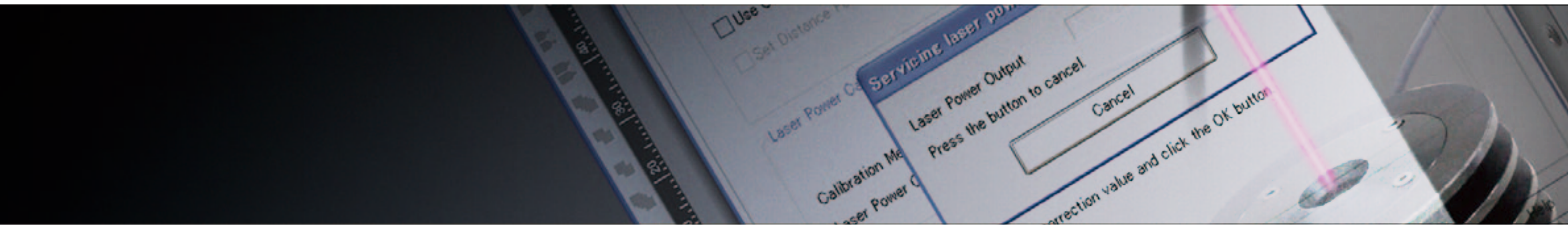
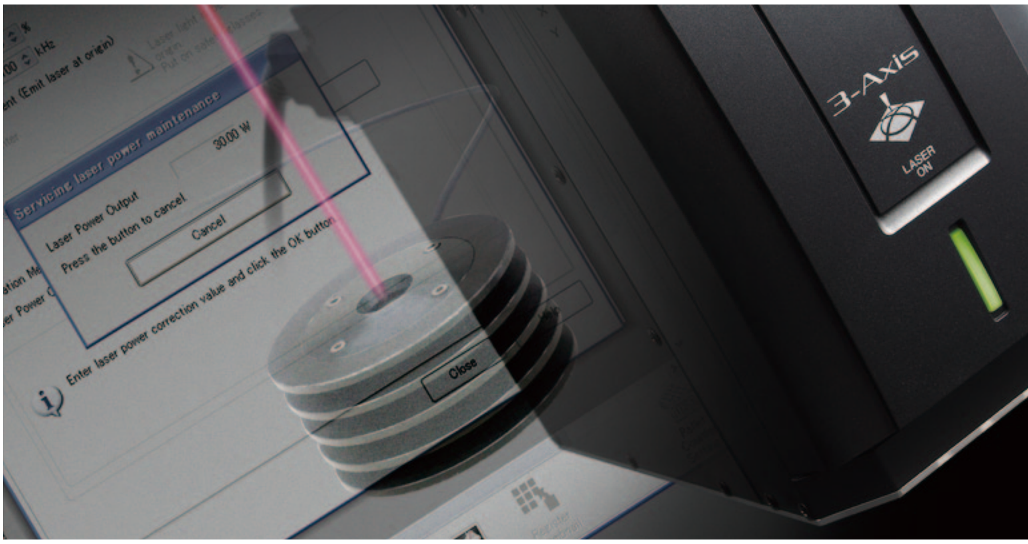
KEYENCE



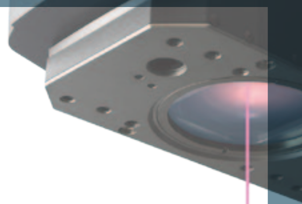


LASER TECH BRIEFS

LASER GENERATION

A comprehensive study of lasers

From sensors and measuring devices to large-scale processing machines, lasers are integrated and used in a wide variety of ways. Depending on the wavelength and output, there are many types of lasers, each having their own "special properties". In order to use these lasers properly it is important to know about "laser technology". Laser Tech Briefs is a series of white paper articles designed to answer the fundamental questions about lasers and laser technology.



What is light?

What is Light?

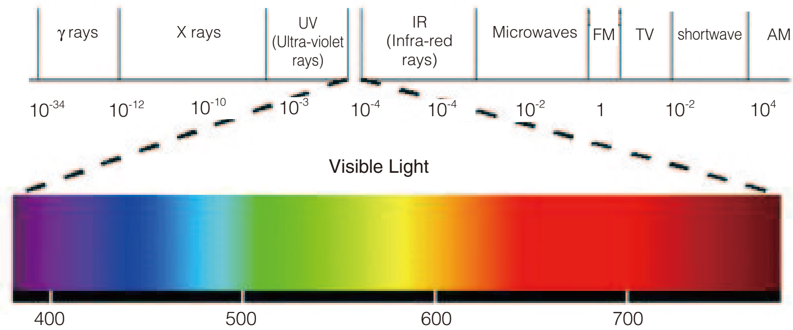
Light is a type of "electromagnetic wave". "Electromagnetic waves" follow a standard of "wavelength" and starting from those of long wavelength, can be divided into radio waves, infra-red rays, visible rays, ultra-violet rays, X-rays, and gamma rays.

What is Colour?

As wavelengths of light hit an object, wavelengths that are reflected without being absorbed by the object are taken in by the human eye (retina). When this occurs, we recognise these wavelengths as the "colour" of the object. The refractive index differs depending on the wavelength, therefore light is split. As a result, we are able to recognise a wide variety of "colours". For example, an apple (receiving day-light, which includes specific light rays that enable humans to see the colour red,) reflects red wavelengths of light (600 to 700 nm) and absorbs all other wavelengths of light. *Black objects absorb all light and thus appear black.

What are Visible Rays?

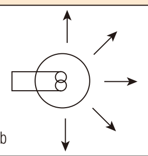
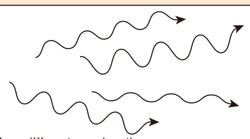
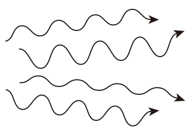
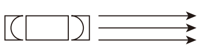
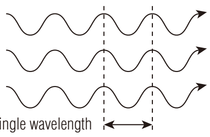
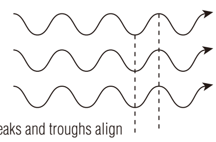
Electromagnetic waves that are within the range of wavelengths that can be seen by humans are called "visible rays". On the short wavelength side, visible rays measure 360 to 400 nm, and they measure 760 to 830 nm on the long wavelength side. Wavelengths that are shorter or longer than "visible rays" cannot be seen by the human eye.



What is a laser?

Differences between ordinary light and laser beams

This is where regular lights (lamps, etc.) and lasers differ.
Lasers emit beams of light with high directivity, which means that the component light waves travel together in a straight line with almost no spreading apart. Ordinary light sources emit light waves that spread apart in all directions. The light waves in a laser beam are all the same colour (a property known as monochromaticity). Ordinary light (such as the light from a fluorescent bulb) is generally a mixture of several colours that combine and appear white as a result. As the light waves in a laser beam travel, they oscillate with their peaks and troughs in perfect synchronisation, a characteristic known as coherence. When two laser beams are superimposed on each other, the peaks and troughs of the light waves in each beam neatly reinforce each other to generate an interference pattern.

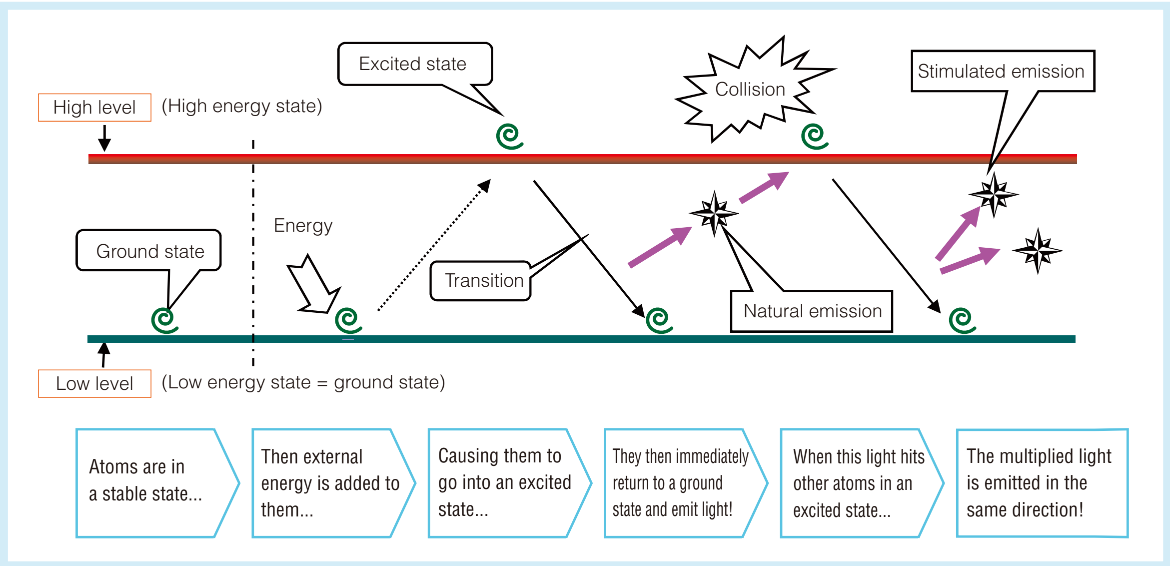
	Directivity (light waves travel in straight line)	Monochromaticity	Coherence
Ordinary light	 Light bulb	 Many different wavelengths	
Laser beam	 Laser	 Single wavelength	 Peaks and troughs align

The Origin of the Word Laser

The word LASER is an acronym, which stands for “Light Amplification by Stimulated Emission of Radiation”.

Laser Principles

When atoms (molecules) absorb external energy, they move from a low level (low energy state) to a high level (high energy state). This state is described as an excited state.
This excited state is one that is unstable and in this state, the atoms will immediately attempt to return to a low energy state. This is called transition.
When this occurs, light that is equivalent to the energy difference is emitted. This phenomenon is called natural emission. The emitted light collides with other atoms that are in a similar excited state, inducing transition in the same manner. This light that has been induced to emission is called stimulated emission.



Laser Oscillation (For CO_2 Gas Lasers)

Oscillation Environment

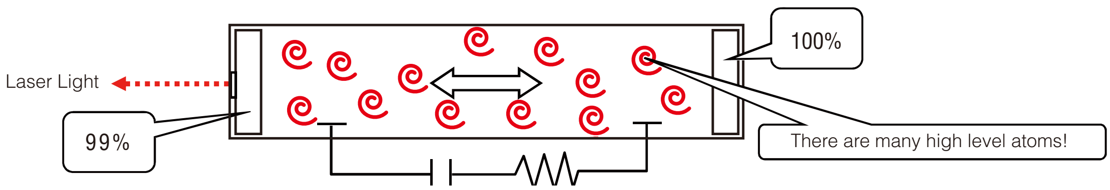
By continuously adding external energy, the number of high-level atoms becomes more than the number of low-level atoms, which then facilitates laser oscillation. This state is called population inversion.

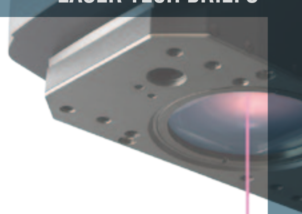
Structure

The structure of a gas laser oscillator seals gas in. It is also equipped with an electrode that produces the charge needed in order to generate population inversion and has optical resonators installed on both sides of its tube.

Oscillation Principles

When a rated electrical current is passed through the laser tube and discharged, it creates strong plasma within the tube and that plasma collides with the atom to create an excited state. Between optical resonators constructed from a pair of reflective mirrors that possess extremely high reflectivity for the wavelength of the laser, the light is amplified as it goes back and forth, and is reflected on one side of a reflective mirror whose reflectivity is around 99%, resulting in the external emittance of laser light.



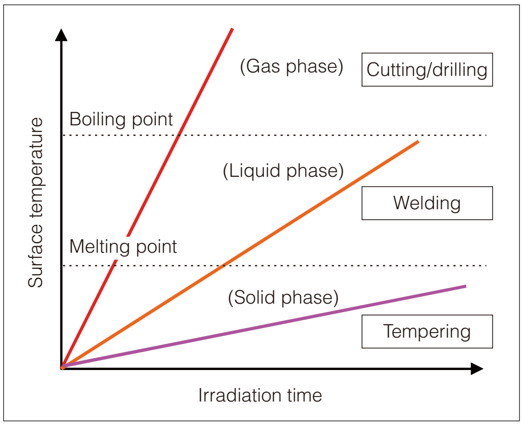


What is Laser Processing?

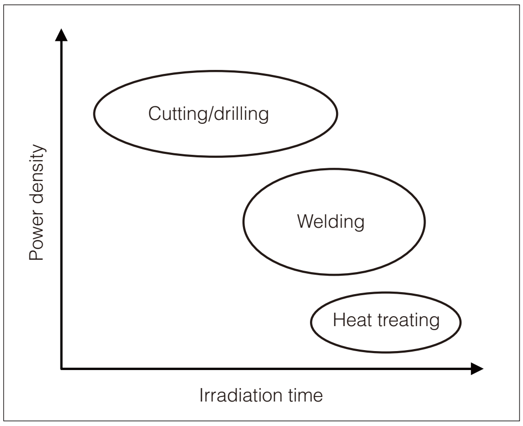
Laser Processing

When concentrating a high-power laser beam with a lens, the power density at the focal point becomes extremely high. Once this beam irradiates the workpiece, the energy is absorbed, increasing the local temperature. This heat is used for processing.

Surface Temperature and Power Density



[Surface temperature based processing applications]



[Power density based processing applications]

What other processes are laser markers capable of?

- Laser processing — Laser applications fall into three categories: Removal, bonding and surface reforming processes.
  - Removal processes — The laser heats the surface of the processed material above its boiling point to evaporate it off.
    - Cutting — • Cutting thin metallic or non-metallic objects
    - Drilling — • Drilling minute holes
    - Scribing — • Grooving and separation of ceramic or other IC chips
    - Trimming — • Removing portions of thin-film commonly used for semiconductor resistor fine-tuning
    - Marking — • Marking to metal and ceramic, etc.
  - Bonding processes — The laser heats the surface of the processed material above its melting point to cause fusion.
    - Welding — • Welding of metal/ceramic
  - Reforming processes — The laser heats the processed material below its melting point.
    - Tempering — • Improving material wear-resistance and strength
    - Vapour deposition — • Improving material wear-resistance and corrosion-resistance

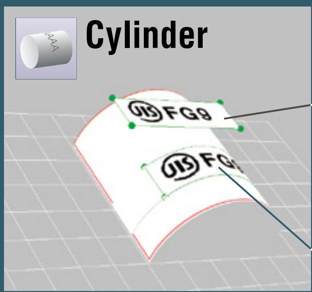
FOR MORE INFORMATION ON LASER MARKERS, CONTACT YOUR NEAREST KEYENCE SALES OFFICE

30 W High-Power Fibre Laser Marker
MD-F3000 Series
Wavelength: 1090 nm

3-Axis YVO_4 laser marker
MD-V9900A Series
Wavelength: 1064 nm

3-Axis CO_2 Laser Marker
ML-Z9500 Series
Wavelength: 10600 nm

Easily setup and align marking on 3D targets using KEYENCE's Marking Builder software.

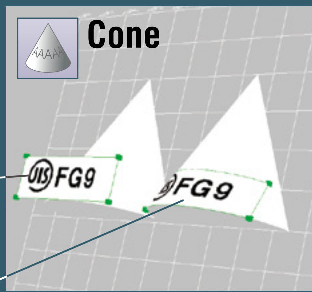


Conventional Technology

MD-V9900A

Marking using conventional technology
With a standard 2 dimensional laser marker, 3D shapes cannot be compensated for.

3-axis marking
3-axis control produces a perfect mark, even on curved surfaces, allowing for precise yet flexible marking and processing.



Conventional Technology

MD-V9900A

More detailed information is available from the Laser Marker Professional Site

http://www.marking-central.com

Please visit: www.keyence.com

SAFETY INFORMATION
Please read the instruction manual carefully in order to safely operate any KEYENCE product.

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