Explanations Provided by Engineers

Revised Laser Marker Technical Guide

Basic

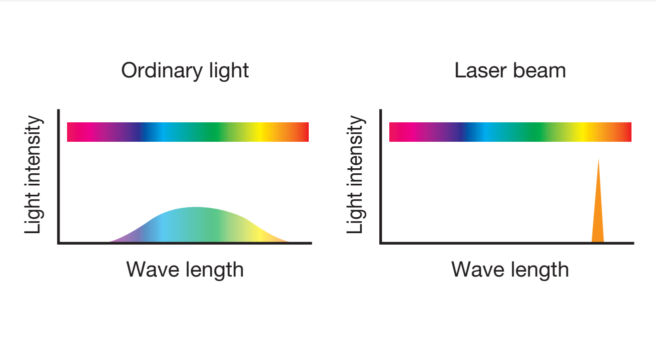
1. Lasers

What is a Laser?

Laser is an acronym for
"Light Amplification by Stimulated Emission of Radiation."

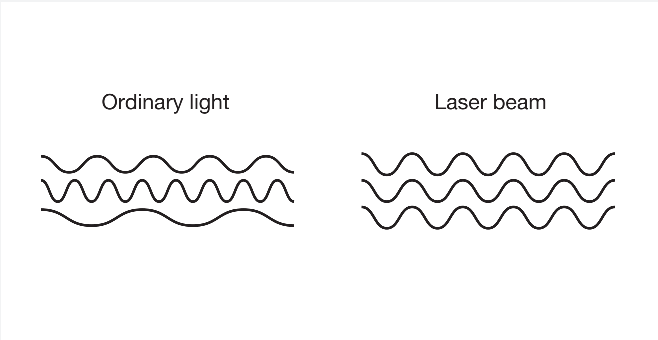
Laser Characteristics

Lasers differ from other light sources (such as the sun, incandescent or florescent lighting, and so on) in the following ways.



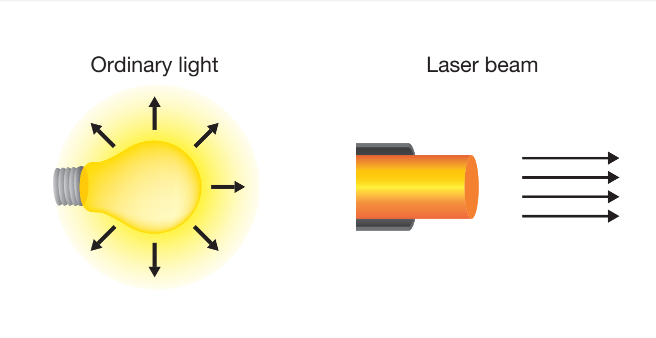
1. High Monochromaticity

Ordinary light is made up of multiple colors (wave lengths, or frequencies). Compared to ordinary light sources, the frequency range (number of colors) of laser light is extremely small.
This characteristic is called monochromaticity.



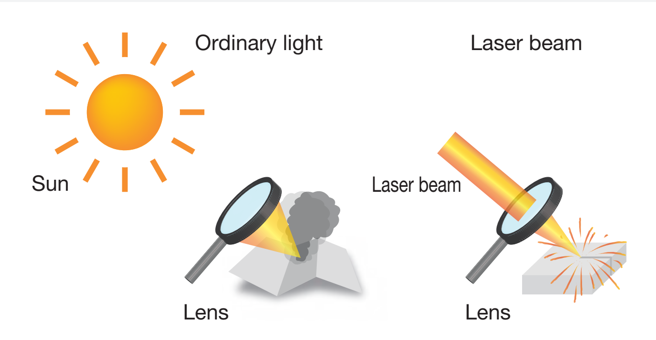
2. High Directionality

Ordinary light emanates in all directions. Laser light is focused in a single direction with very little divergence.



3. High Coherence

Laser light consists of light waves that are not only the same wave length, but are also phase-linked with each other.
This is called coherent light.



4. High Convergence

Compared to ordinary light, laser light can produce much more intense energy in a much smaller area, due to its high monochromaticity and directionailty.

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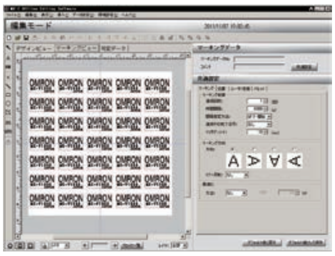
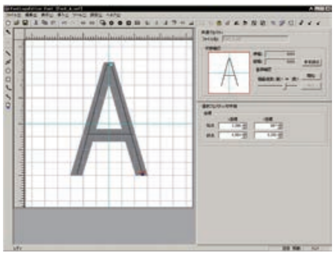
What are Laser Markers?

A laser marker is a device for labeling physical surfaces, without physical contact, using laser energy.
Recent laser markers enable editing the label data (letters and graphics) on a computer, using graphic utilities.
In addition to labeling, they are also used widely for drilling holes, cutting, trimming, and detailed processing.

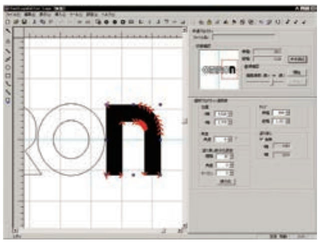
Graphic Utilities



Create and Editing Data



Creating new font data



Creating logo data

Industries Using Laser Markers

Laser markers are used in a variety of industries, such as printing 2D codes on automotive parts, logos on electronic components/electrical devices, lot numbers, and many more applications.

Automotive parts

Electronic components/ electrical devices

Machines/tools

Semiconductors/LCDs

Molded parts

Medical instruments

Benefits of Processing with a Laser Marker

A. Permanent Processing/Labeling

Laser marking is perfect for manufacturing history, process management, and other critical information.
It will not wear off or peel off, because it is marked directly into the product.

B. High Quality, Fine Detail Processing and Marking

This no-contact technology minimizes damage to the product, and allows high quality detailed processing and marking.

C. High Speed Processing/Marking: High Productivity

Laser marking is both faster and easier than other kinds of processing/marking.
It contributes more to productivity than other methods.

D. Operating Cost: Electric Bill

There is no need for periodic maintenance, no ink to refill, no cleaning to be done, no blade to change or sharpen.
The electric bill is really just about the only operating cost.

E. Wide Range of Materials and Processing

Some possible materials include metals, plastics/resins, plastic film, and so on.
(Different laser markers and specifications are required for some materials.)
Labeling data can include logos, graphics, model numbers, serial numbers, 2D codes, and more.

F. Environment-friendly Processing/Marking

There is no ink, and therefore no solvent; no adhesive label, and therefore no backing paper, no waste disposal.

Reference Processing Comparison Table

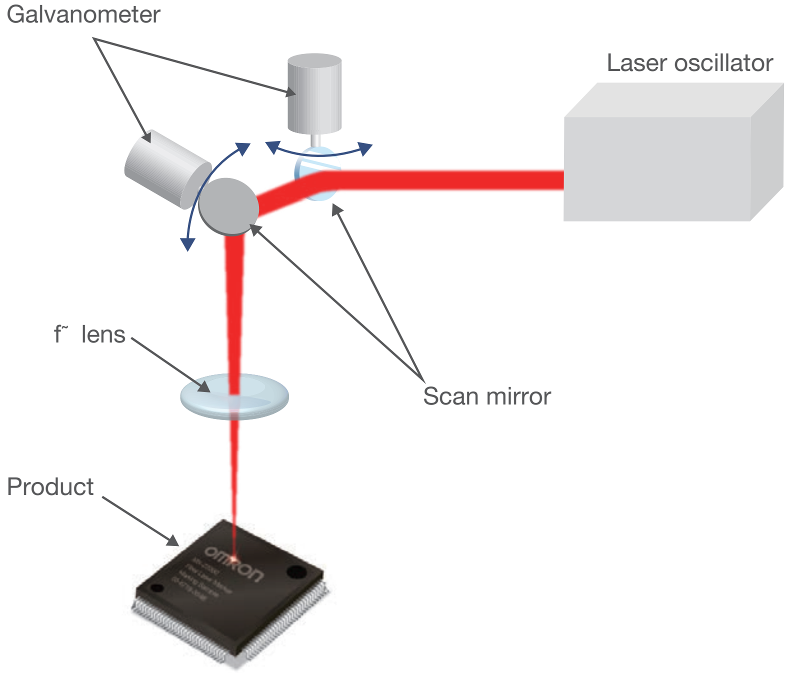
	Laser Marker	Inkjet	Adhesive Label	Stamping	Press Marking	Chemical Marking
Contact/No contact	No contact	No contact	Contact	Contact	Contact	Contact
Permanence	Semi-permanent	Wears off	Peels off	Wears off	Semi-permanent	Permanent
Detailed Marking	Good	Fair	Fair	No good	Fair	Good
Process	Easy	Requires drying	Requires a separate process	Requires drying	Good	No good (requires a separate process)
Label Changes	Easy	Easy	Physical label change	No good	Fair	No good
Inventory Mgt.	N/A	N/A	Label stock	N/A	N/A	Lot production
Waste/ Environmental Impact	Minimal	Ink	Backing paper	Ink	Minimal	Liquid processing issue
Operating Cost	Minimal	Ink refills	Labels	Ink refills	Parts replacement	Liquid processing issue

Operating Principles and Features

Laser markers use laser light to process and mark label data that has been edited using graphic utilities.
There are both 2-dimensional laser markers for flat surfaces, and 3-dimensional laser markers for other kinds of surfaces.

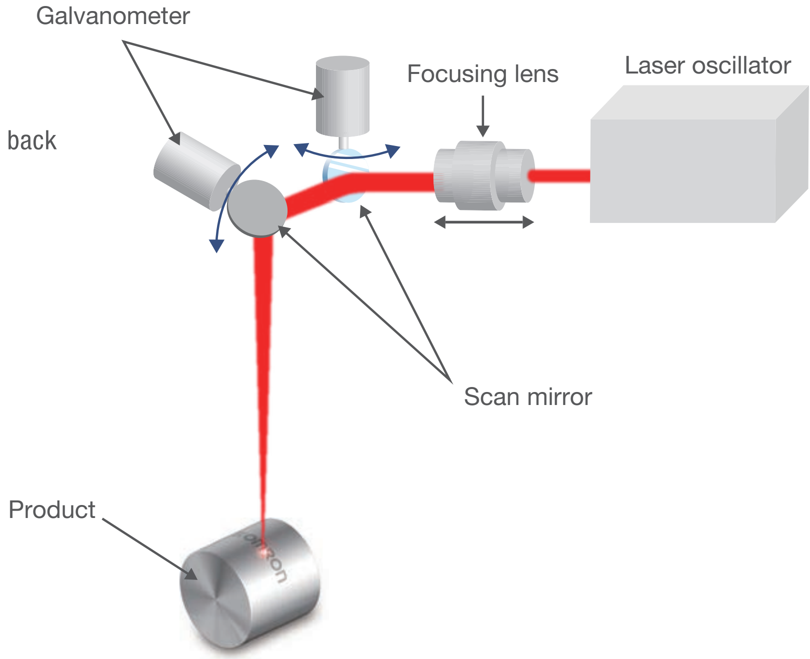
2D Marking (fθ lens)

A mirror galvanometer is used to scan the laser beam and mark the product surface. An f˜ lens is used to concentrate the light on the marking surface.



3D Marking

A mirror galvanometer is used to scan the laser beam and mark the product surface. Moving the focus lens (used instead of the f˜ lens) back and forth enables adjusting the beam not only on the x and y axes, but also on the z axis.



Varieties and Characteristics

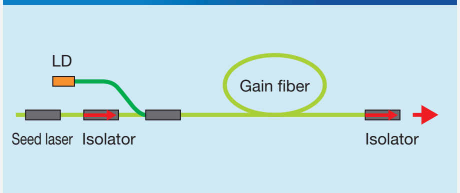
Laser marker varieties are distinguished by the laser oscillator.
The more common laser markers have YAG or YVO_4 solid-state laser oscillators or a fiber laser oscillator generating a 1.06 µm beam, or a CO_2 laser oscillator generating a 10.6 µm beam, and so on.
There are also specialty laser markers used in some applications that have an oscillator that enables SHG and THG by converting the wavelength.

Common Wavelengths	Laser Marker Name	Laser Medium	Characteristics
Fundamental Wave 1.06 µm	Solid-state (YVO_4) laser marker	Nd: YVO_4	The YVO_4 is good for fine print or precision processing; applications that require lower heat levels. The YAG is good for applications that require more heat.
	Solid-state (YAG) laser marker	Nd: YAG	
	Fiber laser marker	Rare-earth-doped fiber	Fiber lasers are compact due to the oscillation principle they use, and are known for generating power efficiently.
SHG 0.53 µm	SHG laser marker	Converts a fundamental laser to half wavelength, using a non-linear optical crystal.	These lasers are effected by wavelength conversions. For materials that have a high absorption rate for these wavelengths, they enable detailed processing with a low thermal effect. However, the operating cost is likely to be high.
THG 0.355 µm	UV (THG) laser marker	Converts a fundamental laser to one-third wavelength, using a non-linear optical crystal.	
10.6 µm	CO_2 laser marker	CO_2	CO_2 lasers have a longer wave than solid-state or fiber lasers, so they are more easily absorbed by clear materials. This makes them good for marking glass or other clear materials.

Reference OMRON's MOPA All-fiber Laser

Common fiber lasers and solid-state lasers use mirrors to resonate and amplify the laser. The laser is output by Q-switching.
Using this technology, it is difficult to produce a reliable, durable laser with high quality and flexibility.
OMRON's MOPA all-fiber laser eliminates the resonator structure, and enables a high quality beam with stability, durability and flexibility.

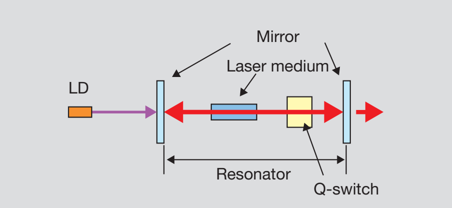
OMRON's MOPA Fiber Laser



* Master Oscillator Power Amplifier

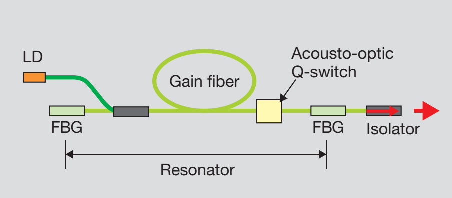
- Wide repetition frequency setting range
- High flexibility for setting pulse width/shape
- High beam quality, high stability, long operating life

Common Solid-state Laser



- Pulse width depends on the repetition frequency
- The LD is always on, accelerating deterioration
- Operating life issues with Q-switch, mirrors, etc.

Common Fiber Laser

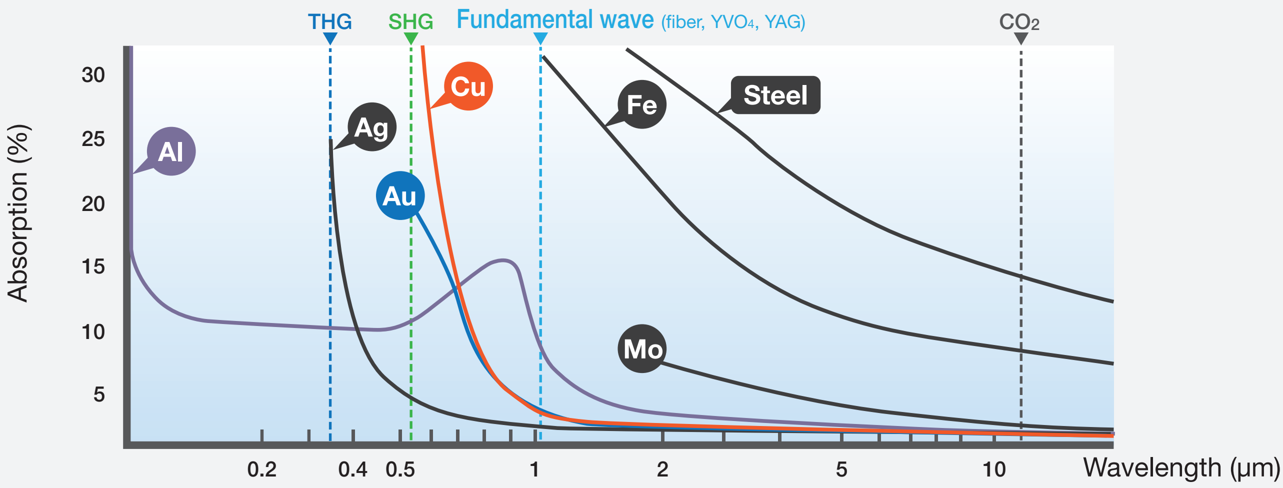


- Difficult to achieve a high peak output.
- Narrow repetition frequency setting range
- Pulse width depends on the repetition frequency

6. Laser Wavelength & Processing Material

Laser Wavelengths & Common Material Absorption

Processing materials with a laser is possible because the surface of the material absorbs the laser beam.
The absorption rate for each wavelength depends on the material. Fiber, YAG and YVO_4 lasers are better suited for processing metals than CO_2 lasers. They have shorter wavelengths, and are better absorbed by metals.



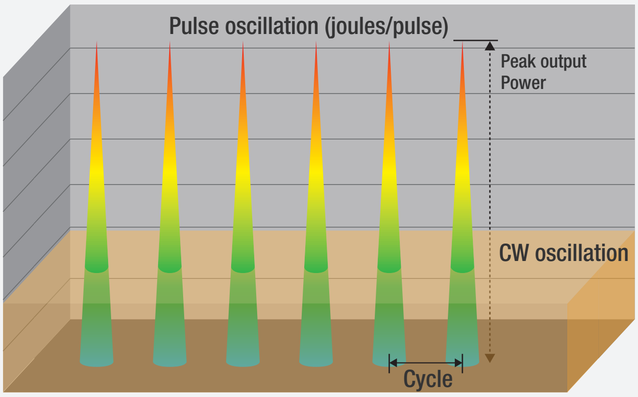
Materials & Laser Marker Processing Characteristics

The following table shows the absorption rate of different laser marker wavelengths for various common materials, such as metals, plastics/resins, etc. Choose the most appropriate laser marker based on the material to be processed.
While SHG laser markers are well suited for processing copper, gold, and so on (due to the high absorption rates), their cost is also high and achieving high output is difficult. As a result, fundamental wave laser markers are often used instead.

Material		Fundamental Wave Laser Marker (Fiber, YVO_4, YAG)	SHG Laser Marker	CO_2 Laser Marker
Metal	Iron	Very good	Good	No good
	Aluminium	Very good	Good	No good
	Stainless steel	Very good	Good	No good
	Copper	Very good	Very good	No good
	Gold	Good	Very good	No good
	Silver	Fair	Very good	No good
Plastic/ Resin	ABS (acrylonitrile butadiene styrene)	Very good	Very good	Good
	PBT (polybutylene terephthalate)	Very good	Very good	Good
	POM (polyoxymethylene)	Very good	Very good	Good
	PC (polycarbonate)	Good	Very good	Good
	PP (polypropylene)	Good	Very good	Good
	PVC (polyvinyl chloride)	Very good	Very good	Very good
	PET (polyethylene terephthalate)	No good	No good	Good
Other	Silicon	Good	Very good	No good
	Ceramic	Good	Good	Fair
	Paper	Fair	Fair	Very good
	Rubber	Fair	Fair	Very good
	Glass	No good	No good	Very good
	Wood	Fair	Fair	Very good
	Transparent electrode	Very good	Fair	No good

Reference Pulse Oscillation & CW Oscillation

In addition to considering the wavelength of a laser, there are also CW (continuous wave) oscillation and pulse oscillation.



As shown in the figure to the left, the CW oscillator generates a constant laser beam, while the pulse oscillator generates a laser beam consisting of constant pulses.
Even though the average output power(W) may be the same, the peak output power differs greatly, and therefore the processing characteristics also differ.
It is easier to control heat with pulse oscillation than CW oscillation, making pulse oscillation more suitable for finely detailed processing.

Note: The average output for pulse oscillation is calculated by dividing the pulse energy (J) by the pulse cycle (s).

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OMRON CANADA, INC. • HEAD OFFICE
Toronto, ON, Canada • 416.286.6465 • 866.986.6766 • www.omron247.com

OMRON ELECTRONICS DE MEXICO • HEAD OFFICE
México DF • 52.55.59.01.43.00 • 01-800-226-6766 • mela@omron.com

OMRON ELECTRONICS DE MEXICO • SALES OFFICE
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OMRON ELETRÔNICA DO BRASIL LTDA • HEAD OFFICE
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OMRON EUROPE B.V. • Wegalaan 67-69, NL-2132 JD, Hoofddorp, The Netherlands. • +31 (0) 23 568 13 00 • www.industrial.omron.eu

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