A Beginner's Guide to Industrial Laser Marking

How to choose the right marking method for your application

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How to Use this Guide

This guide was designed to provide those who mark materials in industrial environments with an understanding of the process of laser marking—including benefits, considerations, and information on how to choose the right method for your application. It explains the different laser marking methods (such as engraving, annealing, foaming, and color change) and gives examples of typical applications for each method.

The section below includes an overview of things to consider when choosing a marking method. To use this guide, we recommend you find the type of material you wish to mark in the materials chart, and then review the applicable methods listed for that material, while keeping any customer requirements in mind. Keep your smartphone or other device handy. Each method described in the laser marking section includes a QR code you can scan to view video examples of the different marking methods.

Things to Consider When Choosing a Laser Marking Method

Customer/industry requirements

Your customers' requirements are among the first things to consider when you are trying to determine which marking method to use. Certain customers will require you to use a specific method because they are required to abide by regulations. For example, the FDA requires that medical devices and instrumentation meeting certain criteria are marked using only the annealing method.

Other customer or industry requirements might include asset-tracking regulations, various government requirements for marking, end-use environment, and general customer preferences, such as a bold contrast or color change.

Material

The material you're marking is another huge factor in determining which laser marking method is best for your application. Certain marking methods are effective only when used on specific materials. The chart below lists the most widely used laser marking methods, and materials for which each method is suitable.

Marking Methods	Suitable Materials	
	Metals	Plastics
Engraving	X	X
Annealing	X	
Color Change	X	X
Foaming		X
Coating Removal	X	X

Laser Marking Basics

Lasers are powerful tools with a wide range of capabilities that can help companies lower production and maintenance costs, reduce turnaround times, streamline processes and increase throughput.

In a nutshell, a laser beam is light which can also transmit energy in the form of heat. The name LASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. Lasers have been around since the 1950s and can be traced back to Einstein's theory of light emission in 1916. Different wavelengths of light can produce different types of lasers and produce different effects. The most common laser types are CO_2 and fiber. The scope of this document is largely limited to fiber laser marking.

Benefits of Laser Marking

Durable mark - Laser marking is abrasion-, heat- and acid-resistant, making it a convenient choice for marking name plates, industrial tags, and other items used in harsh environments. Depending on the laser parameters, it is possible to mark certain metals (e.g. stainless steels) without leaving tangible depressions on the surface.

Flexible/variable data - Lasers can process variable data such as just-in-time online data or data imported from an external system (such as office programs, files, SAP, databases, etc.).

Convenient, economical production - Laser marking is a high-speed process that can produce in some cases as many as 900 characters per second, depending on the equipment and material. Laser processing does not require consumables (for example, ink, chemicals, pastes or sprays) and energy consumption is low, so setup time and costs are kept to a minimum, and the cost-per-mark is always the same—whether you need to mark one piece or 1000.

A precise and complete tool for all materials, sizes and shapes - Laser processing produces highly detailed marks and designs. Even 1-point lettering (sometimes needed for very small plates) and fine lines like technical drawings are clearly legible.

Lowest wear and tear - Due to the contact-less process and a limited number of moving parts, wear and tear on a laser marking system is kept to a minimum. This also saves money, and reduces downtime associated with maintenance.

Laser Marking Methods

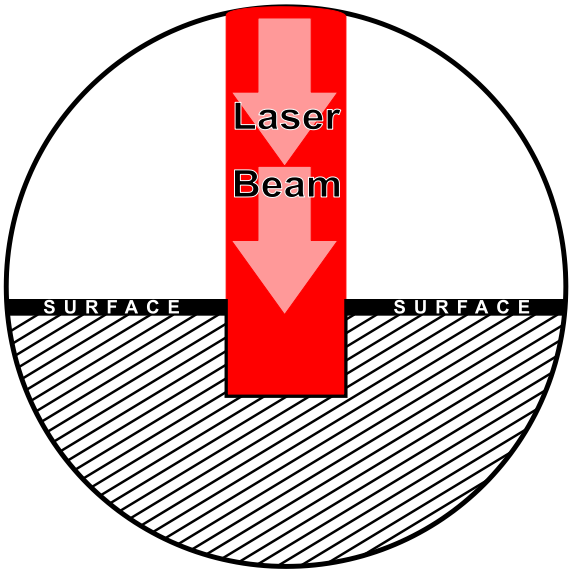
Engraving

The process of laser engraving involves vaporizing some of the base material with the laser beam, creating a cone shaped indent. Most plastics and all metal types, including coated metals, will directly engrave.

Melting or evaporating the metal surface requires a high level of energy. Using a lower frequency will help achieve more engraving depth. Polishing (making a bright mark) is achievable with low energy running high frequency in a second pass.

Laser Engraving

Vaporizing some of the base material, Cone shape indentation



Scan this QR code with your mobile device to watch a short metal engraving process video

Engraving examples

Because engraving is a process that works on many different materials including metals and plastics, it commonly used in a wide range of industries for many different applications. Below are some examples.

Precision marking and small characters on tools and measurement devices

Part numbers engraved on automotive part

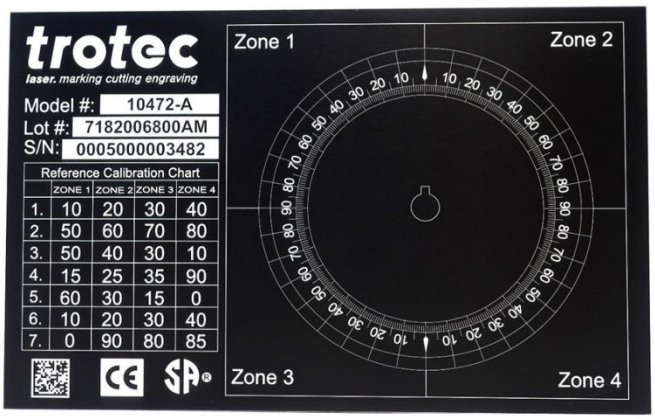
Product info engraved on plastic housing for mechanical component

QR code engraved on stainless steel part for asset tracking

Coating Removal

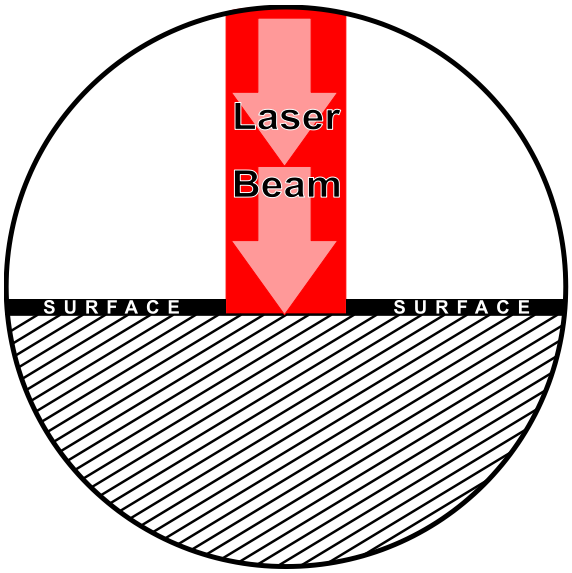
The process of coating removal is accomplished by applying fiber laser heat to remove the top layer or "coating layer" of material. This is a high-speed marking process that produces high-contrast markings.

Examples of "coating layers" include anodization, electro-plating, powder coating, enamel coatings, galvanizing, or bluing.



Coating Removal

Removing coating layer from surface of materials



Scan this QR code with your mobile device to watch a short video on the process of engraving coated metal

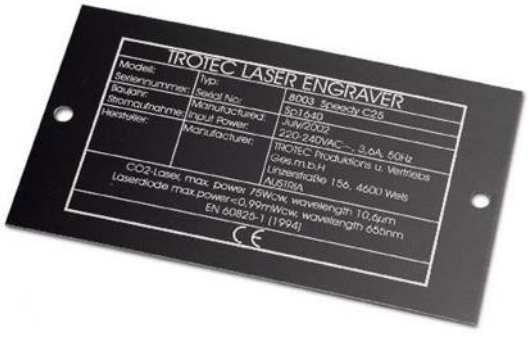
Coating removal examples

Like engraving, the coating removal process can be applied to metals and plastics alike. With coating removal, however, there must be some kind of a top layer or coating layer to remove. Below are some examples of items marked using the coating removal process.

QR code and bar codes marked on anodized aluminum data tag

Stainless steel tumblers personalized using the coating removal process

Bar code and serial number marked on plastic data tag



Product information including small point lettering marked on anodized aluminum data tag

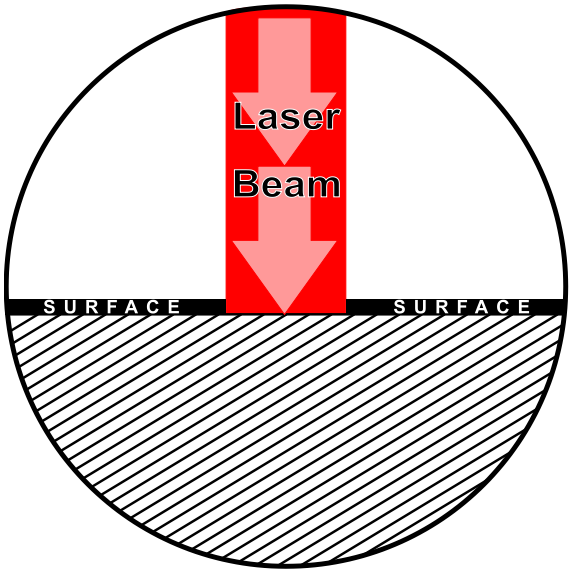
Serial numbers and part numbers marked on ball bearings

Color Change (Plastics)

During the color change marking process, laser heat removes the material's pigment only, drawing out the contrast, but producing no depth. The result depends heavily on the composition of the plastic. Not all plastics will process this way.

Laser Marking

Contrast on surface producing little to no depth



Scan this QR code with your mobile device to watch a short video on plastic contrast marking

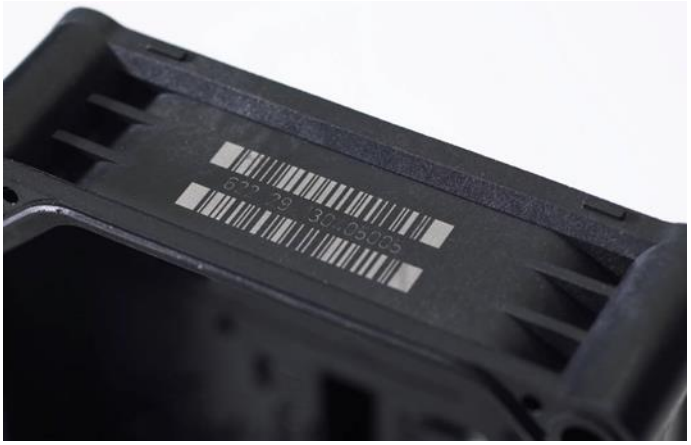
Color change examples

The color change laser marking process is widely used for applications that involve marking plastics such as black acrylic, black ABS, white ABS. Below are some examples.

Small lettering laser marked on remote control using the color change method

Color change marking on an ear bud case

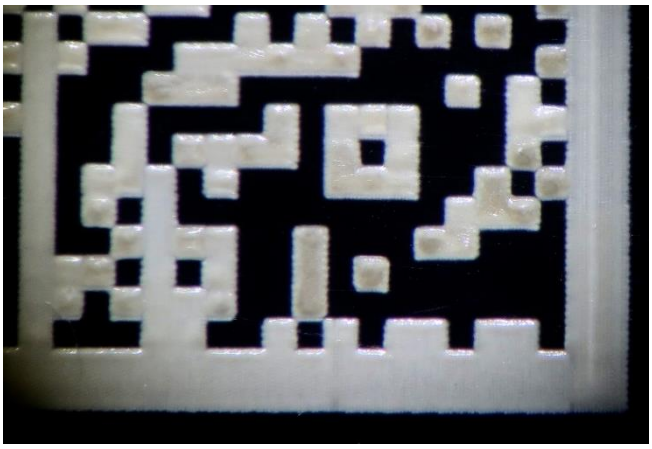
Part number and company logo marked on assembly part



Serial numbers and bar code on automotive part for asset tracking

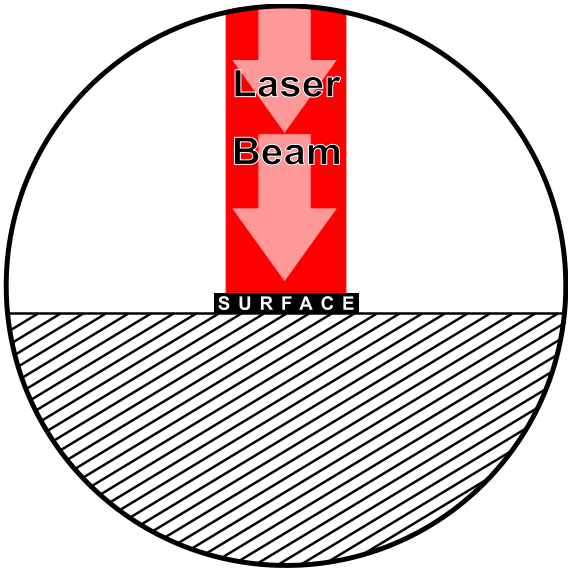
Color Change Foaming

During the color change foaming process, fiber laser heat removes pigment from plastic to create a contrast. The heat also creates air bubbles that produce a slightly raised mark. The result depends heavily on the composition of the plastic. Not all plastics will process this way.



Laser Foaming

High heat with color change producing raised effect



Scan this QR code with your mobile device to watch a short video on the process of contrast foaming

Color change foaming examples

Color change foaming is used only with certain plastics for applications that require a raised mark, such as a keyboard or other controlling devices. The most commonly used material for the method is Delrin. Below are some examples.

Marking on key fob using color change foaming method

Product information marked on assembly part

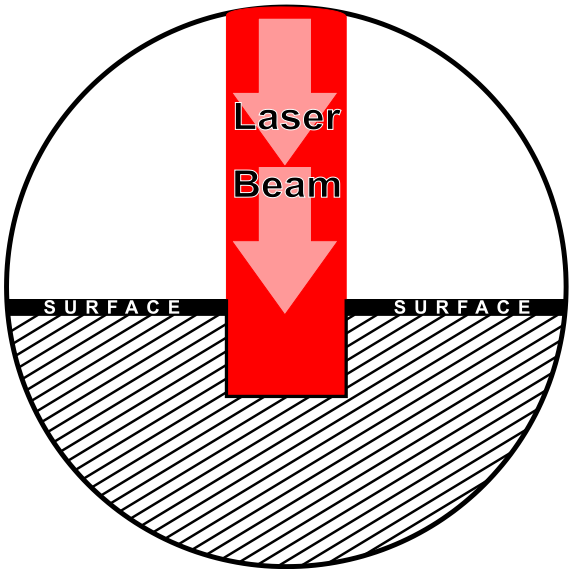
Letters and symbols marked on keyboard keys

Deep Engraving

The deep engraving process is accomplished as laser radiation causes the material to melt or evaporate, creating depressions in the material. Although this is a time-consuming, multi-pass process that requires a high level of energy, it produces a very durable marking.

Laser Engraving

Vaporizing some of the base material, Cone shape indentation



Scan this QR code with your mobile device to watch a short video on the process of deep engraving

Deep engraving examples

Deep engraving can be applied to a broad range of materials, but is seen most commonly in harsh conditions where only an extremely durable mark will hold up over time, and often (though not always) the method is used on metal workpieces. Here are some examples.

Deep engraving on stainless steel control pad

Deep engraving lettering and images on commemorative coin

Deep engraving of a logo on a steel gear

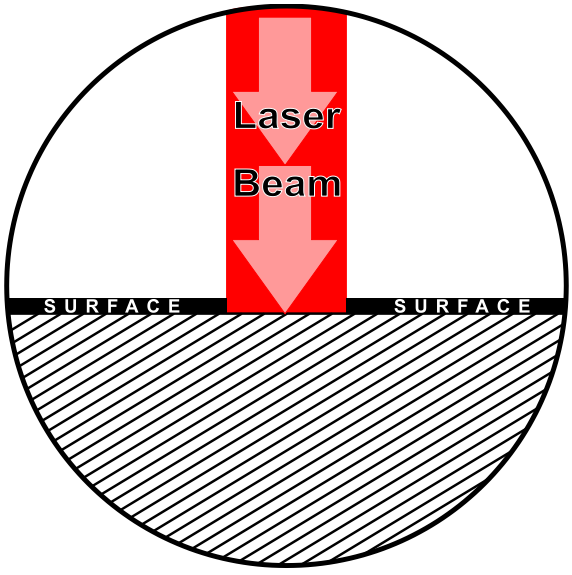
Product information deep engraved on aluminum

Annealing

Marking by annealing involves heating the surface of metals to just below the melting point to create an oxide layer below the surface. Once the carbon rises to the oxide layer (which takes some time), the result is a high-contrast smooth mark that does not damage the material surface. This method is a slower process that requires a defocused laser beam and a generous amount of heat. The annealing marking method works well with metals that have a high carbon content, including stainless steel, titanium, and some other metals.

Laser Annealing

Surface is heated to produce contrast mark with no depth



Scan this QR code with your mobile device to watch a short video on the annealing process

Annealing examples

The method is often used for cutlery and medical devices, and other applications used in environments where a sterile environment is required, because the resulting mark leaves the surface smooth and undamaged so that bacteria cannot collect and grow. Below are some examples.

Product information annealed on medical device

Product information and logo annealed on stainless steel cutlery

Personalized pens

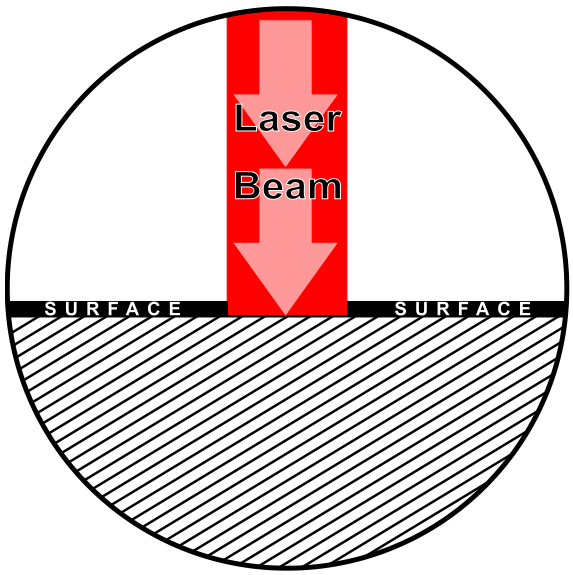
Product information annealed on medical device

Metal Color Change

Metal color change is the same process as annealing, but involves complex setting combinations to achieve a desired effect. Metal surfaces are heated to just below the boiling point to create an oxide layer below the surface. Once the carbon rises to the oxide layer (which takes some time), the result is a high-contrast smooth mark that does not damage the material surface. With the color change process, however, the power, speed, frequency, pulse duration and focus are adjusted to achieve certain colors.

Laser Annealing

Surface is heated to produce contrast mark with no depth



Scan this QR code with your mobile device to watch a short video on the metal color change process

Metal color change examples

Metal color change is most commonly used for effect. Like the annealing process, this method is a slower process that requires a defocused laser beam and a generous amount of heat, leaving the surface smooth and undamaged.

Images, logo and QR code on stainless steel plate

Logo marked on stainless steel plate with the metal color change process.

Resources

In addition to a comprehensive line of laser marking solutions, Trotec provides a higher level of service, including global resources, local, direct-manufacturer support, and a number of laser-marking resources including online tips and tricks, processing guides, local laser workshops, and a library of YouTube tutorials. Contact Trotec at 866-226-8505 or visit our website at troteclaser.com.

Scan QR code with your mobile device to learn more about Trotec laser marking solutions

Scan QR code with your mobile device to watch a short video tutorial on how to set up a basic marking program

Scan QR code with your mobile device to hear one of our customers share their experience using Trotec laser marking solutions.

About Trotec Laser

Trotec Laser is a leading international provider of advanced, high-speed laser equipment for cutting, engraving and industrial marking. With the broadest product line on the market, Trotec systems are used to cut, engrave or mark a wide range of materials including wood, paper, metal, acrylic, leather, stone, plastics, and more. The company's extensive line of quality laser systems, coupled with its unmatched service and support offerings, have made Trotec one of the industry's leading resources for computer controlled engraving equipment and marking systems. Trotec highly values innovation and R&D; in fact, over a decade ago Trotec developed the world's first laser system that combines CO_2 and fiber laser technology in one machine. All major equipment components and products are manufactured in the U.S. and Austria. Trotec machines are currently used in more than 90 countries around the globe. With 500 employees working in 17 international sales branches, Trotec offers customers an international service and sales network.