

초청강연

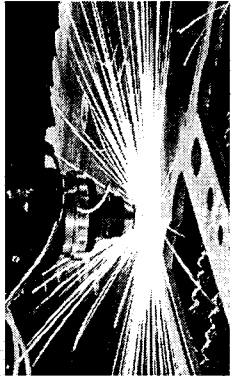
Industry에서의 레이저 응용

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(주)이오테크닉스

The Laser with Intelligence

Laser Industry



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Intelligence

Outline

Introduction

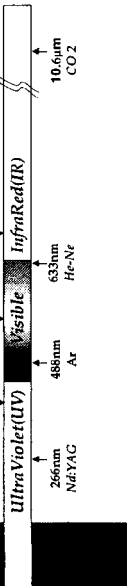
Industrial applications of Lasers

- Separating** : cutting, drilling, material removal
- Joining** : welding, soldering
- Surface treatment** : hardening, remelting, cladding, alloying
- Marking**
- Primary shaping** : stereo-lithography, selective sintering, LOM
- Laser forming**
- Ultrafast processing**

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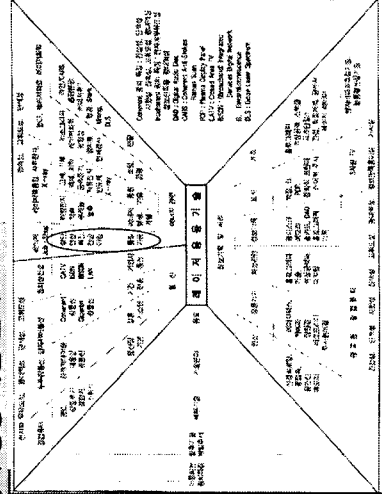
레이저의 종류

Medium	Gas	Liquid	Solid-state	Etc.
Laser	He-Ne, CO ₂ , Excimer	Dye	Ruby, Nd:YAG, Nd:YLF, Nd:glass, Ti:sapphire, ...	Plasma X-ray laser, Free electron laser



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레이저 응용기술분야



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레이저 가공 기술 분야

응용분야	금속 및 비반도체 재료 가공	전자부품 및 반도체 가공	의료, 계속 등 기타	Ultrafast processing
관련기술	<ul style="list-style-type: none"> - Marking - Cutting - Drilling - Welding - Annealing 	<ul style="list-style-type: none"> - Marking - Microvia drilling - Trimming - Laser cleaning - Texturing - Photolithography 	<ul style="list-style-type: none"> - Stents - Eye surgery dental - Sensor 	<ul style="list-style-type: none"> - MEMS - Multi-photon process - TW power - X-ray genera.
레이저	<ul style="list-style-type: none"> - CO₂ - YAG - Diode Laser 	<ul style="list-style-type: none"> - CO₂ - YAG - Diode Laser - Excimer, ... 	<ul style="list-style-type: none"> - CO₂ - YAG - Diode Laser - Excimer, ... 	<ul style="list-style-type: none"> - Ti:Sapphire - Cr:forsterite - Cr:YAG
소재	<ul style="list-style-type: none"> - 금속, 유리 - 아크릴, 목재, ... 	<ul style="list-style-type: none"> - 플라스틱, PCB - 실리콘, 박막, ... 	<ul style="list-style-type: none"> - 금속, 플라스틱 - 유기체 	모든 물질

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Phenomena by Laser intensity

레이저 출력밀도 (W/cm ²)	< 10 ⁵	< 10 ⁷	< 10 ⁹	> 10 ⁹
Main Mechanism	가열	용융	증발	Plasma shielding, Nonlinear absorption
Application	표면경화, 열처리	표면담금화, 용접	용접, 선공	

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Mechanism of Laser material processing

Thermal effect
Melting, melting and vaporization and IR wavelength

Chemical effect
Bonding of molecular bonding (more than 3 eV/photon)
Photon process at high intensity wavelength

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Wavelength dependence (Metal)

Absorption vs temperature for a typical metal surface

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Industrial applications

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I. Separating

1. Laser cutting

Process type

sublimation cutting

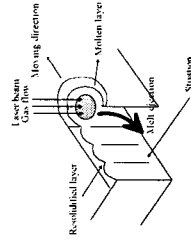
Evaporation of material by high intensity beam
Assist gas (Ar, N to avoid oxidation)
However, no major importance in industry

fusion cutting

Lower power than sublimation cutting
Melted and blown out with an inert gas jet

flame cutting

Considerably higher speed cutting. Much lower energy than sublimation cutting
Oxygen gas used
Heating over ignition temp. + exothermic reaction

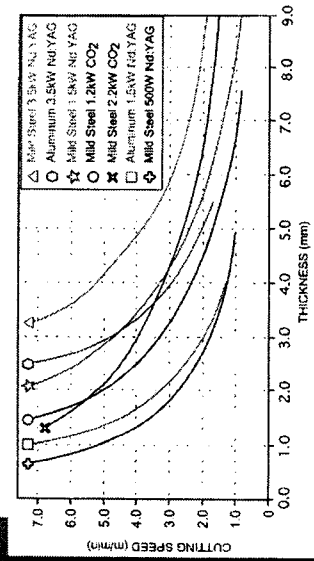


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Laser cutting - Metal cutting

It and how thick can I cut?



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Laser cutting - Metal cutting

As

es it assist?

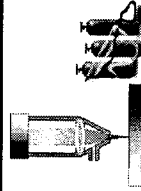
blowing away molten or vaporized metal
preventing material from spattering onto the beam-focusing optics
cooling the workpiece and minimizing the heat affected zone

and of gas is used?

oxygen; generally used when cutting mild steels (~1.03 MPa)

→ Cutting rate up to five times higher

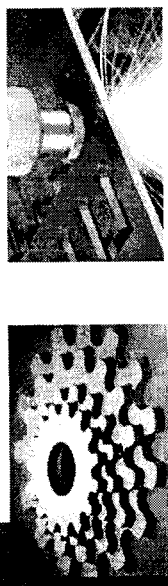
inert gas (Ar, He): used when oxide-free cut is needed (~2.06 MPa)



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Laser cutting - Metal cutting
mild steel



(Source: rotin)

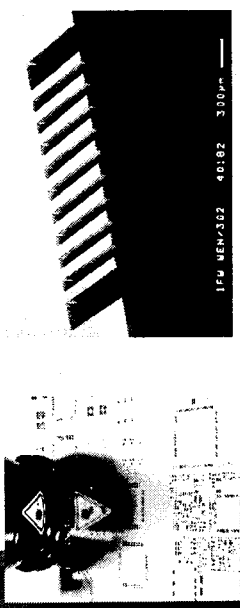
(Source: rotin)

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Laser cutting - Metal cutting

Mask for patterning the soldering paste on PCB



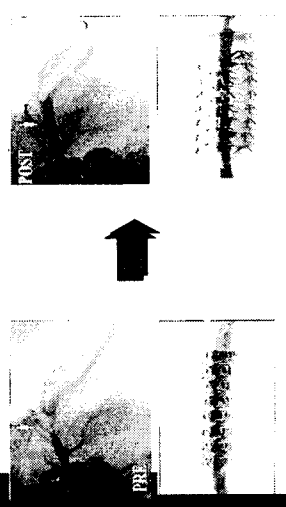
1F0 MEN/302 40182 300µm

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Laser cutting - Metal cutting

cal tool for curing a blood vessel hardening, by enlarging itself.

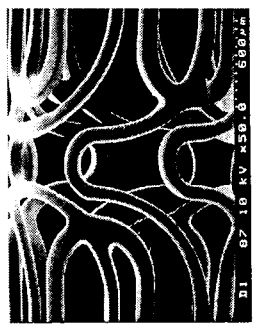


POST

PRE

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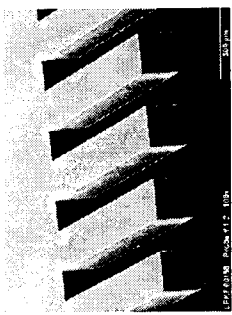
31 62 18 EV *58 8 666µm

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1. Laser cutting - Polymer cutting

A Polymer stencil

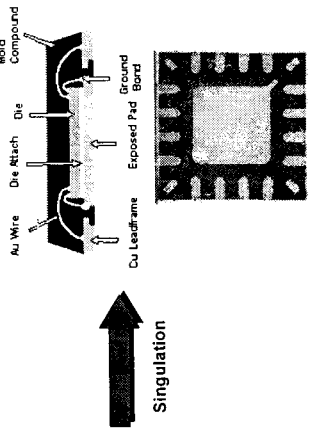


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1. Laser cutting - Polymer cutting

B Micro Lead Frame (MLF) cutting




MLF chip

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B Micro Lead Frame (MLF) cutting



SEM of a single chip


Cut edges by laser (upper) and punch (lower)

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Laser cutting - Glass cutting

of Laser OWCT (zero-width cutting technology)



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I. Separating

2. Laser drilling

process of multi-layered PCB (Resin Coated Copper)
Electrical connection between layers

Dry Film
 RCC Lamination
 by Hot Press
 Laser Drilling
 Desmear
 (Hall Cleaning)
 Copper Plating

Window Image
Developing

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hole drilling – Copper direct drilling

Cu : 9µm
 FR4 : 400µm
 Cu : 9µm

MEC treated copper
 Cu 9µm / FR4 400µm / Cu 9µm
 Diameter : 100µm

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Features of Laser DWCT

- no additional mechanical cutting
- no fragments and microcracks by the scribing
- no on-vertical fracture by the deep scribing
- narrow-width cutting
- no material loss & chips
- no subsequent treatment (polishing, chamfering, etc.)
- availability to thin glasses with a thickness of less than 1.1 mm

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hole drilling

100 µm 150 µm 250 µm

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1. Separating

3. Material removal (Laser ablation)

Process by which material is removed from a solid surface

Advantages

- Non-contact
- No mechanical stress
- No chemical waste
- High precision
- High speed
- High accuracy
- High repeatability
- High reliability
- High yield
- High quality
- High efficiency
- High productivity
- High cost-effectiveness
- High flexibility
- High adaptability
- High scalability
- High sustainability
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- High security
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Applications

- ITO (Indium Tin Oxide) ablation
- Laser cleaning
- Electric cable skiving, ...

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3.2 Laser deflashing

Material of extraneous mold compound resin has been leaked onto lead frame or heat slug during the molding process.

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Laser deflashing

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Laser PDP/LCD cell repair

Repair PDP/LCD by ablating ITO in an inferior (winking) cell

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Ablation

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3.4 Laser LCD trimmer

Trimming electrodes for the COG process

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II. Joining

1. Laser welding

Advantages

- There is no physical contact with external components
- Similar metals can be welded
- Welding can be carried out in a controlled atmosphere
- Workpiece sealed within optically transparent material necessary

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Welding speed and how thick can I weld?

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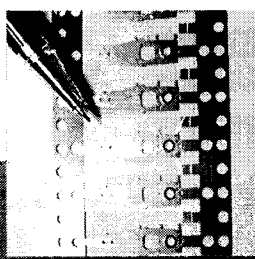
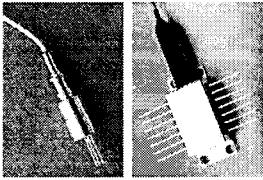
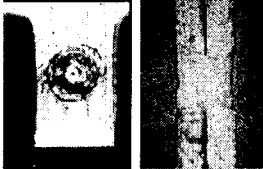
Seam welding (continuous welding)

Stainless steel

Radiator

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Spot welding

Stainless steel

Fiber communication

Semiconductor

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II. Joining

2. Laser soldering

Laser Soldering

of very small metallic workpiece (approx. 10~200 μm)
Cu-Zn, tin alloys

(T > 800°C), Soft soldering (T < 230 °C)



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III. Surface Treatment


Intensity radiation + comparatively long interaction time.
Lasers are suitable.

Hardening (표면경화)
Furnace hardening or induction hardening.

Surface treatment (표면 재처리)
wear on highly stressed surfaces.

Coating (표면 형성)
on the layer supplied as powder, wire or paste

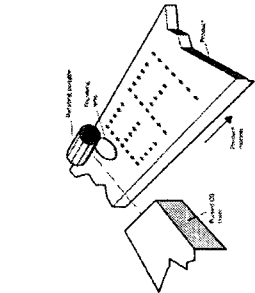
Hybrid material (표면 합금화)
Hybrid material mixing two materials



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IV. Laser Processing

Ice removal, surface melting, color change



Polygon rotating

Micro-mirror scanning

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What material can be ?

Keyboard supplies
 Keyboard
 ANAN
 Automobile
 Pen
 Film

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Chip Scale Marking

Marking on the back-side of wafer at a time, before dicing

200mm Si wafer

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What kind of shape can be ?

CD
 Serial
 2D Matrix
 Barcode
 OCR
 Picture
 Intelligence

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In-glass Marking




Marking inside of glass
 No particle generation, No outside damages
 → Permanent marking

Data matrix and Serial number
 In-glass marking with Nd:YAG

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V. Primary Shaping

bulk substance transformed into 3D shape based on CAD data.
(Rapid Prototyping).

Photolithography
by layers in photopolymer resin


Selective Laser Sintering
by heating powder particles so they fuse or sinter together.

Laminated object manufacturing (LOM)
by slices looked like laminated wood.

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VI. Laser forming

model or change the shape of a workpiece.
thermal stresses may cause components to deform.

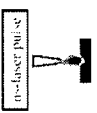


Laser formed doubly formed sheet

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VII. Laser processing


기초 레이저 가공



IS-LASER PULSE

- Significant thermal effect
- Avalanche breakdown process caused by single-ionized electron
- Large melting zone

원통형 레이저 가공






IS-LASER PULSE

- Minimal thermal effects due to minimum absorption and thermal diffusion length.
- Multiphoton electron ionization and electron-lattice coupling
- Reduction of melting zone even at NIR laser pulse

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VIII. Laser fine processing

Stainless Steel

Etchtech, Etchabang

400um

Model: T-1000	Material: SUS 304	Surface of Pulse: 1000
Power: 1.1 W (Pulse)	Power: 1.1 W (Pulse)	Power: 1.1 W (Pulse)
Wavelength: 10.6 um	Wavelength: 10.6 um	Wavelength: 10.6 um
Spot Size: 0.1 mm	Spot Size: 0.1 mm	Spot Size: 0.1 mm
Frequency: 100 Hz	Frequency: 100 Hz	Frequency: 100 Hz
Speed: 10 mm/min	Speed: 10 mm/min	Speed: 10 mm/min
Depth: 0.1 mm	Depth: 0.1 mm	Depth: 0.1 mm
Angle: 90°	Angle: 90°	Angle: 90°

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8. Summary

□ Why use LASERS for material processing ?

- contact : reduced chance of damage
- solvent chemicals : Eco-friendly, simplified process
- active material removal : enabling the impossibilities
- flexibility : soft-retooling with computer

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The Laser with Intelligence



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