
5. Pulse Width [Pulse Energy와 material이 interaction하는 시간(nS)]
6. Repetition Rate [초당 pulse 개수(Hz=1/S)]
7. Fluence [Beam Spot의 1cm² 당 에너지 밀도(Fluence=J/cm²)]
8. Laser Spot Overlap [LSO(%)]
9. Drawing Amend

Sample 및 가공 요구조건에 맞게 Parameters를 적절히 변화시켜
가면서 최적의 가공 조건 도출!

Laser Parameters for material processing

Ex) Pulse width: 10nS, Repetition Rate 10KHz, Pulse Energy: 100μJ



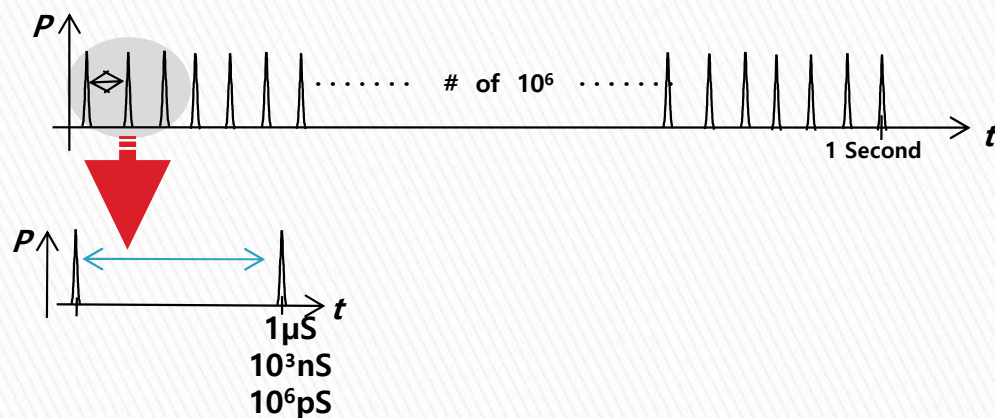
Average Power(W) = Pulse Energy(J) x Repetition Rate(1/S)

Peak Power(W) = Pulse Energy(J)/Pulse Width(S)

Laser Parameters for material processing(2)

$$\text{Pulse Energy(J)} = \frac{\text{Average Power(W)}}{\text{Rep. Rate(Hz)}}$$

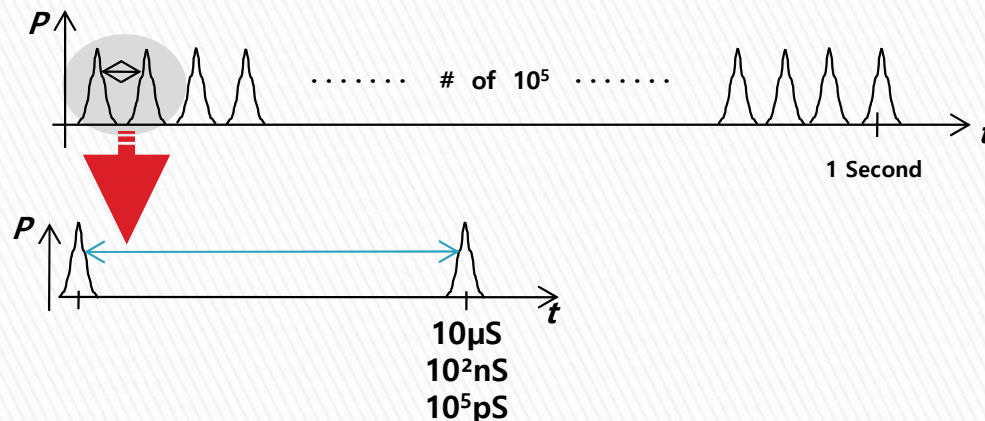
Ex1) Pico Laser, Average Power: 20W, Rep Rate:1MHz



$$\text{Pulse Energy(J)} = \frac{\text{Average Power(W)}}{\text{Rep. Rate(Hz)}}$$

$$20\mu\text{J} = \frac{20\text{W}}{10^6\text{Hz}}$$

Ex2) Nano Laser, Average Power: 20W, Rep Rate: 100kHz

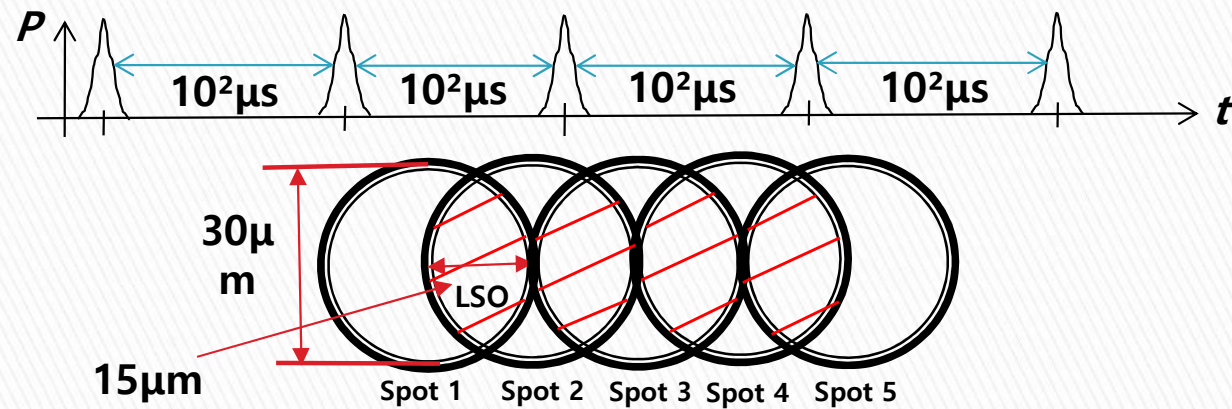


$$\text{Pulse Energy(J)} = \frac{\text{Average Power(W)}}{\text{Rep. Rate(Hz)}}$$

$$200\mu\text{J} = \frac{20\text{W}}{10^5\text{Hz}}$$

Laser Spot Overlap(LSO)-1

Ex) Repetition Rate: 10KHz, Scan Speed: 150 mm/S Beam Spot Diameter: 30 μ m



$$150 \text{ mm/S} \times 10^2 \mu s = 15 \mu m$$



Laser Spot Overlap(ISO)-2

Ex). Repetition Rate(r): 10KHz, Scan Speed(v): 150 mm/S
Beam Spot Diameter(d): 30μm

$$\text{ISO} (\%) = \left(1 - \frac{v}{r \times d}\right) \times 100 \quad \Rightarrow \quad \text{ISO} (\%) = 50\%$$

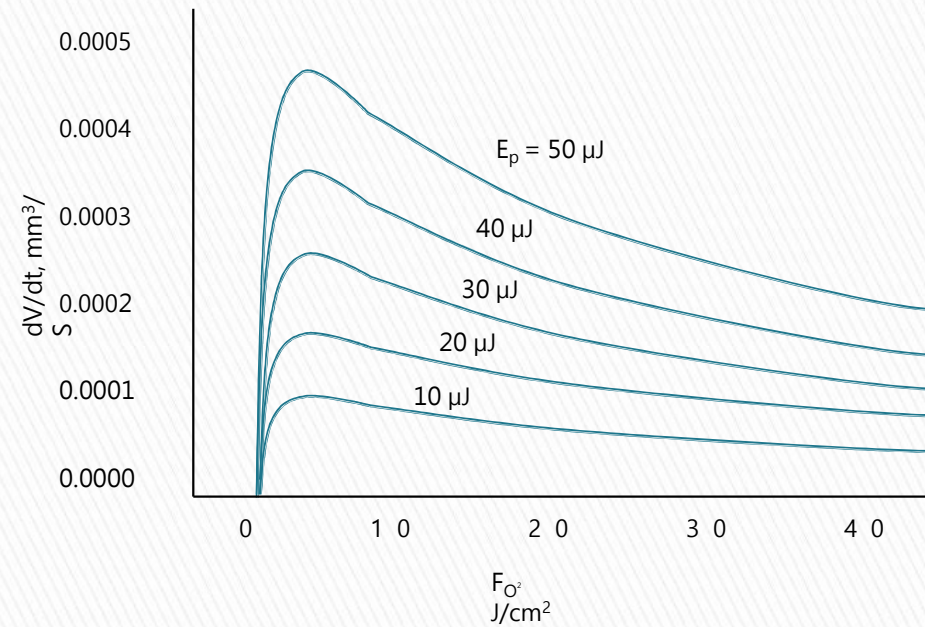
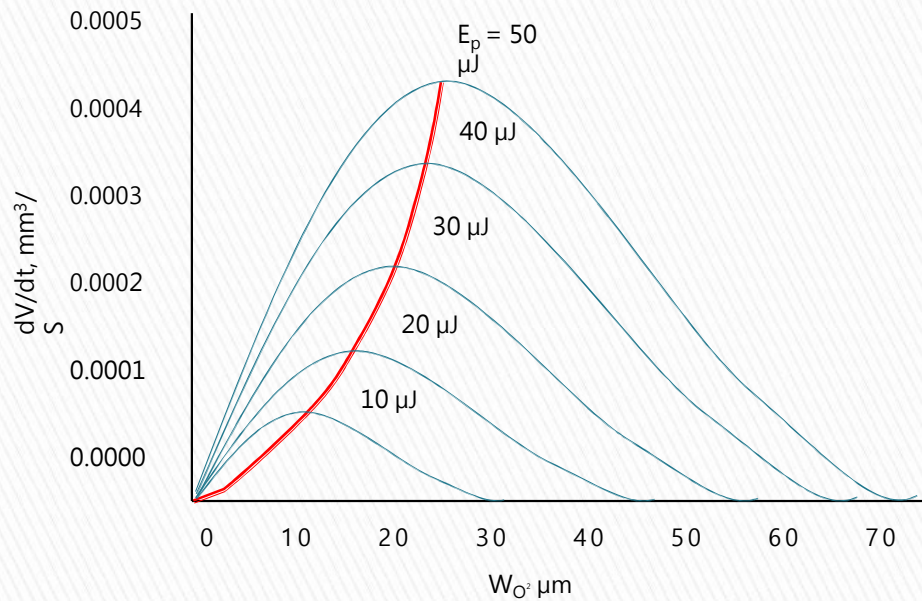
ISO High Level이 요구 될 경우

Repetition Rate(r)  / Scan Speed(v) 

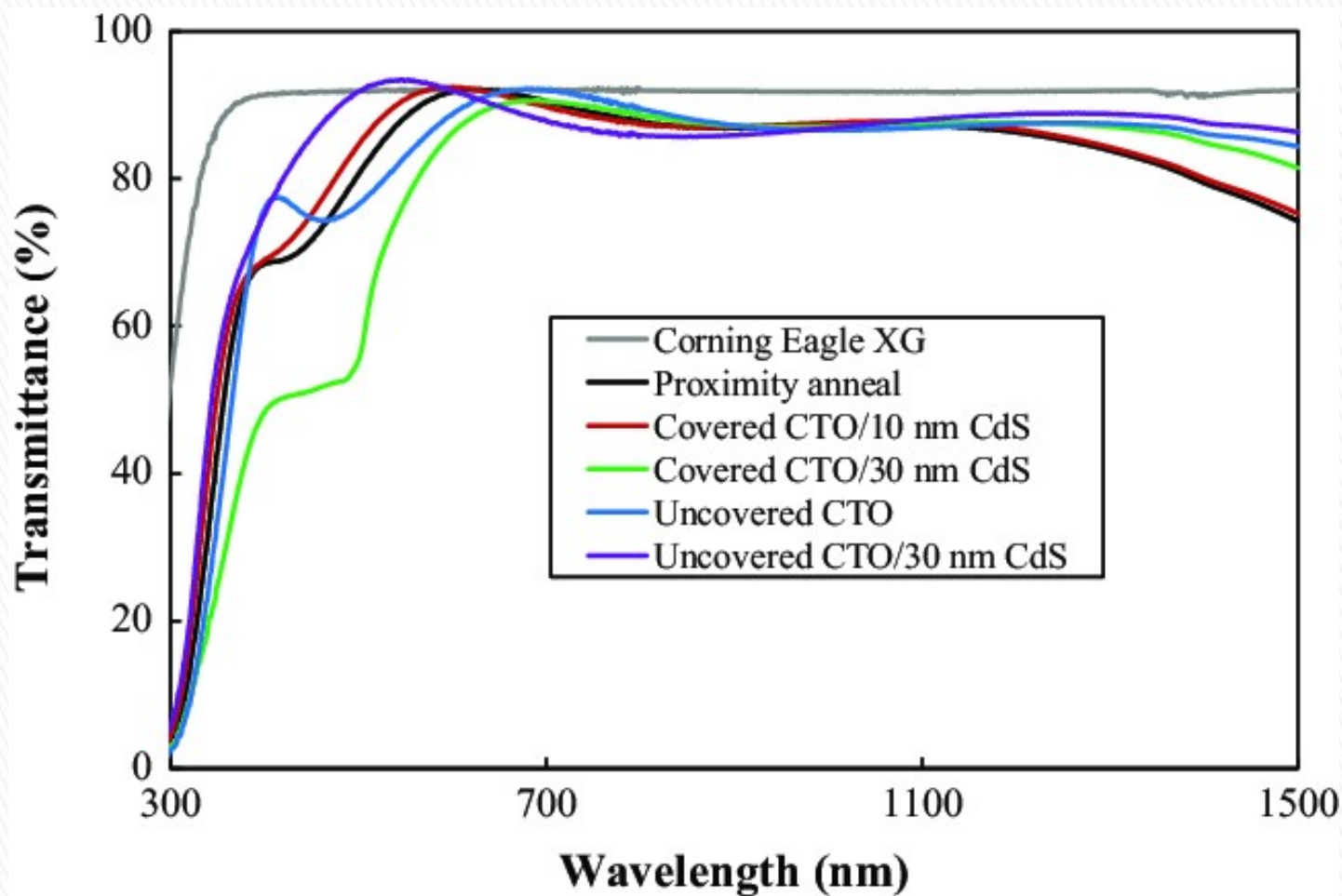
ISO Low Level이 요구 될 경우

Repetition Rate(r)  / Scan Speed(v) 

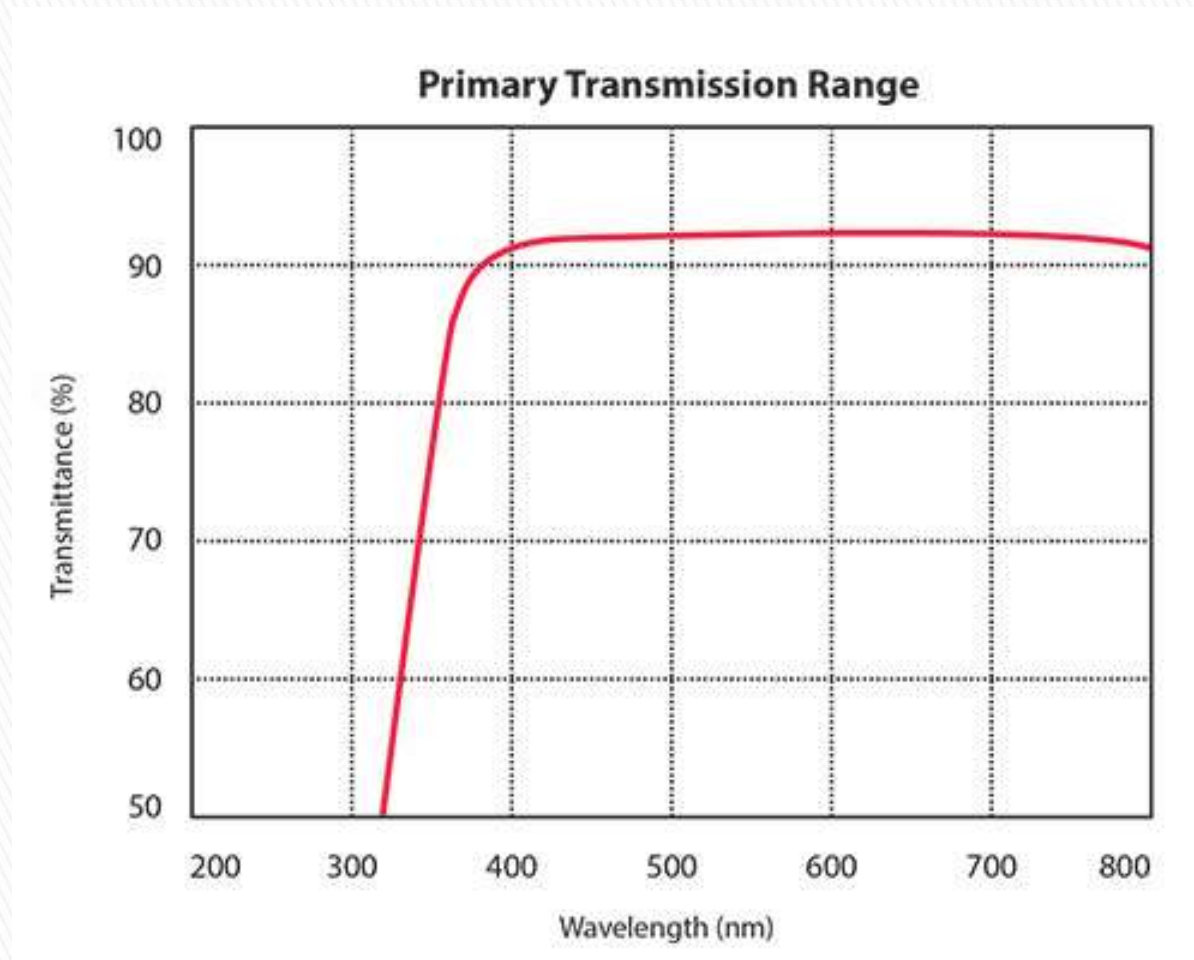
Crater, Beam waist and Fluence



Eagel XG glass and CTO glass Transmittance

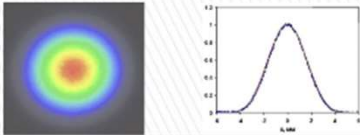
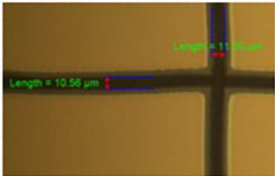
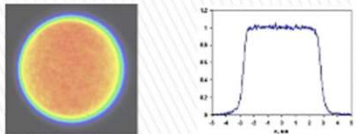
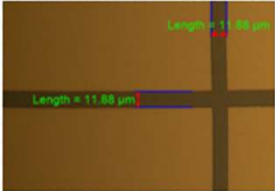
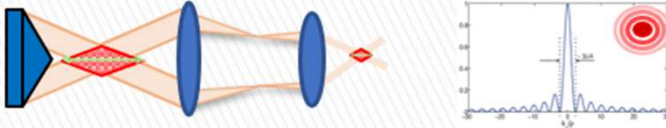
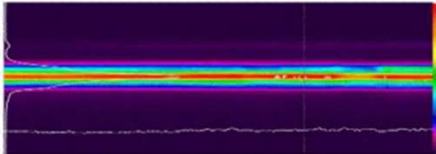


Alkali Free Boro-Aluminosilicate Glass Transmittance



Beam profile

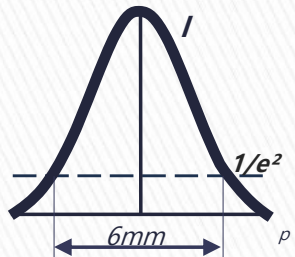


Gaussian Beam	• Typical shape of Laser Beam • Energy is concentrated in center	 Gaussian Beam Shape and Energy distribution	 Wavelength : 532nm
Tophat (Flat top Laser Beam)	• Modulated Beam of Gaussian • It have constant energy density • It make uniform Laser Processing result • Power is lower than Gaussian	 Top-Hat Beam Shape and Energy distribution	
Bessel Beam	• Beam have long focus position • It use process of Transparent material like glass, sapphire, quartz.	 Bessel Beam Diameter 2-3μm by Axicon Lens Energy distribution of Bessel Beam	 Wavelength : 1064nm
Line Beam	• Modulated Beam of Gaussian to narrow line • It use lower power, make same power density in a thin line by lower cost.		
Maskless Beam by SLM	• Light transmitted by SLM can be reshaped to desired shape • It make single laser beam to split multi beam		

Beam Shaper 기능

* after the F- π Shaper

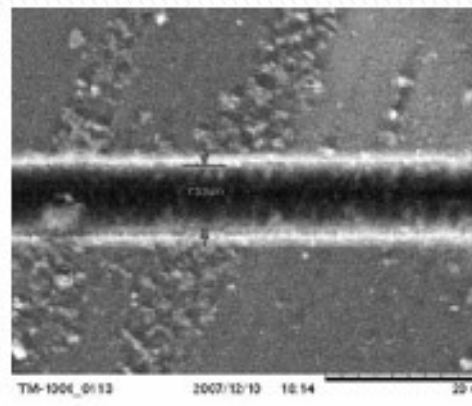
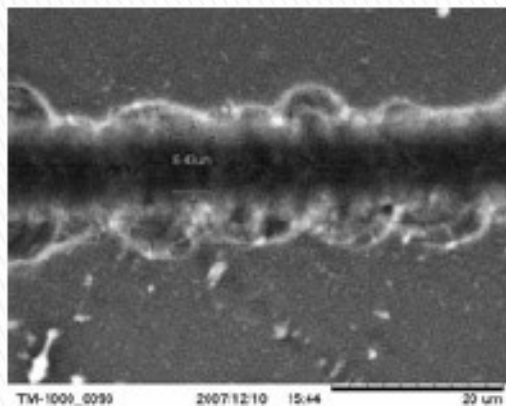
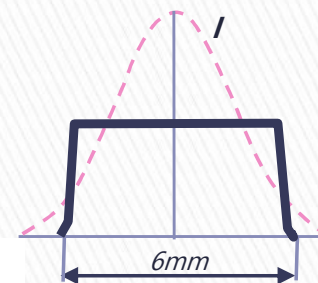
Input laser beam



π Shaper 6_ 6_ 1064



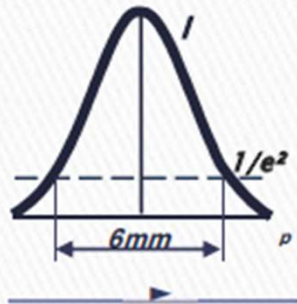
Output beam



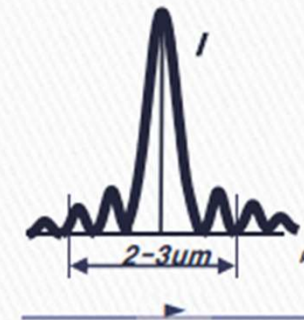
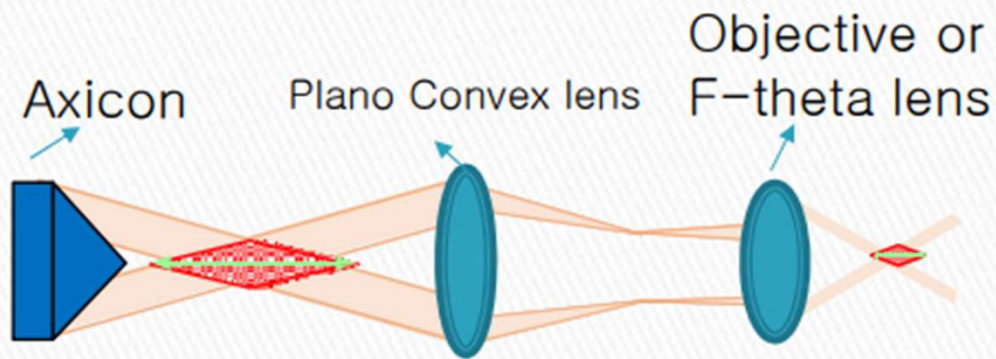
F- π Shaper 필요한 경우 alignment, system setting 등 추가 작업이 필요(10 시간 추가비용 소요)

Axicon Lens 기능

- Axicon은 원뿔 형태의 프리즘으로 alpha (α)와 apex angle로 정의됩니다.



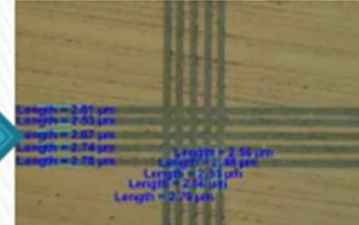
Bessel beams use a 4- f spatial filtering system that requires no specialized optical components.



Line width: 25um



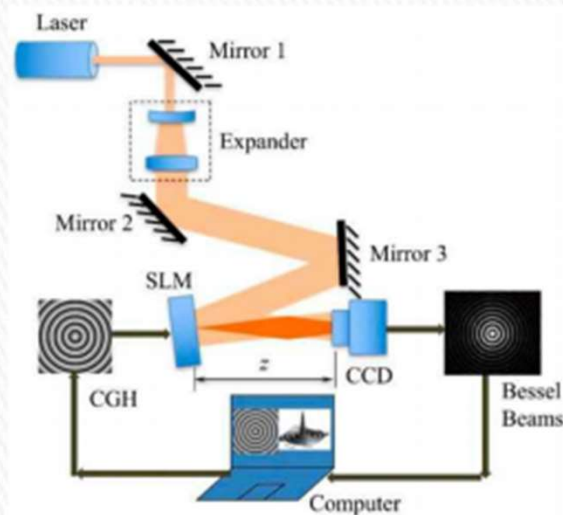
Line width: 2-3um



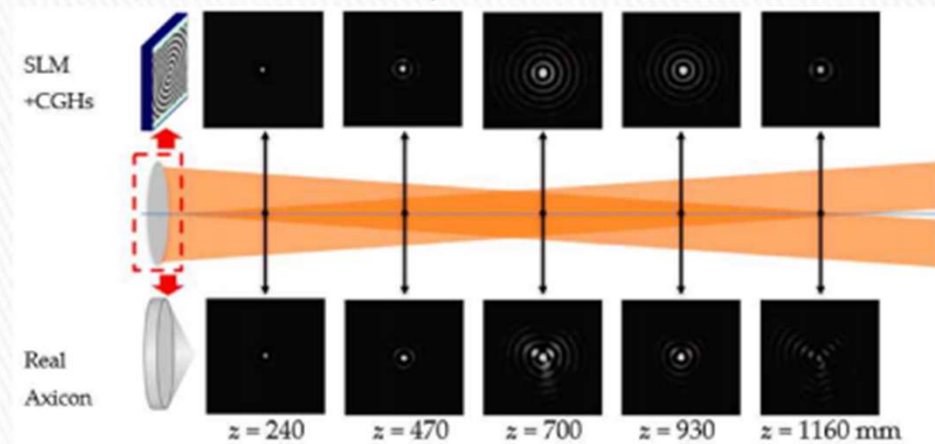
SLM(spatial light modulator) 의하여 Bessel beam 생성

- 공간 광 변조기(SLM)를 사용하여 Axicon Lens을 사용한 것과 같은 값의 Bessel Beam을 생성합니다.

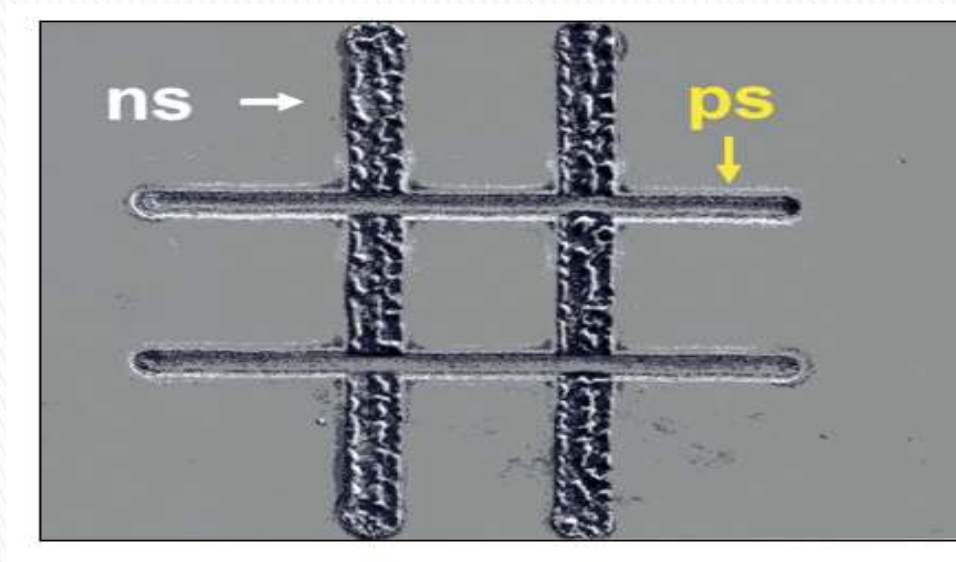
SLM set-up



Bessel beams generated by the SLM and the real axicon at different z planes.



Pico Vs. Nano Second Laser

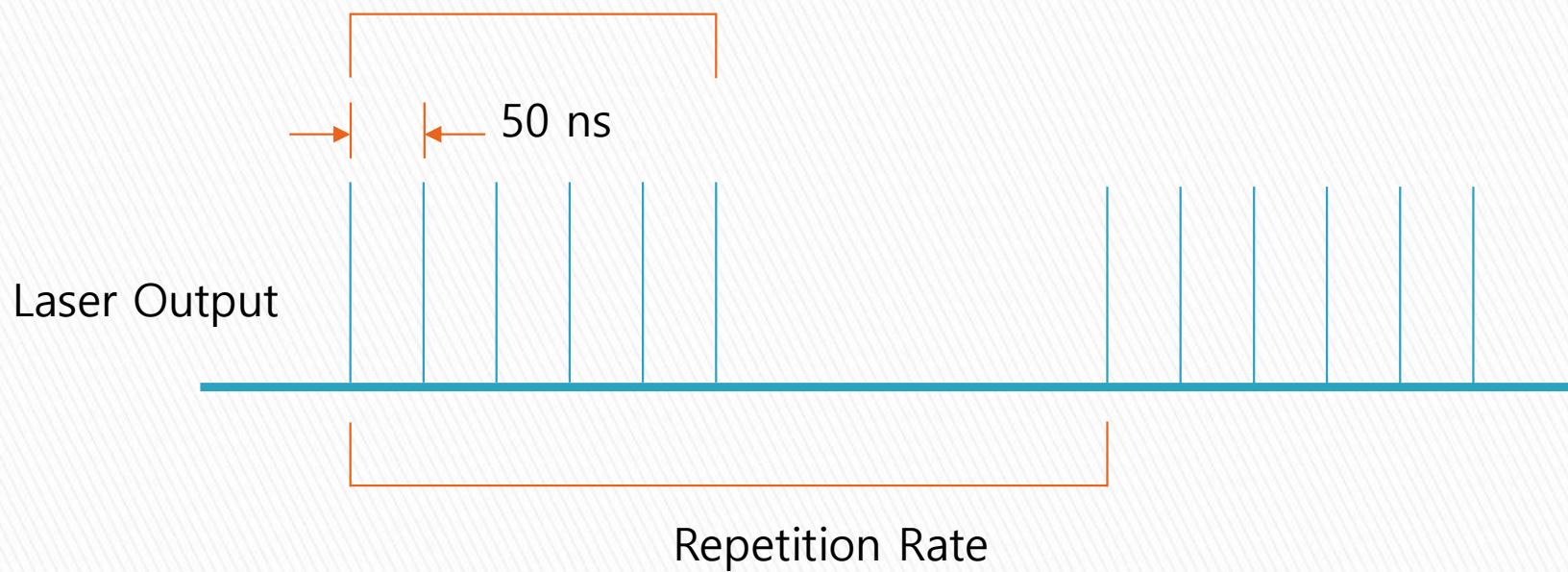




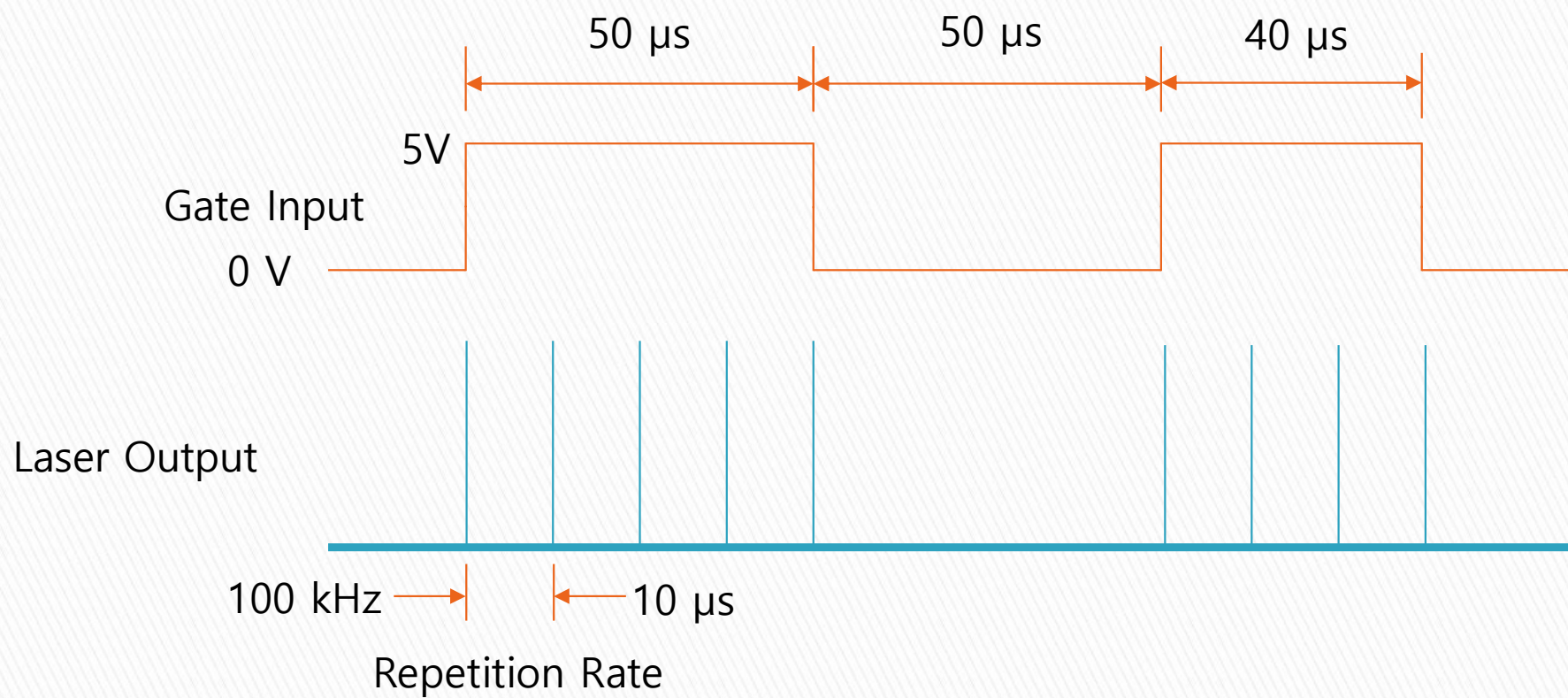
Laser Process Parameters

Process Parameter Scribing Line	Pass (#)	Scribing Speed (mm/S)	Pulse Energy (J/Pulse)	Repetition Rate (Hz)	Pulse Width (pS)	Fluence (J/cm ²)	Resistance (Ω)/Kerf Width/Beam Profile	Remark
Layer 1								
Layer 2								
Layer 3								
Layer 4								
Pulse Duration & Repetition Rate				Pico Laser	7 $\pm$ 2 pS		Repetition Rate 일정	
				Nano Laser	10~100 nS		Repetition Rate가 증가함에 따라 Pulse Width는 증가	

Burst Mode



Gate or Packet Mode



3. LASER SAMPLE TEST 진행 절차



(주)코썸사이언스

① **기술문의**
(가능여부 및 가공의 종류, 두께, 재질, wavelength choice 등)

② 견적송부

③ **가공의뢰서 & 샘플 송부**

④ **가공비용 지급**



가공 의뢰인

⑤ 가공완료

⑥ 가공시료 **현미경 촬영** (이메일송부)

⑦ 가공시료 세정(초음파 세정기)

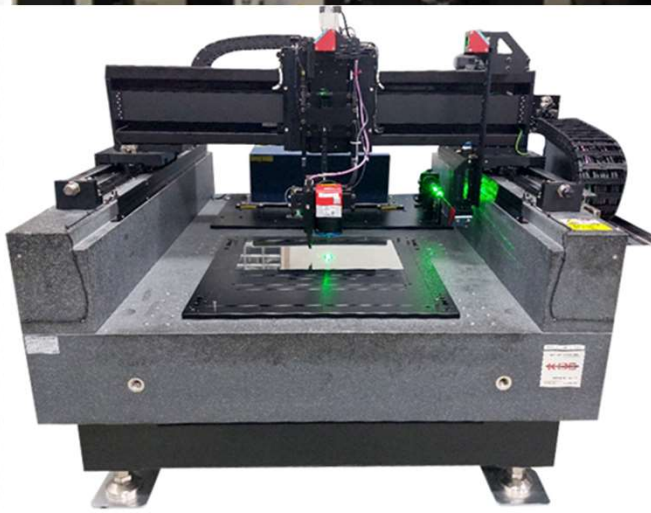
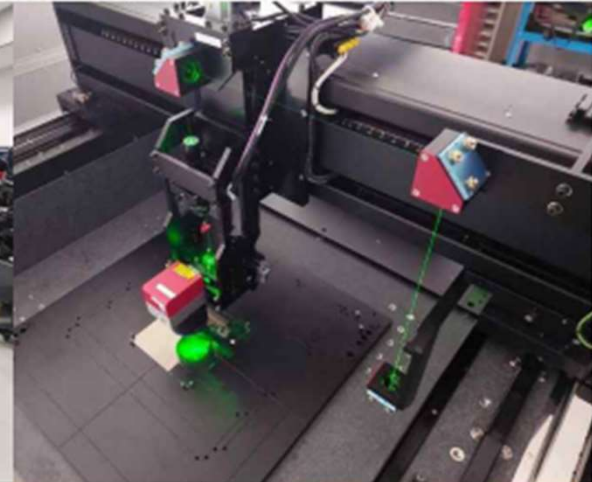
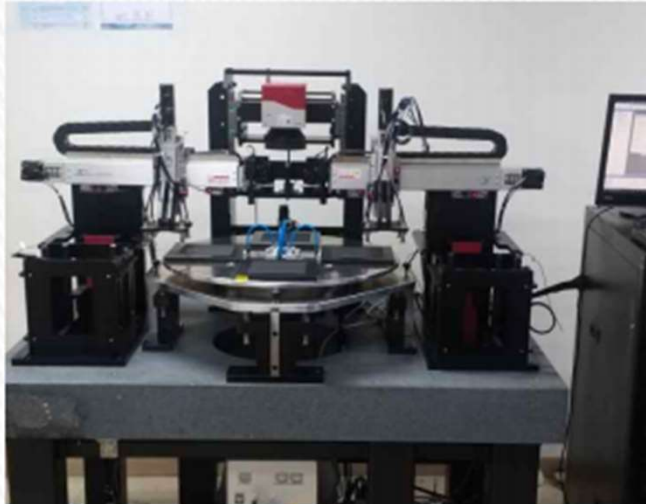
⑧ 택배송부 (납품완료)



4. LASER SAMPLE TEST 작업 종류

- ❖ Cutting
- ❖ Hole Drilling
- ❖ ITO / FTO Patterning
- ❖ Scribing
- ❖ Marking
- ❖ Film Cutting (Polymer 계열)
- ❖ Transparent materials such as Glass, Quartz, Sapphire, Fused Silica(CaF_2 , MgF_2)
- ❖ ITO/PI, ITO/PET, ZnO/PI, ZnO/PET
- ❖ Carbon, Graphene

5. 장비 및 기타사항



5. 장비 및 기타사항 – PICO Laser(UV/Green/IR)



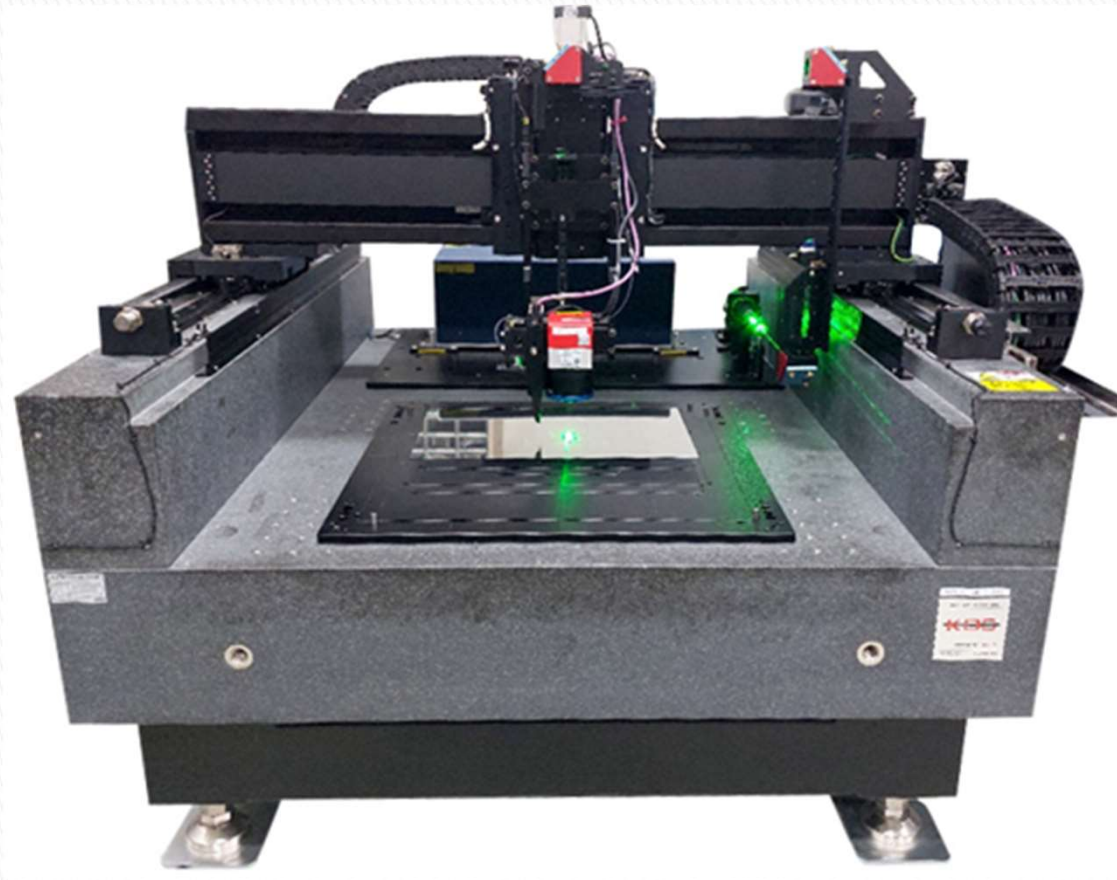
μ-FAB Picomachining System

- ❖ 3 wavelengths diode Laser
- ❖ 1064/532/355nm wavelengths
- ❖ Scribing speed: 300-5000mm/s
- ❖ Scribing width < 30um
- ❖ Assist gas and Suction system
- ❖ Auto alignment and inspection system

Applications

- | | |
|--------------------------------|-----------------------|
| - Marking | - Engraving |
| - Soldering | - Micromachining |
| - Cutting | - Micro hole drilling |
| - Scribing | - Sintering |
| - Thin film patterning | |
| - Edge isolation of solar cell | |

5. 장비 및 기타사항 – Femto Laser



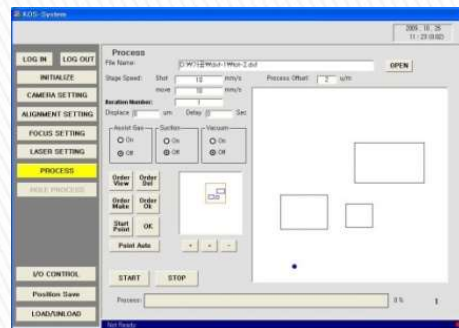
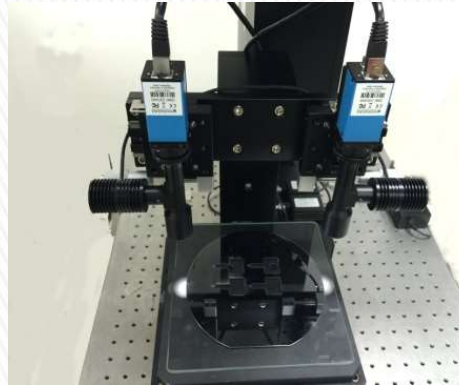
μ-FAB Femtomachining System

- ❖ Femto seconds Laser
- ❖ 1030/515 wavelengths
- ❖ Accuracy -> $\leq \pm 0.5 \mu m$
- ❖ Repeatability -> $\leq \pm 0.5 \mu m$
- ❖ IFOV(Infinite field of view) 모드 동작
- ❖ Auto alignment and inspection system
- ❖ Glass 가공 특화(TSV, TGV)

Applications

- | | |
|--------------------------------|-----------------------|
| - Marking | - Engraving |
| - Soldering | - Micromachining |
| - Cutting | - Micro hole drilling |
| - Scribing | - Sintering |
| - Thin film patterning | |
| - Edge isolation of solar cell | |

5. 장비 및 기타사항 – IR Laser



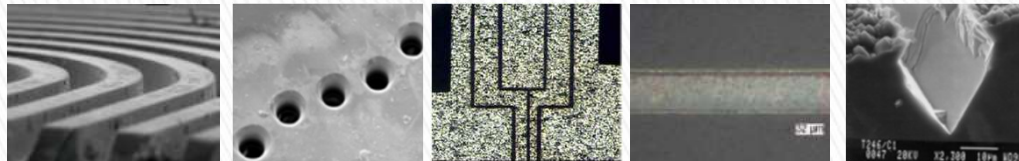
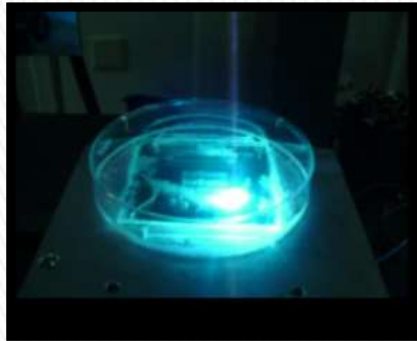
μ-LAB Microscope/Scanner

- ❖ NIR radiation : 1064 nm
- ❖ Precisely small beam control
- ❖ Compact size design
- ❖ Easy to use with a software
- ❖ Up to 20W average output power
- ❖ More than 20kW peak power
- ❖ Works in true CW or pulsed regime

Applications

- Marking
- Soldering
- Cutting
- Scribing
- Thin film patterning
- Edge isolation of solar cell
- Engraving
- Micromachining
- Micro hole drilling
- Sintering

5. 장비 및 기타사항 – 532 / 355 Laser(Nano)



μ-FAB Micromachining System

- ❖ Single Nd:YAG Laser
- ❖ 532/355nm wavelength
- ❖ Scribing speed: 300-2000mm/s
- ❖ Scribing width < 60μm
- ❖ Vacuum chuck system
- ❖ Assist gas and Suction system
- ❖ Auto alignment and inspection system

Applications

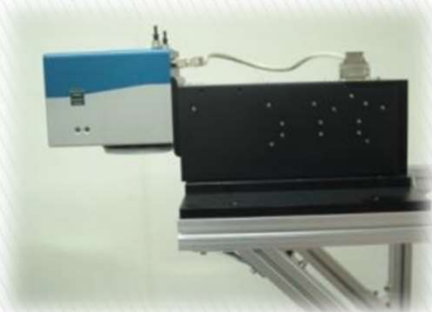
- Marking
- Soldering
- Cutting
- Scribing
- Thin film patterning
- Edge isolation of solar cell
- Engraving
- Micromachining
- Micro hole drilling
- Sintering

5. 장비 및 기타사항 – CO₂ Laser



Light from CO₂ lasers is absorbed strongly by most non-metallic materials. This makes CO₂ lasers a natural choice for cutting a wide variety of organic and plastic materials. CO₂ lasers can cut materials of varying thickness-for example, from 0.05mm for ceramic to 30mm for wood.

ABS,PET	Cotton	Polyethylene
Acrylic	Epoxy Resins	Polyimide(Kapton TM)
Alumina	Leather	Polyurethane
Aluminum Nitride	Maple	PVC
Birch	Mylar TM	Quartz
Borosilicate Glass	Nylon	Rosewood
Cardboard	Paper	Rubber
Ceramic	Plywood	Silicon
Corian TM	PMMA	Teflon TM



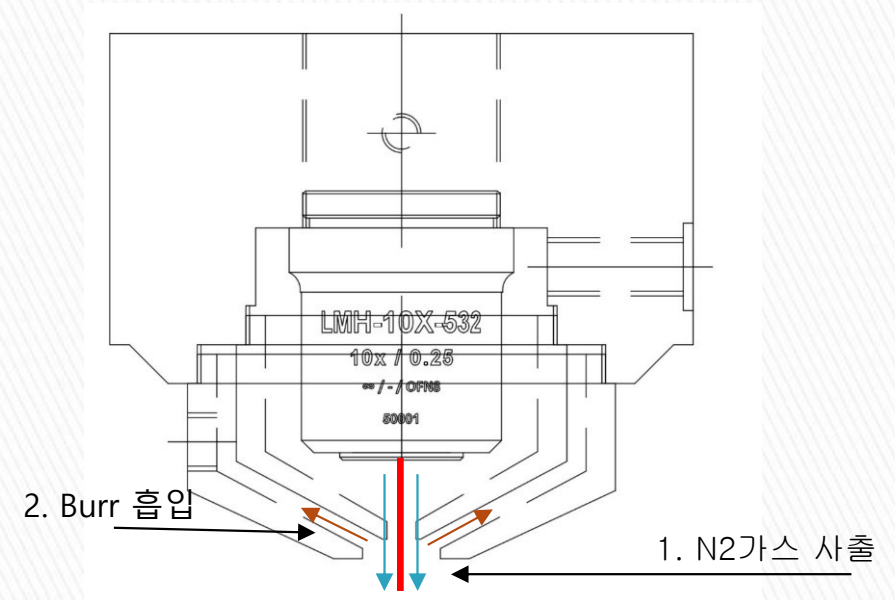
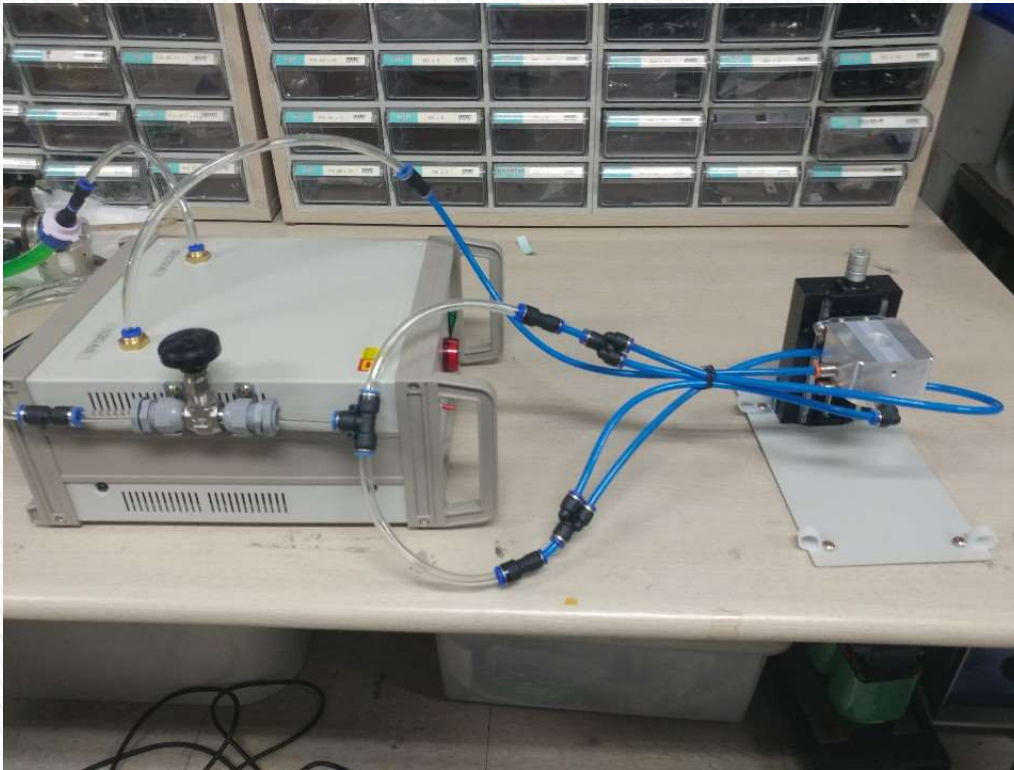
5. 장비 및 기타사항 – 초음파 세정기



물, 혹은 세척액 속 시료에 높은 주파수의 초음파를 가하여 소리의 진동으로 시료에 묻은 이물질을 제거하는 장비

- ❖ 진동 주파수: 40KHz
- ❖ HEATER: 1℃~80 ℃(1 ℃씩 변경 가능)
- ❖ 세정조 규격: 300X150X150 m/m

5. 장비 및 기타사항 – Extraction Nozzel



- Fixed Optic 모드로 레이저 가공 시 가공 부위에 N2가스를 사출하여 Burr를 날리는 동시에 흡입하는 장비

- 레이저 빔 조사 시에만 작동하기 때문에 N2가스를 절약할 수 있음

5. 장비 및 기타사항 – Laser Jig



두께 100 μ m 이하의 얇은 필름 소재 샘플이
가공 도중 밑으로 쳐지는 것을 방지하는 장비
→ 필름류 소재 가공 시 샘플의 품질 향상

5. 장비 및 기타사항 – APPLICATIONS

❖ Photovoltaic Applications – Thin Film

- Scribing P1, P2, P3
- Edge Deletion P4

❖ Photovoltaic Applications – c-Si

- Edge Isolation
- Doping / Diffusion
- Data-Matrix marking
- Metal Wrap Through
- Selective Emitter

❖ Semiconductor

- Dicing
- Via drilling(TGV, TSV)
- Thin film ablation

❖ Microelectronic

- PCB cutting, drilling
- Depanelling

❖ Ceramic

- Cutting
- Engraving / cavity
- Drilling

❖ Polymer / Polyimide

- Cutting
- Drilling
- Texturing

❖ Metal

- Deep engraving / 3D
- Drilling
- Texturing

❖ Films

- Cutting
- Ablation

❖ Carbon - Graphene

- Cutting
- Drilling



5. 장비 및 기타사항 – LASER SPECIFICATION

❖ ND-YAG (DPSS) LASER (fS)

- 515nm(10W) / 1030nm(20W)

❖ ND-YAG (DPSS) LASER (nS)

- 355nm(10/20W) / 532nm(12W) / 1064nm(20W)

❖ CO₂ LASER

- 10.6 μ m / 9.35 μ m / 9.4 μ m

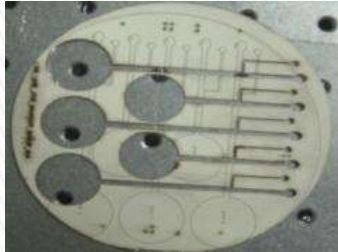
❖ ND-YAG (DPSS) LASER (pS)

- 355nm(30W) / 532nm(45W) / 1064nm(90W)

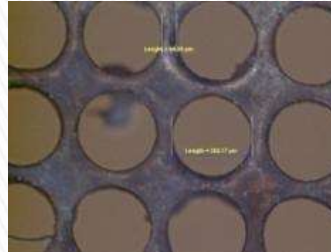
❖ EXCIMER LASER

- 193nm / 248nm

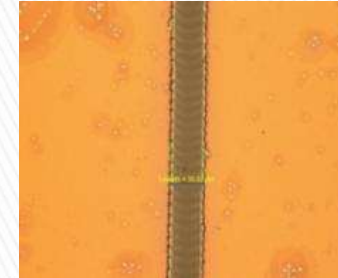
6. 가공 예시 – Nano _ Polymer (1)



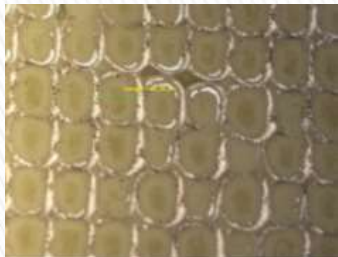
Cutting of polymer
Wavelength: 1064nm
Pulse energy:
Rep rate: 40kHz
Proceeding speed :
300mm/s



**Hole Drilling
(on the PI film)**
Wavelength: 355nm



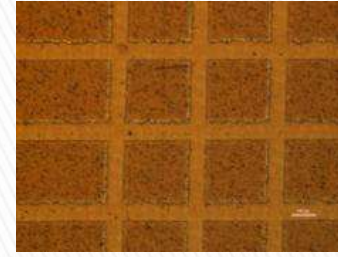
**Scribing of
IMI film on Glass**
Wavelength: 532nm
Pulse energy:
Rep rate: 30kHz
Proceeding speed :
500mm/s



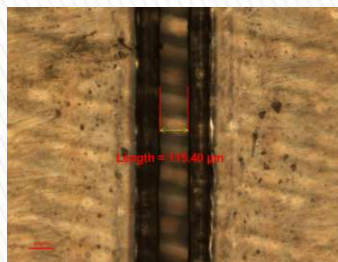
Film Release
Wavelength: 532nm



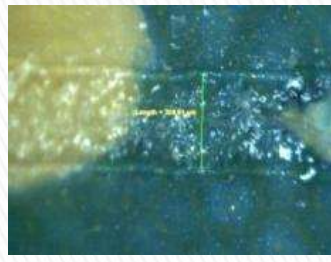
**FTO Patterning
(FTO on glass)**
Wavelength:
1060nm



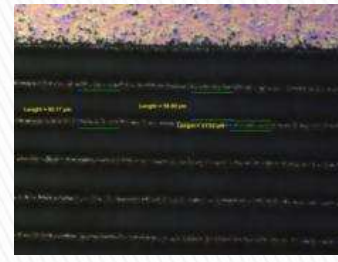
**FTO Patterning
(on the PI film)**
Wavelength:
1080nm



PET Film Cutting
Wavelength: 10.6 μm



PET Easy Cut
Wavelength: 355nm

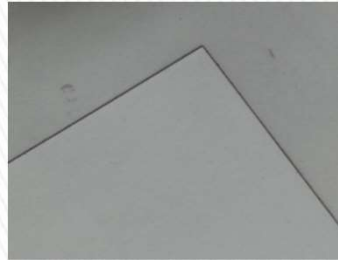


**ITO Patterning
(on the PET film)**
Wavelength: 355nm

6. 가공 예시 – Nano _ Polymer (2)



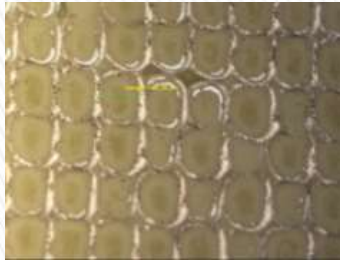
PET Film Cutting
Wavelength: 355nm



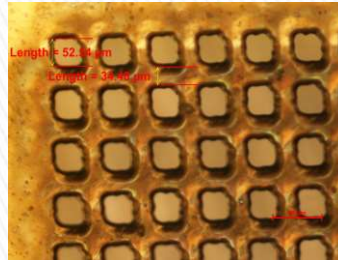
PET Film Cutting
Wavelength: 355nm



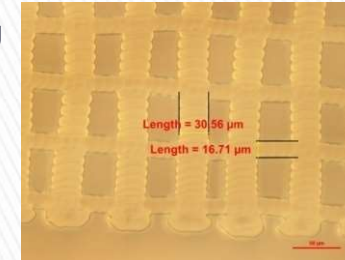
**FTO Release
(FTO on glass)**
Wavelength: 355nm



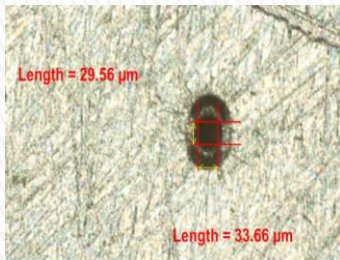
Polyimide Film Release
Wavelength: 532nm



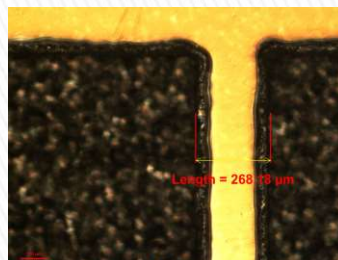
Polyimide Film Cutting
Wavelength: 355nm



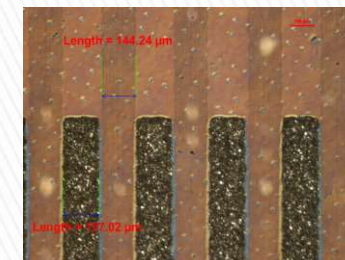
**ITO Scribing
(Including Ag)**
Wavelength: 355nm



ABS Hole Drilling
Wavelength: 355nm
Thickness: 2.8mm

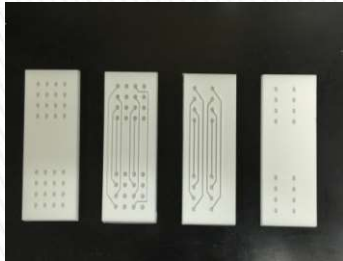


**Polaroid Film
Patterning**
Wavelength: 355nm

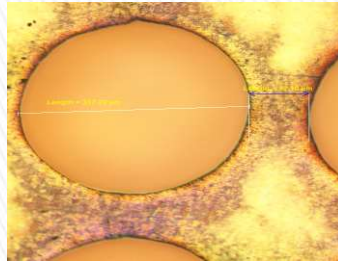


**ITO Scribing
(Ag Including)**
Wavelength: 355nm

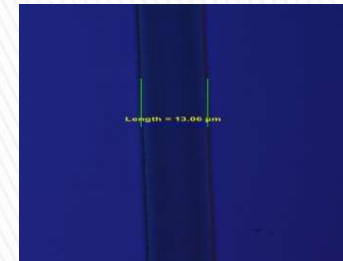
6. 가공 예시 – Nano _ Polymer (3)



Acrylic Resin Patterning
Wavelength: 10.6 μm
Thickness: 5mm



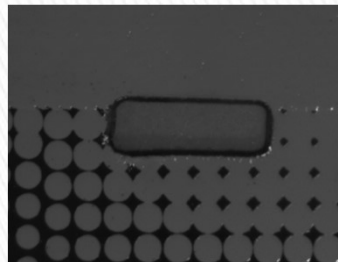
PI Film Drilling
Wavelength: 355nm



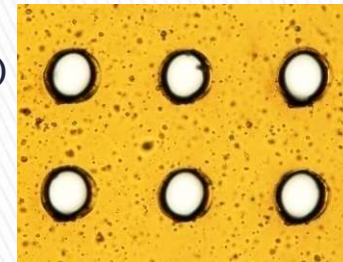
ITO Patterning
Wavelength: 1,080nm
(PICO Laser)



PMMA Cutting
Wavelength: 10.6 μm



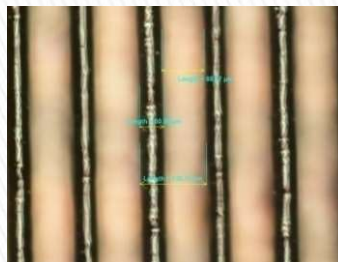
**Ag Film Punching
(Ag & Polymer Film)**
Wavelength: 10.6 μm



PI Film Drilling
Wavelength: 355nm



FTO Scribing
Wavelength: 532nm

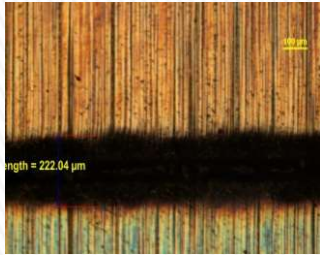


**Polymer Deposition
Thin-film Patterning**
Wavelength: 355nm

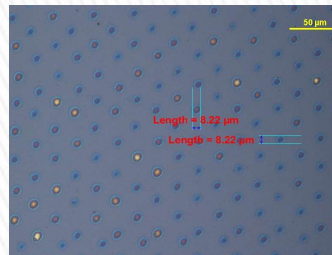


ITO Scribing
Wavelength: 1,080nm

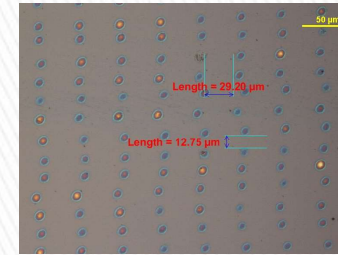
6. 가공 예시 – Nano _ Polymer (4)



Al+Pet Scribing
Wavelength:
532nm

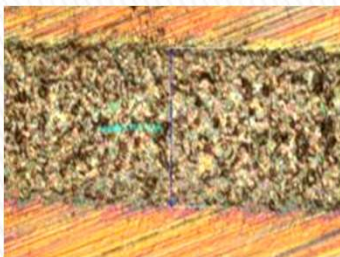


ITO+Glass Scribing
Wavelength:
355nm



ITO+Glass Scribing
Wavelength:
355nm

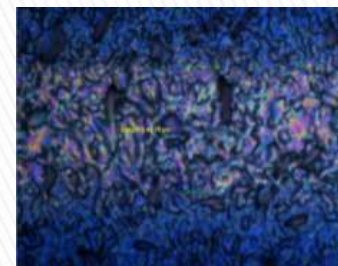
6. 가공 예시 – Nano _ Wafer (Si/Ceramic) (1)



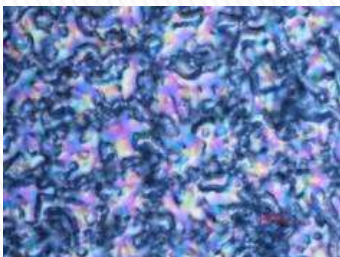
Scribing of Ceramic
Wavelength: 1080nm



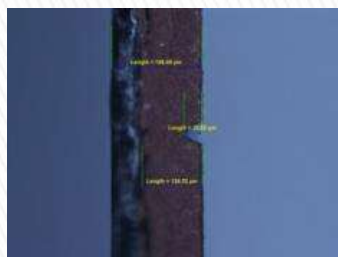
**Solar cell Wafer
Edge isolation**
Wavelength : 532nm



**Solar Cell
Wafer Doping**
Wavelength: 532nm



Wafer Doping
Wavelength : 532nm



**Ceramic Film
Patterning**
Wavelength: 532nm



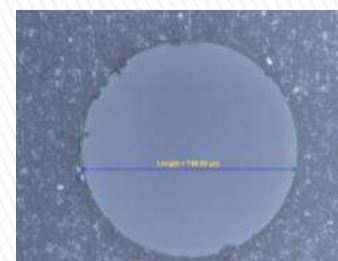
LED CELL
Wavelength: 532nm



Si Wafer Drilling
Wavelength : 532nm

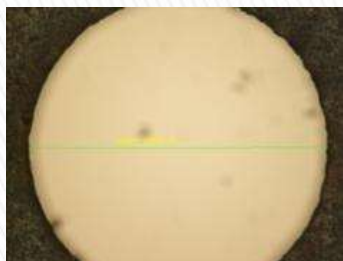


**Si Wafer Align Key
Marking**
Wavelength: 355nm



Ceramic Hole
Wavelength: 10.6 μm

6. 가공 예시 – Nano _ Wafer (Si/Ceramic) (2)



Drilling of Si-Wafer

Wavelength: 1064nm
Pulse energy:
Rep rate: 10kHz
Proceeding speed :
20mm/s



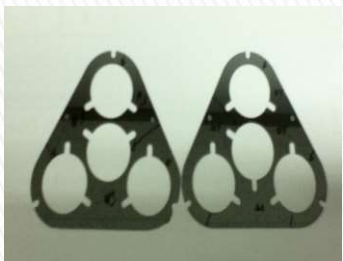
Si Wafer Round Cutting

Wavelength: 532nm
Thickness: 520 μ m



Edge Isolation of Si Solarcell

Wavelength: 1064nm
Pulse energy:
Rep rate: 500kHz
Proceeding speed :
2m/s



Si Wafer Pattern Cutting

Wavelength: 532nm



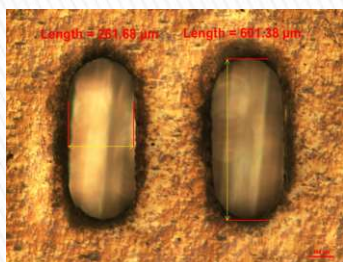
Removal of TCO on CIGS + Mo+Glass

Wavelength: 1064nm
Pulse energy:
Rep rate: 500kHz
Proceeding speed :
2m/s



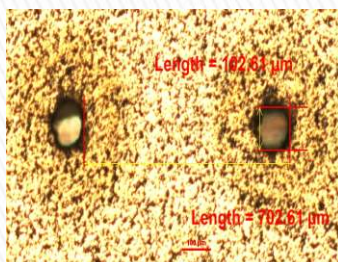
Removal of CIGS on Mo+Glass

Wavelength: 1064nm
Pulse energy:
Rep rate: 500kHz
Proceeding speed :
2m/s



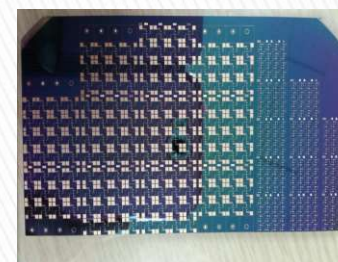
Silicone Sheet Hole Drilling

Wavelength: 355nm



AlN Wafer Hole Drilling

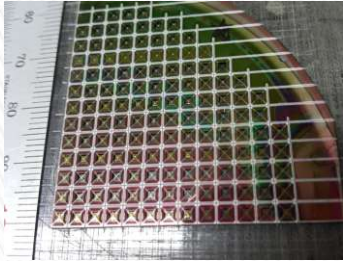
Wavelength: 355nm



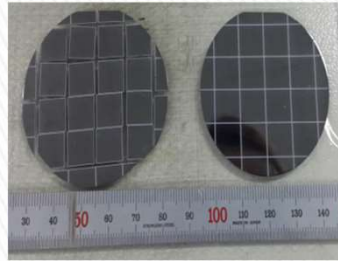
Si Wafer Pattern Cutting

Wavelength: 532nm

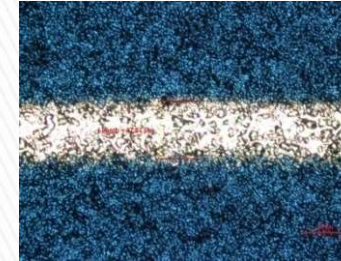
6. 가공 예시 – Nano _ Wafer (Si/Ceramic) (3)



Patterned Si-Wafer Cutting (Membrane Pattern)
Wavelength: 355nm



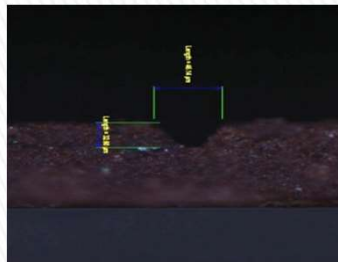
Si Wafer Full Cutting
Wavelength: 532nm



ARC Ablation (Anti-Reflective Coating)
Wavelength: 355nm



LGBC Scribing (Laser Grooved Buried Contracts)
Wavelength: 355nm



Green Sheet Scribing (Unfired Ceramic Sheet)
Wavelength: 532nm



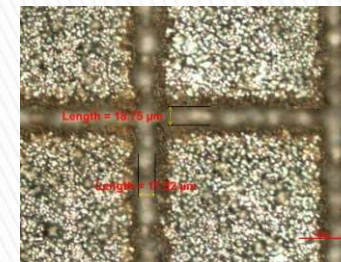
Si Wafer Cutting
Wavelength: 532nm



Fired Ceramic Sheet (Via Hole)
Wavelength: 355nm

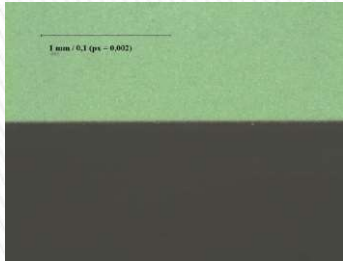


Si Wafer Patterning
Wavelength: 532nm



Si Wafer Scribing (Scanner Type)
Wavelength: 532nm

6. 가공 예시 – Nano _ Wafer (Si/Ceramic) (4)



**Ceramic Cutting
(Ni Oxide + YSZ)**
Wavelength: 1064nm



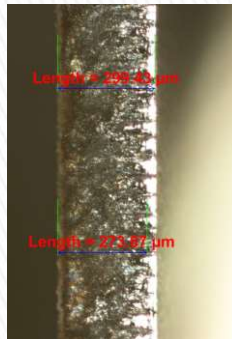
**Ceramic Cutting
(Ni Oxide + YSZ)**
Wavelength: 1064nm



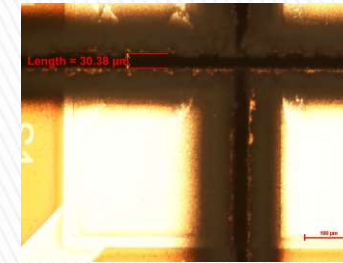
**Si Wafer Round
Cutting**
Wavelength: 532nm



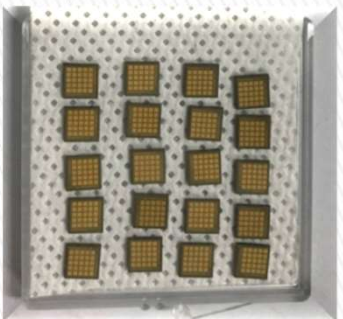
**Si Wafer Hatching
Patterning**
Wavelength: 355nm



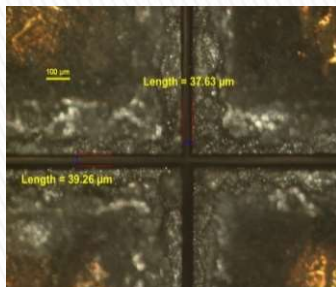
**Si Wafer Full Cutting
(Cross-Section)**
Wavelength: 532nm
Thickness: 0.3mm



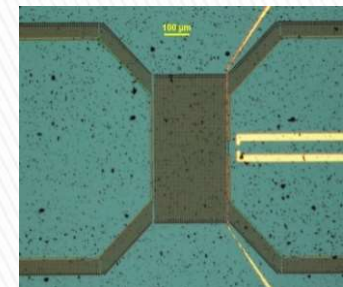
**Si Wafer Cutting
(Membrane Pattern)**
Wavelength: 532nm



**Ceramic+Si
Wafer Cutting**
wavelength:532nm



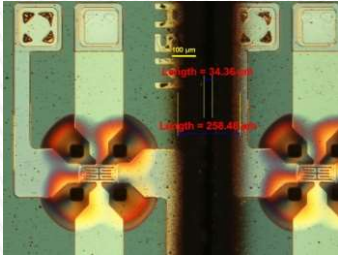
**Bi₂Te₃ Pattern
Cutting**
wavelength:532nm



SOI Wafer Cutting
wavelength:532nm



6. 가공 예시 – Nano _ Wafer (Si/Ceramic) (5)



Si Wafer Cutting
Wavelength: 532nm



SiC Wafer Cutting
Wavelength: 355nm
Thickness: 0.6mm

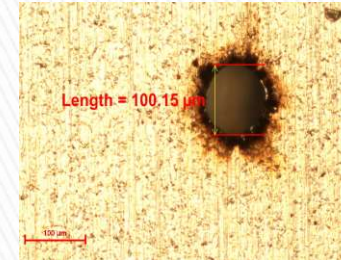
6. 가공 예시 – Nano _ Metal/Ferrite (1)



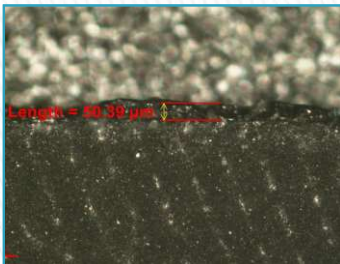
Via Hole
Wavelength: 355nm



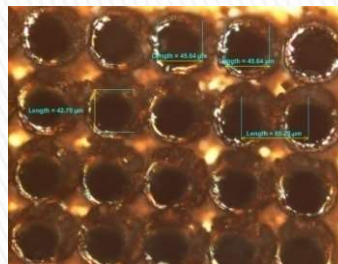
Metal on PET
Wavelength: 10.6μm



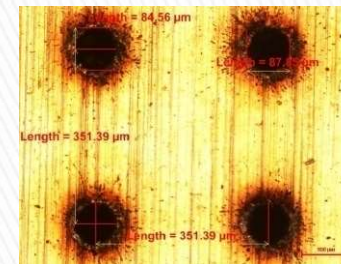
**SUS Thin Film
Hole Drilling**
Wavelength: 355nm



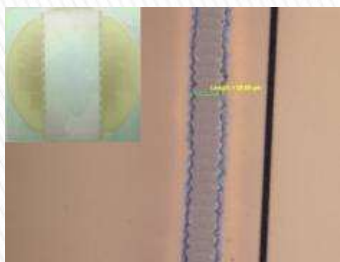
**Ferrite Compound
Cutting
(Cross-Section)**
Wavelength: 355nm
Thickness: 150μm



Metal Hole Drilling
Wavelength: 355nm



Cu Thin Film Drilling
Wavelength: 355nm



**Scribing of ZnO
on glass**
Wavelength: 532nm

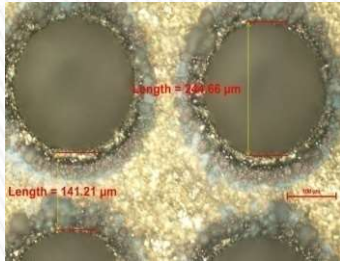


**Mo Scribing
(Solar Cell Thin Film)**
Wavelength: 532nm

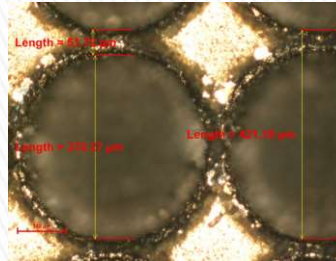


**Removing of
ZnO on Glass**
Wavelength: 355nm
Pulse energy:
Rep rate: 30kHz
Proceeding speed :
200mm/s

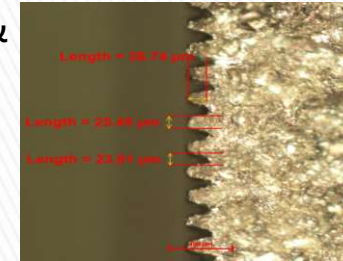
6. 가공 예시 – Nano _ Metal/Ferrite (2)



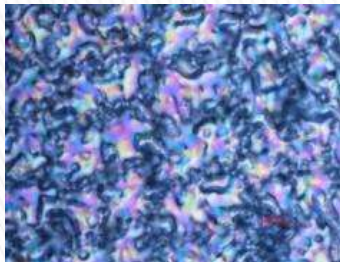
**Tungsten-Carbide
Hole Drilling
(Via Hole)**
Wavelength: 355nm



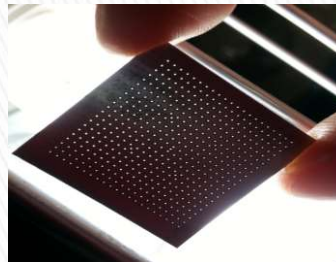
**Tungsten-Carbide &
Nickel Complex
Hole Drilling
(Via Hole)**
Wavelength: 355nm



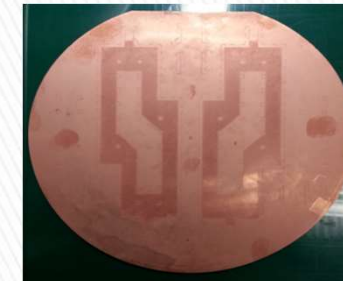
Mg Surface Patterning
Wavelength: 355nm



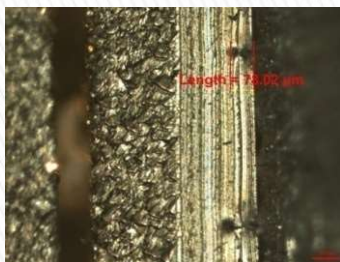
Wafer Doping
Wavelength : 532nm



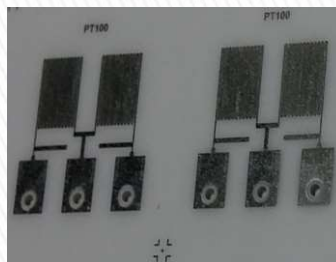
**Tantalum (Ta)
Hole Drilling**
Wavelength: 532nm



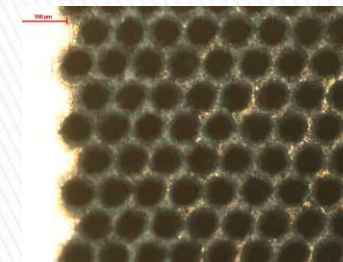
Cu Wafer Cutting
Wavelength: 532nm



**Gold Thin Film
Patterning
(Inner Transparent
& Flexible PDMA
Film)**
Wavelength: 532nm

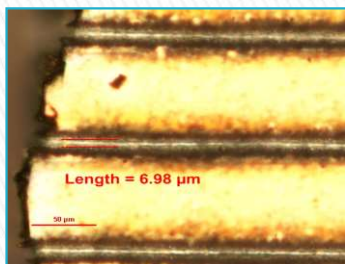


**Aluminium Oxide
Wafer Hole Drilling**
Wavelength: 355nm

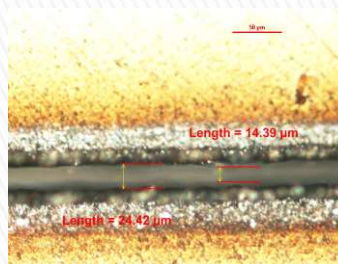


**Mo (Molybdenum)
Thin Film Hole Drilling**
Wavelength: 355nm

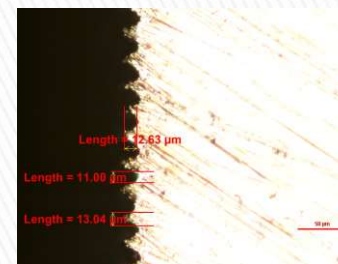
6. 가공 예시 – Nano _ Metal/Ferrite (3)



SUS Scribing
Wavelength: 355nm



Invar Steel (Fe-Ni) Scribing
Wavelength: 355nm



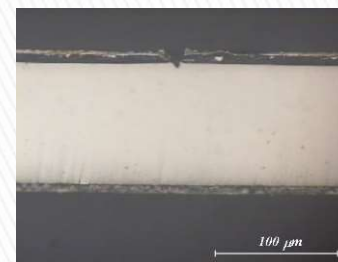
SUS420J2 Scribing
Wavelength: 355nm



Cathode/Anode Electrode Cutting (Copper & Aluminium)
Wavelength: 355nm
Thickness: 25μm



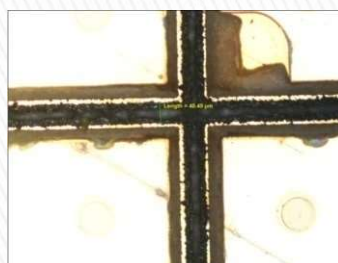
Pure Mg Cutting (Magnesium)
Wavelength: 355nm



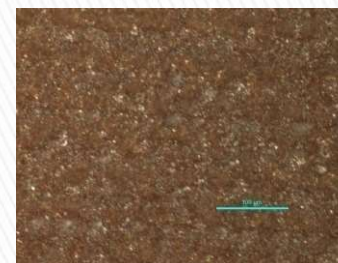
Ag Coated GdBCO on STS Cutting (Cross-Section)
Wavelength: 355nm



Aluminium Through Line Patterning
Wavelength: 532nm

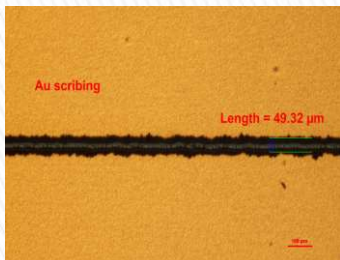


Metal Oxide Film Ablation
Wavelength: 532nm

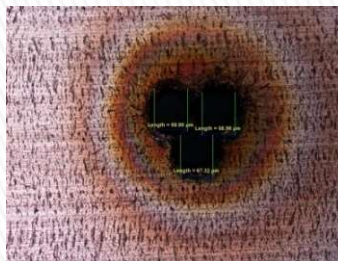


Si Wafer Metal Layer Ablation
Wavelength: 355nm

6. 가공 예시 – Nano _ Metal/Ferrite (4)



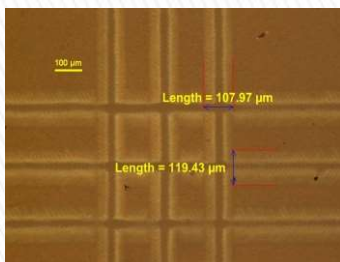
Au Pad Full Scribing
Wavelength: 355nm



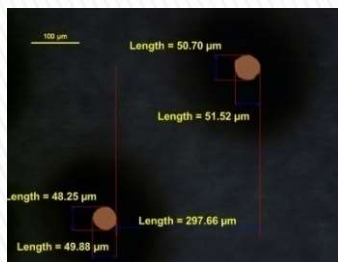
Copper Foil Hole Drilling
Wavelength: 532nm



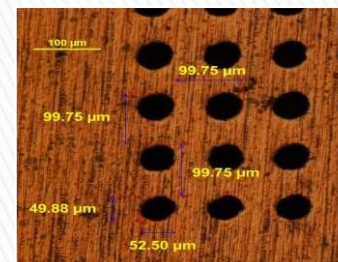
Back Electrode Film Ablation (ZnO on the Glass)
Wavelength: 355nm



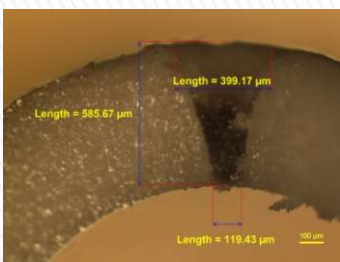
Ag Nano Wire Thin-film Scribing
Wavelength: 1064nm



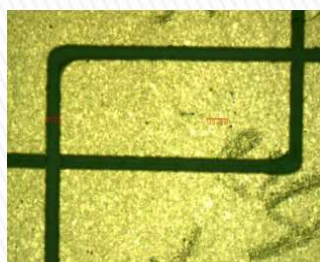
Cu Hole Drilling
Wavelength: 355nm
Thickness: 0.1mm



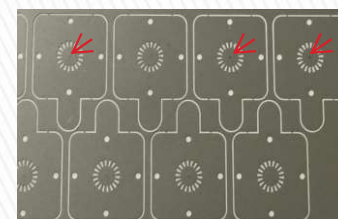
SUS Hole Drilling
Wavelength: 355nm
Thickness: 0.1mm



Alumina Tube Hole Drilling
Wavelength: 10.6μm

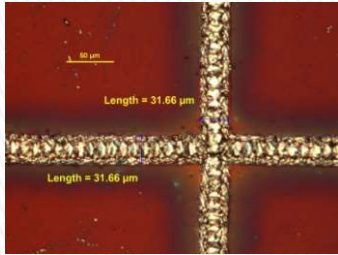


Metal Film Patterning
Wavelength: 355nm

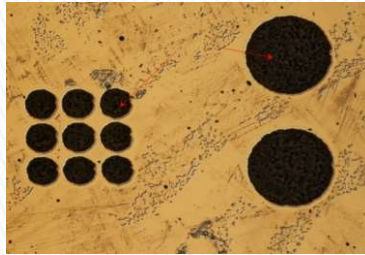


SUS304 Hole Drilling
Wavelength: 355nm

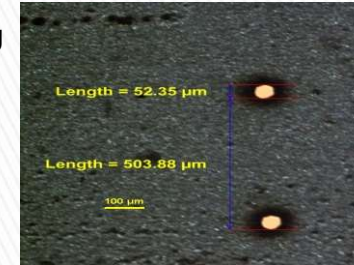
6. 가공 예시 – Nano _ Metal/Ferrite (5)



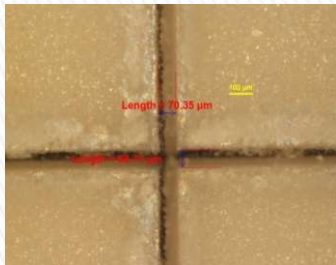
Mo Thin Film Scribing
Wavelength: 532nm



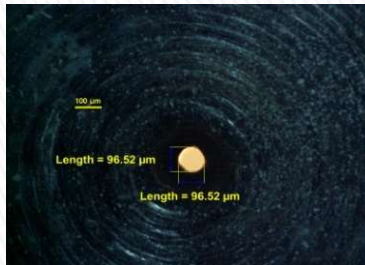
Mo Thin Film Drilling
Wavelength: 532nm



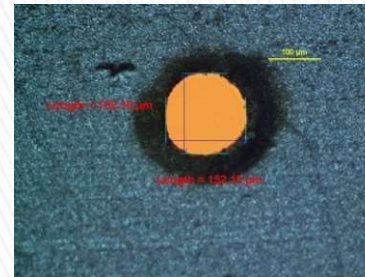
SPCu Hole Drilling
Wavelength: 355nm



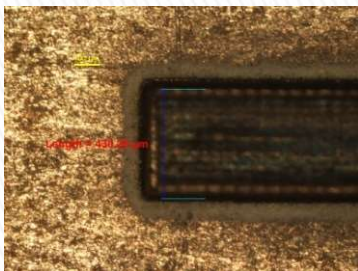
Al Plate Cutting
Wavelength: 532nm



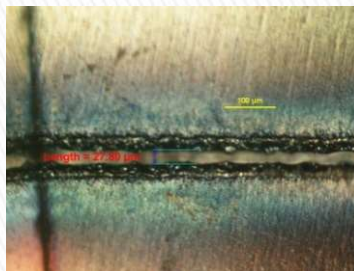
SUS Hole Drilling
Wavelength: 532nm



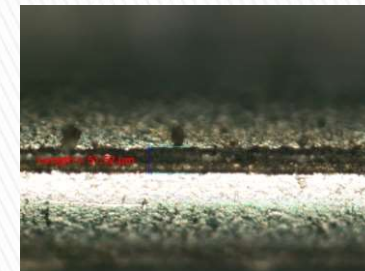
Cu + Ag Hole Drilling
Wavelength: 355nm



Cu Scribing
Wavelength: 532nm



SUS Cutting
Wavelength: 355nm
Thickness: 0.01mm



Needle Scribing
Wavelength: 355nm



6. 가공 예시 – Nano _ Metal/Ferrite (6)

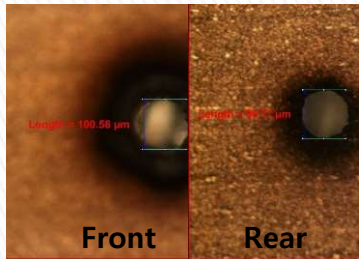


SUS Cutting

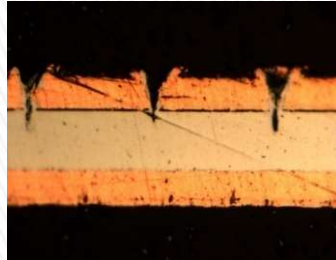
Wavelength: 355nm

Thickness: 0.1mm

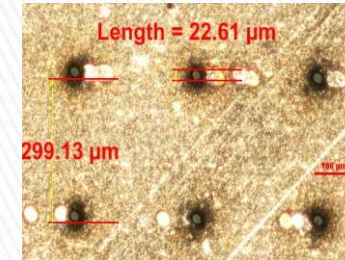
6. 가공 예시 – Nano _Superconductor. (1)



**Superconductor
GdBCO Thin Film Hole
Drilling
(Through Hole)**
Wavelength: 355nm

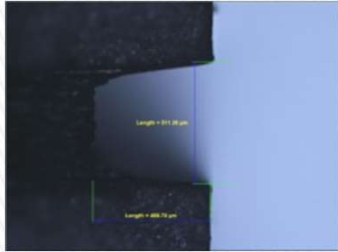


**Superconductor
GdBCO Thin Film
Scribing
(Cross-Section)**
Wavelength: 355nm



**Superconductor
GdBCO Thin Film Hole
Drilling
(Through Hole)**
Wavelength: 355nm

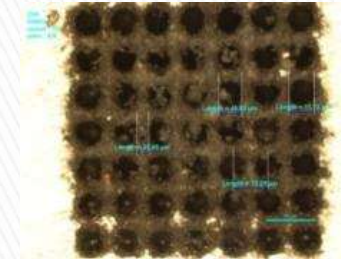
6. 가공 예시 – Nano _ Carbon/Glass/Diamond/Quartz. (1)



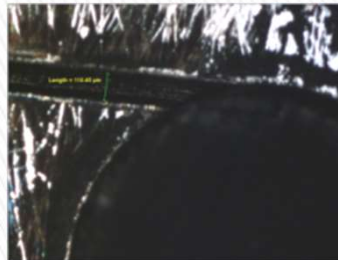
Graphite Patterning
Wavelength: 355nm



Scribing of Glass
Wavelength: 532nm
Pulse energy:
Rep rate: 30kHz
Proceeding speed :
200mm/s



**Hole Drilling
on the Aluminium**
Wavelength : 355nm



**Artificial
Diamond Patterning**
Wavelength: 532nm



Glass Patterning
Wavelength: 355nm



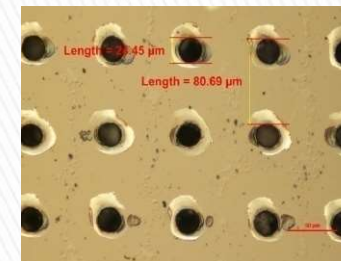
Quartz Patterning
Wavelength: 355nm



Graphene Cutting
Wavelength: 355nm

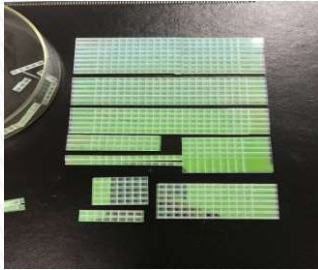


**Carbon Disk
Hole Drilling
(100% Carbon)**
Wavelength: 355nm

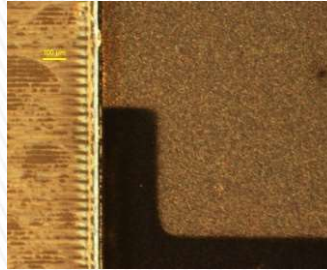


**Quartz Hole Patterning
(Via Hole)**
Wavelength: 355nm

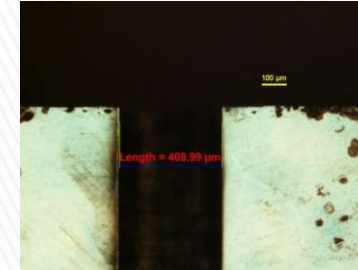
6. 가공 예시 – Nano _ Carbon/Glass/Diamond/Quartz. (2)



Quartz Glass Cutting
wavelength: 532nm



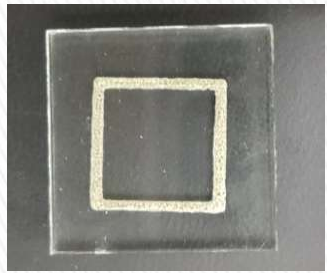
Al+Mo ITO Glass Scribing
wavelength: 532nm



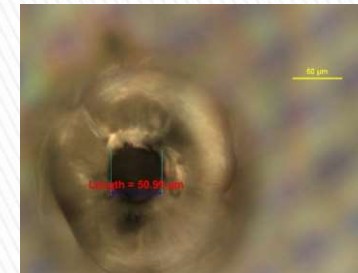
Diamond Pattern Scribing
wavelength: 532nm



Glass Hole Drilling
wavelength: 355nm
Thickness: 4mm



Glass Welding
wavelength: 1080nm



Glass Hole Drilling
wavelength: 355nm

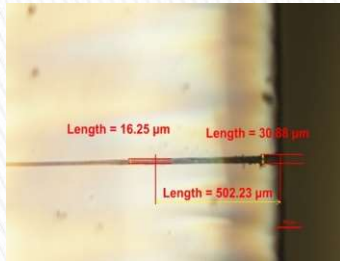


Glass Cutting
wavelength: 355nm

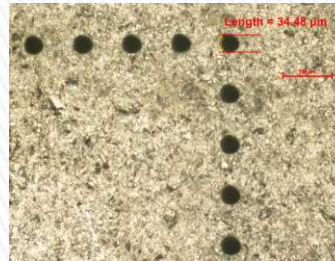


Non-Alkali Glass Cutting
wavelength: 355nm

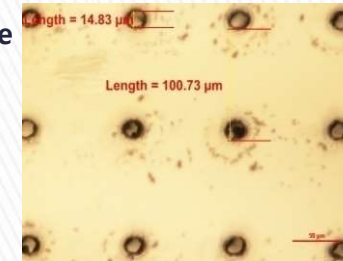
6. 가공 예시 – Nano _ Transparent materials. (1)



Quartz Micro-Hole Drilling (Cross-Section)
Wavelength: 355nm



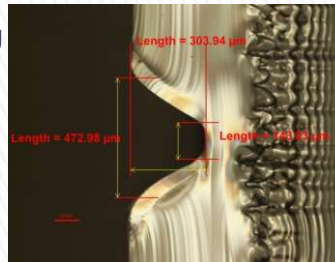
Sapphire Micro-Hole Drilling
Wavelength: 355nm
Thickness: 420μm



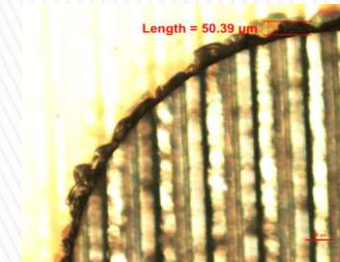
Soda-Lime Glass Hole Scribing (Via Hole)
Wavelength : 355nm



Epoxy Resin Patterning
Wavelength: 10.6μm



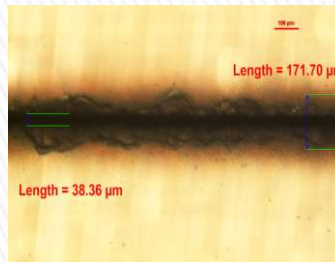
Quartz Scribing
Wavelength: 10.6μm



Flexible Gorilla Glass Cutting
Wavelength: 355nm



Slide Glass Cutting
Wavelength: 355nm

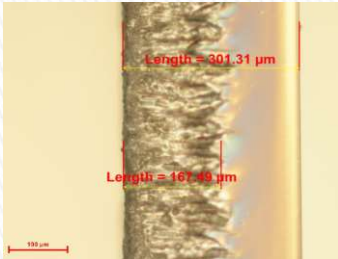


Glass Full Cutting
Wavelength: 355nm



PC Hole Drilling
Wavelength: 355nm
Thickness: 4mm

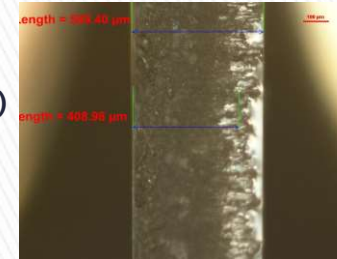
6. 가공 예시 – Nano _ Transparent materials. (2)



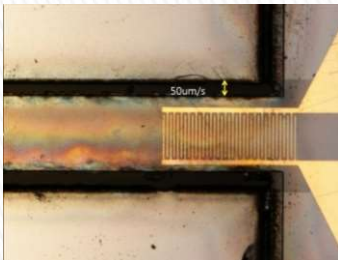
**Sapphire Wafer Cutting
(Cross-Section)**
Wavelength: 355nm



**Gold/Pt/CVD Diamond
Pattern Scribing
(Using Edge Alignment)**
Wavelength: 355nm



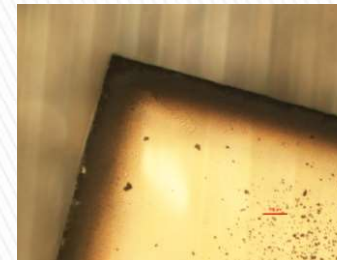
Glass Full Cutting
Wavelength: 355nm
Thickness: 0.5T



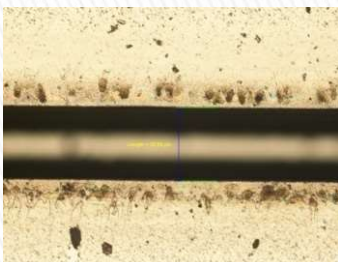
**PMN-PT Patterning
(Piezoelectric Element)**
Wavelength: 532nm



**Glass Microwire
Cutting**
Wavelength: 355nm



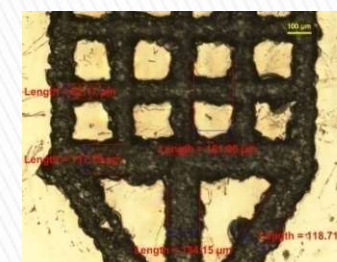
**Quartz Thin Film
Cutting**
Wavelength: 355nm



**Sapphire Wafer
Scribing**
Wavelength: 355nm

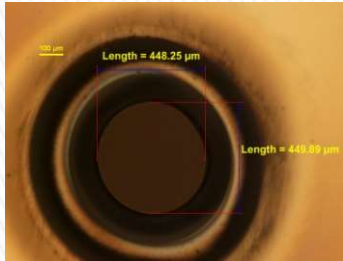


**OLED Light Hole
Drilling**
Wavelength: 355nm
Thickness: 0.88mm

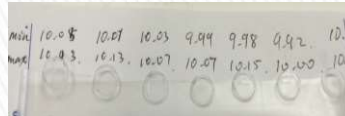


**Glass Channel
Patterning
(Lab-on-a-chip)**
Wavelength: 355nm

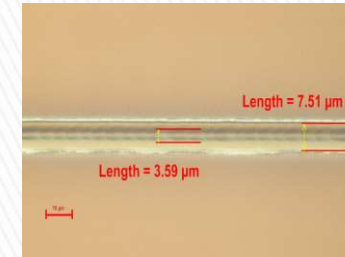
6. 가공 예시 – Nano _ Transparent materials. (3)



Quartz Wafer Hole Drilling
Wavelength: 10.6μm
Thickness: 500μm

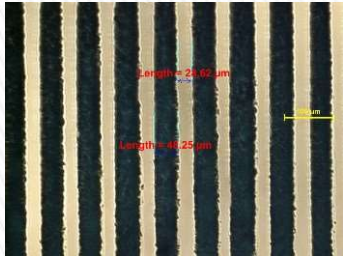


Quartz Wafer Round Cutting
Wavelength: 10.6μm
Thickness: 680μm

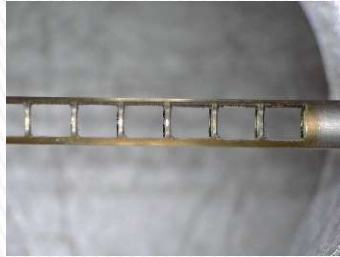


Transparent Electrode Scribing
Wavelength: 355nm
Thickness: 0.71mm

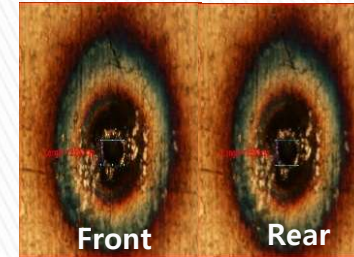
6. 가공 예시 – Pico _ Metal. (1)



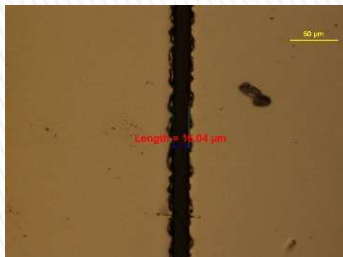
Aluminum Foil Cutting
Pico 355 UV
Thickness: 48.25μm



Ni-Ti Pipe Cutting
Pico 355 UV
Thickness: 100μm
Diameter: 1.65mm



SUS Thin Film Hole Drilling
Wavelength: 355nm
Thickness: 30μm
Diameter(front):32.49 μm
Diameter(Rear):25.5 μm



Molybdenum Scribing
Pico 532 Green
Thickness: 16.04μm

6. 가공 예시 – Pico _ Glass. (1)



Glass Hole Drilling
Pico 355 UV
Thickness: 30µm
Diameter: 21 µm



LCD(2 Layers) Hole Cutting
Pico 355 UV
Thickness: 300µm
Diameter: 1mm



6. 가공 예시 – Pico _ Silicone. (1)

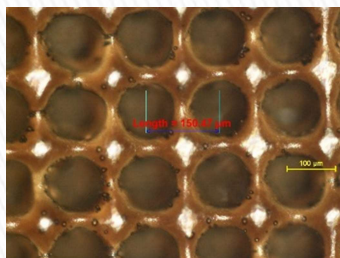


Perovskite Scribing
Pico 355 UV
Thickness: 30 μ m

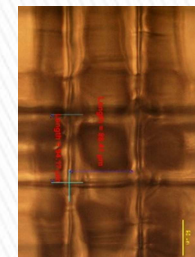
6. 가공 예시 – Pico _ Plastic. (1)



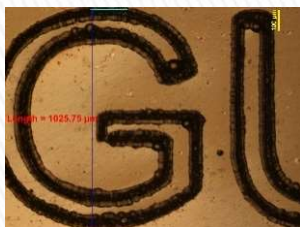
Plasitc Scribing
Pico 355 UV
Depth: 50μm



Plasitc Scribing
Pico 355 UV
Depth: 50μm



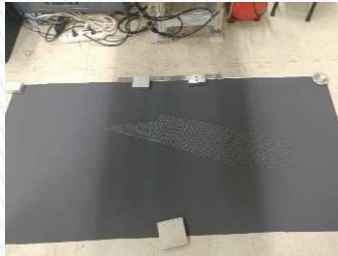
OHP film Marking
Pico 355 UV
X Axis Width: 88.4μm
Y Axis Width: 94.1μm



OPP film Marking
Pico 355 UV
Thickness: 20μm
Diameter(mm):3x1



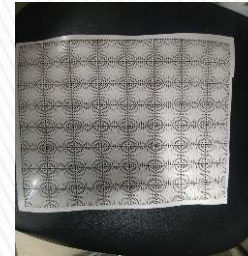
6. 가공 예시 - CO2



PVC Marking
CO2(400W)
Working range(mm):
1021x329
Line width: 1mm
Depth: 2mm



PET Hole Drilling
CO2(400W)
Thickness: 2mm
Diameter: 56 μ m



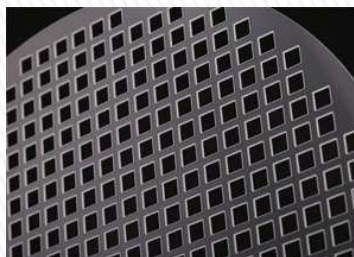
PET Hole Drilling
CO2(400W)
Working range(mm):
244.5x247.5
Thickness: 250 μ m

6. 가공 예시 – AOC Laser APPLICATIONS(1)



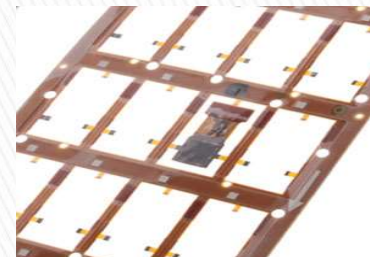
Polycarbonate Marking

by UV nanosecond laser



LED Scribing/Cutting

by diode-pumped solid-state laser



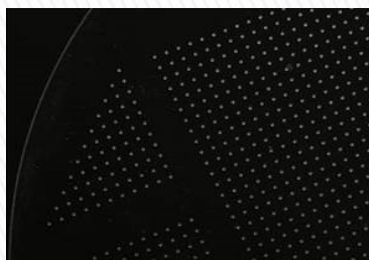
PCB and Flex Circuit Singulation

by 355-20-30-y laser



Stainless Steel Color Marking

by nanosecond laser



Glass Substrate Drilling

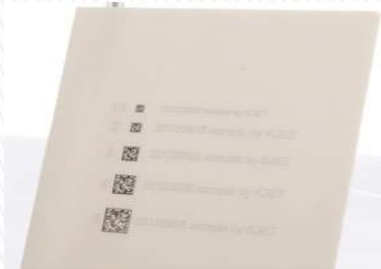
by diode-pumped solid-state
UV nanosecond laser



Internal Glass Engraving

by nanosecond laser

6. 가공 예시 – AOC Laser APPLICATIONS(2)



Ceramic Marking

by diode-pumped solid-state
UV nanosecond laser



Si Scribing

By diode-pumped solid-state
Green and UV nanosecond laser



Sapphire Marking

by diode-pumped solid-state
UV nanosecond laser



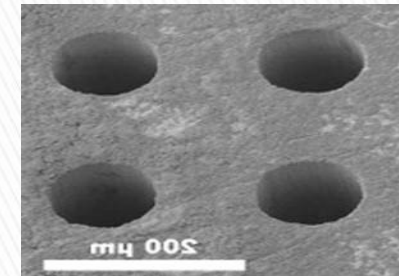
Brittle Material Cutting

by diode-pumped solid-state
green femtosecond and picosecond laser



Marking on Glass

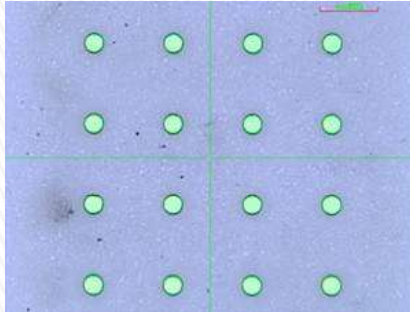
by UV nanosecond and picosecond laser



Silicon Wafer Drilling

by diode-pumped solid state
UV nanosecond laser

6. 가공 예시 – AOC Laser APPLICATIONS(3)



Ceramic Hole Drilling

by nanosecond laser



Polycarbonate Marking

by UV nanosecond laser



Stent Cutting

by diode-pumped solid-state
Femtosecond laser

Thank you

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