LASIT
LASER MARKING SYSTEMS

METAL AND ALLOY MARKING

100% Made in Italy

INSTRUCTIONS FOR USE

Precise machining, indelible and traceable over time

AUTOMOTIVE | MEDICAL | MECHANICAL | TOOLS

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LASER MARKING SYSTEMS

Metal and alloy marking

Intro

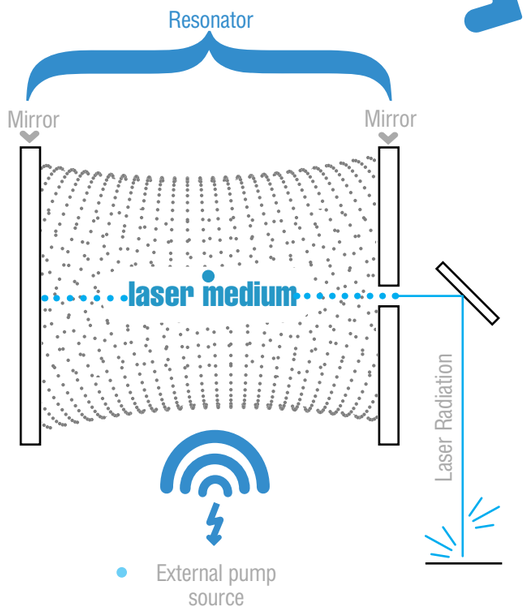
Various marking methods have been used for metal. The most common examples are laser markers, moulds, marking, labelling and micro-point machines using punches. Laser marking is becoming the most widely used method given its numerous advantages.

On discovering these advantages, many users have replaced traditional marking methods with laser marking. This guide explains why laser marking is becoming increasingly popular on metal.

1 HOW DOES METAL LASER MARKING WORK?

LASER stands for “Light Amplification by Stimulated Emission of Radiation”. In short, light particles (photons) excited by current cause energy release in light form. This light is directed towards a beam. By doing so, a laser beam forms.

How does laser work?
Basic principles



All lasers are composed of **3** parts:

- External pump source;
- The active laser medium;
- The resonator.

The pump source directs the external energy to the laser.

The active laser medium is positioned inside the laser. According to the design, the laser medium can be composed of a gas mix (CO2 laser), a crystal body (YAG laser) or fibreglass (fibre laser). When transferred to the laser medium through the pump, energy is emitted as radiation.

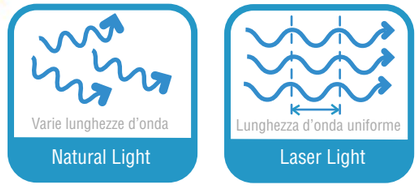
The active laser medium is positioned between two mirrors, the “resonator”. One of these mirrors is one-directional. Radiation of the active laser medium is amplified by the resonator. At the same time, only certain radiation can leave the resonator through the one-directional mirror. This directed radiation is laser radiation.

Characteristics of a laser beam

Laser radiation has **4** fundamental properties:

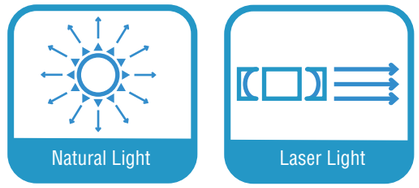
- Monochromaticity
- High Coherency
- High Directionality
- High Energy Density

Monochromaticity



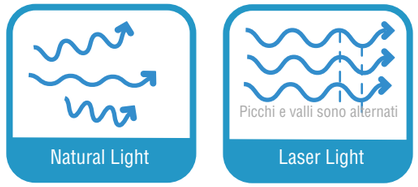
Natural light includes a series of wavelengths that range from ultraviolet to infra-red. Instead, a laser is a strip of light with a single wavelength. This characteristic is called monochromaticity. Monochromaticity has the advantage of allowing greater optical design flexibility. This gives precise designs that transmit the laser beam over large distances and concentrate the laser in a very restricted area.

High Directionality



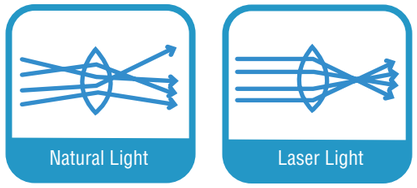
Directionality is the property of maintaining light direction while it travels through space. High directionality indicates the direction is maintained with high precision and low expansion. Natural light is a set of light strips propagating in all directions, while laser light is highly directional, making it easy to design optical systems that prevent the light from expanding based on the distance.

High Coherency



Coherency describes in what measure light interferes with itself. Considering light as a wave, you could say the more uniform the light beam, the greater its coherency. Given the phase, wavelength and direction of laser light do not change, a strong wave can be maintained to transmit laser beams over a long distance without diffusion. This means it is possible to concentrate light in a small area with a lens.

High energy density



Given laser has excellent monochromaticity, directionality and coherency, they can be concentrated in an extremely small area, thereby creating light with high energy density. Concentrating laser light in an extremely small area, you can increase its intensity (power density) even to obtain sufficient energy to cut metal.

In virtue of these properties, laser light is used in many areas of modern machining of materials. Intensity is maintained for a long time thanks to coherency and can be directed even further with the help of lenses. The laser beam engraves the surface of the material, is absorbed and heats the material. This heat generation causes the material to be removed or completely evaporated. This enables, engraving, marking or cutting of a vast range of materials.

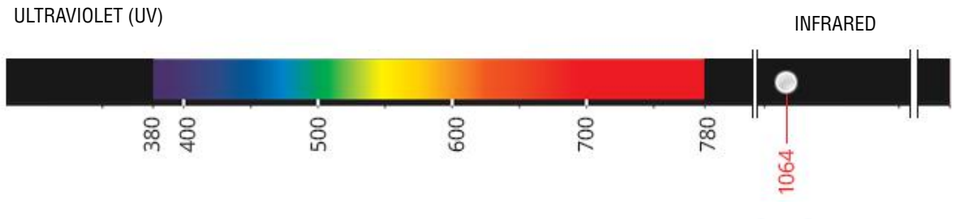
2 What is the best laser source for metal marking?

The best and most innovative laser technology for metal marking is without doubt fibre laser, ideal for precision marking, micro-machining and cutting of any type of metal or alloy; painted metal and metal with surface treatments such as anodised aluminium.

Fibre technology has reached an extraordinary goal in laser beam generation: a myriad of optical and mechanical parts was eliminated by new sources, the intrinsic cause of faults and instability, and was replaced by a single active optical fibre reel. The expected life of a fibre laser is over 100,000 hours of marking thanks to the "single emitter" diodes used and the completely integrated construction of the optical part.

Wavelength

The wavelengths of the infra-red rays (IR) are the most versatile for laser machining. As the name indicates, IR rays are outside the visible spectrum of the human eye, below red (valid for wavelengths over 780 nm).



Fiber Laser FiberFly

Typical characteristics of lasers with a wavelength interval of 1064nm.:

- Ample range of machining applications, from resin to metal;
- Unsuitable for machining of transparent materials, such as glass, since the laser beam crosses it;
- Easy creation of a contrast on resin.

Advantages of fibre laser marking:

- High speed;
- High quality;
- Indelible marking;
- Dynamic dimensioning of marking;
- Easy to use data matrix code;
- Wide variety of markable materials.

3 Can fibre laser be used to engrave any type of metal?

Yes, you can engrave any type of metal or alloy, from steel to aluminium, copper to gold, brass to nickel. It should be pointed out however that not all metals react in the same way and in any case one machining process instead of another can be conducted on the same material, based on specific requirements.

Examples of laser marking based on the material

Brass

Steel

Aluminum

Copper

Markings comparison on steel

Marking on steel has two major categories:
white marking and black marking

WHITE MARKING

Metal is marked in such a way diffused light makes the markings appear white.

- Fast marking.
- Increasing the number of passes, deep incision can also be obtained.

WHITE

BLACK MARKING

Generates oxide films on metal surfaces in such a way black markings appear.

- Less irregular surfaces with projections and indentations (based on the materials).
- The oxide films generated by marking prevent rust formation.

BLACK

4 Is laser marking indelible or does it disappear over time?

Absolutely indelible. In fact, laser marking guarantees the identification and traceability of products with a high-resolution finish, ensuring long-lasting and resistant machining over time against acids, chemical agents and corrosion phenomena. Basically, to delete a laser marking the surface layer must be removed.

5 Is coloured marking possible?

In general, yes, it is possible, even if you should always evaluate the type of metal on which you want to conduct this type of machining. For example, ferrous metals (iron, steel, stainless steel) and titanium are certainly the most adapt, even if excellent results are also obtained on treated materials such as anodised aluminium (where a beautiful black can be obtained).

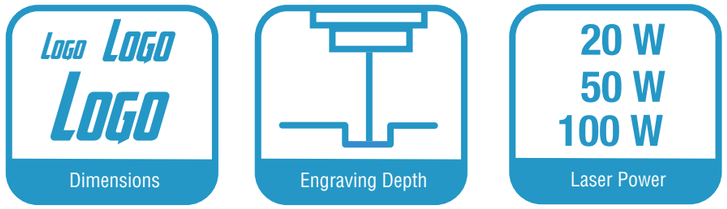
In fact, these materials allow a machining process defined “annealing”, during which an oxide layer is obtained through localised heating of the material, which is usually black, but can also have other annealing colours (e.g. yellow, red or green).

The colours obtained depend on the temperature of the heated layer. The surface of the material is maintained uniform through blackening; in fact, tinting is obtained not through removal, but localised heating of the material. On the surface of the metal, heat usually reaches a depth of between 20 and 30 µm, making marking non-abrasive.

6 How long does laser marking take?

A general answer isn’t possible, as there are too many factors to consider. The most important are:

- Dimensions of the object to mark (logo, code, text);
- Required engraving depth;
- Laser power used.



In any case, laser marking is a process that usually takes 2 to 10 seconds.

7 Could marked material get deformed?

Generally, no, even if each application is unique.

For example, in the “Aerospace” sector, where no type of material alteration is ever possible or permitted, shallow surface markings are made to avoid any type of deformation or change in chemical-physical characteristics of the engraved material.

8 Can metal markings oxidise?

As for the previous question, it all strictly depends on the type of machining you want to do. In some specific cases, in fact, oxide development could be a sought-after aesthetic result. Instead, in other cases it should absolutely be avoided.

In the latter case, by running various tests and entering the correct laser parameters, indelible markings can be made, while at the same time avoiding unwanted oxidation of the material in a constant, certain and safe manner.

9 Can I also make cuts on thin sheets using a marking laser?

Yes, micro-cuts can be made with an excellent finish, even if some fundamental aspects must be considered:

Example of cut with 30W laser

- THICKNESS

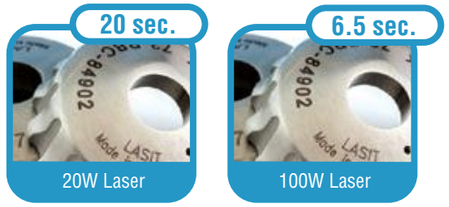
The thickness of the sheet must not be over one millimetre, otherwise the cutting time may be too long and the material could deform if subjected to thermal stress.

- CUTTING AREA

The cutting area must not exceed ø50mm since this portion of space (i.e. the space exactly under the marking head) is where the laser beam has greater perpendicularity to the surface. This guarantees the highest concentration of energy possible and therefore the capacity to make fast and precise cuts.

10 Does the quality and capacity of the incision depend on laser power?

No, the quality and capacity of the incision are not linked to power, the only parameter dependent on power is speed. In fact, regardless of whether you use a laser with 20W or 100W power, the aesthetic performance and depth obtainable remain the same, the only value that changes is time;



11 Can I write anything with a marking laser?

Absolutely yes, one of the fundamental advantages of laser is its intrinsic versatility.
You could in fact mark whatever you want; from simple alphanumerical code to elaborate logos and any kind of identification code (e.g. Datamatrix, QR code, B/Code etc.).

Examples

12 What is the maximum incision depth? And the minimum?

Adjusting the fundamental parameters of the laser (power percentage used, pulse frequency, number of repetitions and beam speed), you can use the same laser for markings ranging from a minimum depth of 10 micron to a maximum of 0.9/1mm.

13 What are the advantages of laser marking?

Laser marking is an imperceptible and permanent sketch, ideal for etching writing, logos, instructions or otherwise on any material with extreme flexibility, rapidness and exemplary quality, therefore it can be applied to countless sectors. Laser marking easily replaces less efficient and long-lasting systems (for example screen printing, pad printing, hot printing) or systems that create intolerable incisions on parts (e.g. punching or micro-point marking).

In particular, the main advantages of laser marking are definitely:

Versatility

versatility, allowing indifferent creation of logos, writing with any alphanumerical characters, barcodes, progressive numbering, drawings, data matrix, etc.;

High Definition

Laser marking also allows creation of smaller and more detailed geometric shapes with maximum precision. Multiple marking processes can be combined to clean the material after machining or to give marking further contrast (e.g. data matrix codes).

Contactless

Material machining is safe and contactless. Non-contact between the part and marking system allows the surface to be maintained intact, reaching areas that would otherwise be inaccessible, without having to block or firmly fasten the materials.

Indelible

Differing from other technologies, metal laser marking is permanent and resists wear, heat and contact with acids; this is particularly important to guarantee product traceability and quality.

Speed

Marking is really fast, even with variable content (e.g. serial numbers, codes). Furthermore, a vast range of different markings can be made without re-equipping or changing machinery tools.

Efficiency

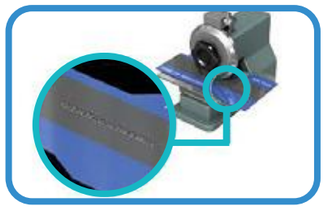
Metal laser marking does not involve any costs for consumable materials, such as ink, chemical substances, pastes or sprays. Similarly, costs are eliminated for treatment or polishing of such materials, which are often expensive. No pre/post-treatments are necessary. No equipment wear.

Examples of typical marking methods on compared metals

Laser marker

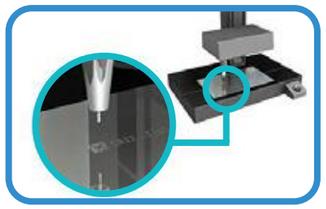
- High quality thanks to contactless marking
- No operating costs
- No maintenance required
- Can mark barcodes and 2D codes indelibly
- Higher production

Marking Machine



- Low initial costs
- Equipment conversion required
- Difficult to maintain uniform quality
- Requires labour for sheet control
- Damages the targets

Micro-point marking with punching machine



- Low initial costs
- Unstable marking quality due to tip wear
- Requires noise control
- Long marking time
- Involves maintenance costs

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