Mecco Training
Laser 101

A Basic Overview
Comparison of Laser Marking Technologies
What is a **LASER**?

Light
Amplification by the
Stimulated
Emission of
Radiation!
Every object in the universe is made up of atoms. These atoms are constantly in motion; vibrating, moving and rotating.

Atoms can be in different states of excitation; either ground state or excited level. In order for an atom (electron) to reach an excited level some type of energy must be applied via heat, light or electricity.
Once an electron moves to a higher-state, it wants to return to its original state. When it does, it releases its energy as a photon -- a particle of light. These photons of light create laser energy.

Although there are many types of lasers, they all have certain essential features. Either a medium that is excited to give off a specific color of light. The medium is rod or a gas tube is excited by light or electricity (flash lamp, diodes or RF frequency) to release photons of light.
Common Laser Marking Wavelengths

- Nd:YAG: 1064nm
- Nd:YVO₄: 1064nm
- CO₂: 10.6 μm (9–11.8 μm)

Frequency Doubled Nd:YAG: 532nm
Frequency Tripled Nd:YAG: 355nm

X-Ray
Ultraviolet
Visible
Near Infrared
Mid Infrared
Far Infrared
<table>
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<th>Material</th>
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Types of Lasers

Green
532nm Frequency Doubled

UV
266nm Frequency Tripled

Less common, higher cost by $10K to $20K
lower power=slower speed
Best for plastics marking in some cases
Types of 1064nm Lasers

1064nm

- Fiber (Ytterbium) 1070nm
- Nd:YAG Flash Lamp
- Diode Pumped Vanadate (Nd:YVO\textsubscript{4})
How Lasers Work: Flash Lamp

Light from lamp excites atoms that release photons

Photons bounce back and forth on mirrors and laser beam exits out one end
Nd:YAG Lamp Laser Cavity

In the beginning
Flash Lamp Laser
Flash Lamp Laser with Chiller
Technology is more than 20 years old
Highest Cost of Ownership
Large size
Requires high power 220V
needs a large chiller $9,000 extra to keep it cool
Most versatile and flexible system
Flash Lamp will run for 500 to 1000 hours
Flash Lamp costs $150.
Diode Pumped

Very similar to Nd:Yag Diode Pumped
Different crystal for rod: Nd:YVO₄
Designed to deliver more peak power at higher q-switch frequencies.

Benefits of a Vanadate system:

Higher peak energy allows you to move spot faster but still maintain dot overlapping for continuous line.
Smaller package than flash lamp and diode pumped
Fiber delivered head allows ease of integration
Air Cooled
Diode Packs last between 15,000 to 20,000 hours
No consumables
Better cost of ownership than flash lamp and diode pumped
Can be mounted in any orientation
Q-switch frequencies from 20 kHz to 200 kHz
Runs on 110VAC

Disadvantages of a Diode Pumped system:

Diode pack replacement costs between $5k to $7k
No repairable parts in laser head. Must send system back to manufacturer for repair
Fixed beam size. No adjustment for beam expansion or focus.
Q-switching can only go as low as 20kHz. Applications requiring low q-switch frequencies such as deep engraving and some medical plastics will need to use either a flash lamp or diode pumped laser.
Small spot size may increase mark time
Why Fiber is Good

- Long Life
- Sealed Solid State
- Air cooled
- Lower Power Use
- Small Footprint
- Flexible
Fiber Laser

Galvo Scanhead

Safety Shutter

Collimating optics: straighten beam

Beam expansion

F theta Flat Field Focus Lens

Optical isolators: prevent laser beam from traveling back into laser from reflective part

Working Distance

Fiber Coil Ytterbium Diode Cluster

Ytterbium Fiber Optic Cable

Air-cooling fans draw air through

Master Oscillator for Pulsing

Working Distance
Beam Steering and Marking Area

XY Axis Galvanometer Motors with Scanning Mirrors

Flat Field Focusing Lens

Working Distance

Focused Spot

Marking Area Field
## 1064nm Lens Types

### 1064nm Lenses

<table>
<thead>
<tr>
<th>Focal Length</th>
<th>Marking Field</th>
<th>Work Clearance</th>
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<tbody>
<tr>
<td>100mm</td>
<td>65mm x 65mm (2.5&quot; x 2.5&quot;)</td>
<td>97mm (3.82&quot;)</td>
</tr>
<tr>
<td>160mm</td>
<td>110mm x 110mm (4.3&quot; x 4.3&quot;)</td>
<td>175mm (6.89&quot;)</td>
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<tr>
<td>254mm</td>
<td>175mm x 175mm (6.9&quot; x 6.9&quot;)</td>
<td>296mm (11.65&quot;)</td>
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<tr>
<td>* 330mm</td>
<td>225mm x 225mm (8.9&quot; x 8.9&quot;)</td>
<td>387mm (15.23&quot;)</td>
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<tr>
<td>* 420mm</td>
<td>290mm x 290mm (11.4&quot; x 11.4&quot;)</td>
<td>494mm (19.45&quot;)</td>
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### CO₂ Lenses

<table>
<thead>
<tr>
<th>Focal Length</th>
<th>Marking Field</th>
<th>Work Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mm</td>
<td>70mm x 70mm (2.8&quot; x 2.8&quot;)</td>
<td>81mm (3.19&quot;)</td>
</tr>
<tr>
<td>200mm</td>
<td>140mm x 140mm (5.5&quot; x 5.5&quot;)</td>
<td>184mm (7.24&quot;)</td>
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<tr>
<td>360mm</td>
<td>250mm x 250mm (9.8&quot; x 9.8&quot;)</td>
<td>351mm (13.82&quot;)</td>
</tr>
<tr>
<td>435mm</td>
<td>300mm x 300mm (11.8&quot; x 11.8&quot;)</td>
<td>422mm (16.62&quot;)</td>
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Pulses

Laser systems are like strobe lights. Marking results vary based on how often we flash or pulse the laser as well as how much power we use and how fast we are traveling over the surface.

1mJ per pulse
20-200KHz
CW
Laser Marking Types

- Engraving
- Removing Layer
- Carbon Migration
- Bonding

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All 1064nm lasers can achieve some level of engraving since the laser is removing material. For engraving depths of 0.003” or greater, the 50W Fiber is the preferred laser. Since it can deliver more power, it can more easily remove the material in the shortest time. Varying the depth is achieved mostly by the # of passes.
Laser Marking Plastic

Sample 3
1USA-SC052-CC
5K20B1

325-1412

1234-95001-AR
56789

6.5/7.2mm REDUCTION POLYAXIAL SCREW CADDY
45mm
45mm
40mm
50mm

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CO₂ Laser

Lower cost, not able to mark on metal 10, 30, 40, 60, 80 and 100 watt models

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**CO₂ Laser**

CO₂ laser is a gas laser that is used to mark on “organic” materials such as wood, glass, packaging and plastics. It delivers a non-contrast mark on most materials.

**Benefits of a CO₂ system:**

- Available in 10, 30, 60 and 100 Watt models
- Lowest initial costs of all lasers. ~$20k to $25k for 10W system
- CO₂ tube will last 45,000+ hours
- No consumables and minimal maintenance
- Air-cooled design
- Cost to recharge tube is $2k
- Best Cost of Ownership over Flash Lamp, Diode Pumped, Vanadate and Fiber systems
  - 110V 1-phase, 10A
- Small footprint for ease to integrate on existing assembly lines.
- Can be mounted in any orientation.

**Disadvantages of a CO₂ system:**

- Not a q-switched laser. The beam is pulsed but does not deliver peak power.
- Limited applications. Can remove anodize and paint but can not etch or engrave into metals.
- Recharge of tube requires laser to be sent back to factory. Alignment of system may need to be performed.
- Larger spot size than YAG lasers. It has 10x the wavelength of YAG lasers at 10.6 microns. Bigger spot will reduce power density and resolution.
  - YAG (4.5” field) 25-35 microns
  - CO₂ (4.5” field) 300 microns
Laser marking with CO$_2$

**Samples:** Marking cardboard, wood, labels and glass with a CO$_2$ laser

**Summary:**
The CO2 is ideal for marking on organic materials such as cardboard, labels, wood and glass.
Laser Marking Software

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Laser Marking Software

- What You See Is What You Get (WYSIWYG) Interface
- Windows based
- Easy to use, intuitive interface
- Can easily create text and barcodes
  - Text: True Type and Stroke Fonts
  - Barcodes: Code 128, Code 3 of 9, 2D data matrix
  - Serialize, Date Codes, Time Stamps
- Import graphics directly into software
  - DXF, WMF, EPS, BMP, JPEG’s
- Control and apply Laser Parameters
- Interface to external equipment such as PLC’s, XYZ actuators, Rotary Indexers
Laser Safety

CDRH Laser Safety Ratings

Class I:
No way to get hurt

Class IV:
Customer needs to provide shielding
Laser Safety

Protective Housing:

• “Light Tight”:

  No direct exposure from laser light. Laser must take more than 1 bounce or reflection to harm operator

• Overlapping of panels on any access point

• Safety Interlocks (2x) on doors or access panels to the laser enclosure/zone

• Viewing windows are available in both glass and plastics. Substrates are coated for specific wavelength of laser.

• Emission and shutter indicators.

• Must file Class 1 enclosure with CDRH
Fiber Laser Layout

Laser Rail

19” Rack Control Box

PC & Monitor

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Class I Enclosures

- Standard Size
- Large Size
- Pneumatic Doors
- Rotary Table
- Programmable Z-Axis
- Rotary Indexer
- XY Table
- Tag Feeder
- Safety Seal

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Class 1 Enclosures

Standard Enclosure: 24” x 24”

Large Enclosure: 30” x 42”
Laser Options: Pneumatic Door

Pneumatic Door
Dial Indexer Workstations

2 & 4 Position Rotary Workstations

888-369-9190
www.mecco.com
Laser Tag Feed Enclosure

Laser Tag Feed Systems
Manual and Programmable Z-Axis

Manual Z-Axis

Programmable Z-Axis
Laser Options: XY Tables

XY Tables
3-Jaw & 5C Pneumatic Rotary Indexers

Manual 3-Jaw Indexer

5C Pneumatic Indexer

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Vacuum device to seal to part prior to marking

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  - Process development to determine best marking parameters
  - 10W, 20W, 30W & 50W Fibers
  - 10W & 30W CO2’s
  - Mecco can email files & parameters

Free Phone Support for the life of the machine

Laser Marking Services
  - Contract Marking
  - Over-production or limited runs

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  - On-site, at Mecco or Over the Web
• Permanent mark on variety of materials
• Non-contact to part
• Repeatable every time
• Software allows user to easily add, change and delete text, graphics, barcodes, etc
• Minimal consumables as compared to ink jet and pad printing
• Cost effective