GRAVOTECH

by BRADY

EBOOK

Getting started with laser marking on plastics

Are you a company (small, medium or large) that has already purchased a laser machine, and would like some advice on how to **get started with plastic marking?** Or perhaps you're still wondering **which laser technology to choose** for engraving your plastic parts or those of your customers?

To successfully mark your plastic parts, you need to know the **characteristics** of your material, the **laser sources** to choose, and the expected **rendering**.

In this guide, you'll find all the information you need... and a few tips from our experts!

Our experts

Juan José FRANCISCO DIEZ
Gravotech's Industry Segment Market Manager, Juan José defines product development strategy based on industrial trends and applications.

Industry Segment Market Manager

Dylan GARCIA
A photonics prototyping and validation engineer, Dylan is in charge of developing test strategy, technology watch and piloting innovation projects linked to laser technologies.

Prototype testing and validation engineer

Watch our video!

Summary

The chemical composition of thermoplastics (TPE) and its impact on laser marking

Before getting started with laser marking, you need to know the material you're marking. Here's an overview of plastic types and their properties.

1 PET

2 HDPE

3 PVC

4 LDPE

5 PP

6 PS

7 OTHER

For further details see page 6 ⟶

Polymers: 3 levels of classification to consider

1. Polymers or plastics

In common usage, the word "polymer" is often used as a synonym for "plastic". But this is a **misuse of language**: plastics are not made up of polymers alone. They also contain **various additives** (plasticizers, colorants, fillers, etc.).

We distinguish **three main families** of plastics:

Thermoplastics
(e.g. LDPE, HDPE, PVC, PP....)

- No chemical change in plastic structure
- Malleable, high deformability

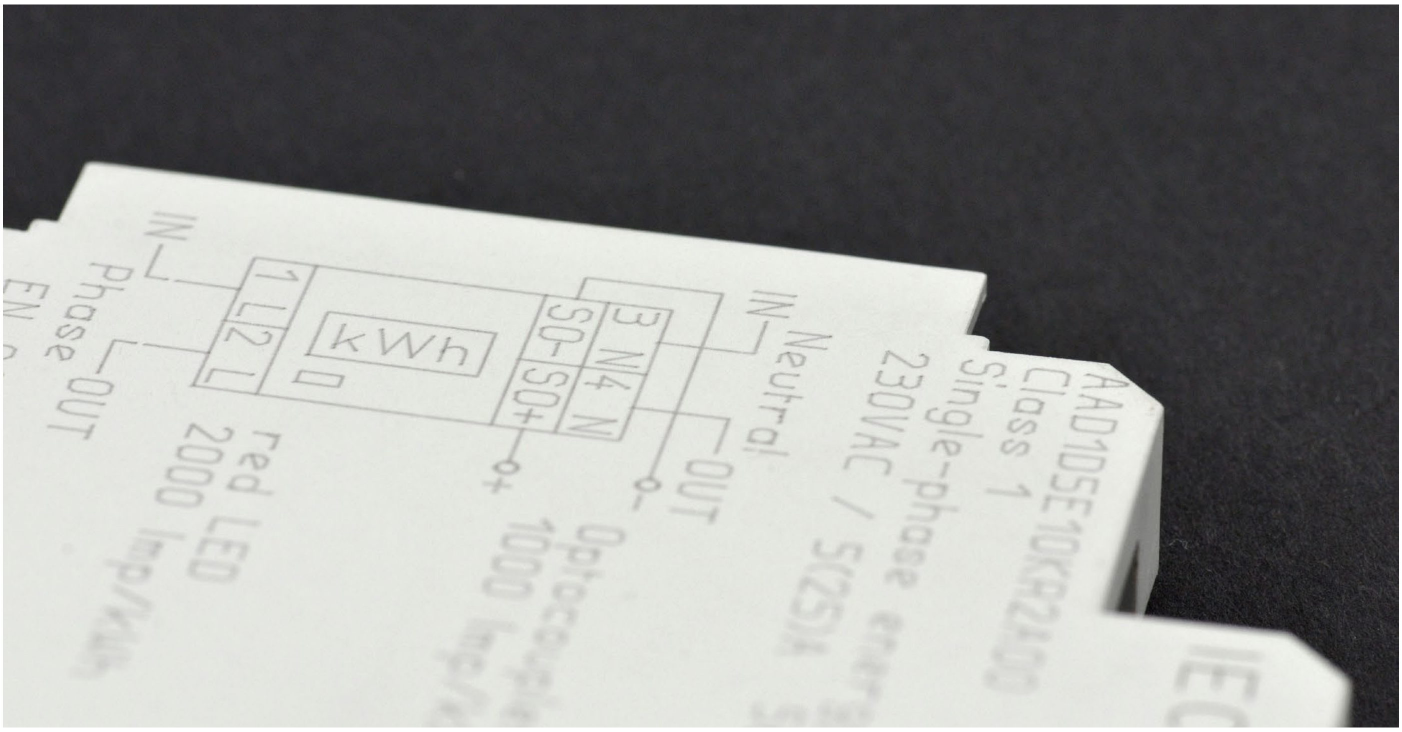
Thermostable / thermosetting
(e.g. Bakelite, Epoxy, PU...)

- Chemical change to be expected
- Cannot change shape once transformed

Elastomers
(e.g. Rubber, IR, CR, NBR...)

- Elastic
- High deformability

We'll only mention the **most widely used** plastics here: **thermoplastic** polymers. They owe their popularity to their **chemical stability** - even when subjected to heat - and their **malleability**. Produced on a large scale since the 1970s, they are widely used in the automotive industry.



2. Thermoplastics, the most widely used polymers

There are **8 sub-families of thermoplastics**, with distinctly different properties. Manufacturers therefore favor one or the other, depending on the intended use.

	Family	Sub-family	Examples of use
Thermoplastics	Polyolefin	**PP, PE**	Food storage, stretch film, automotive parts, etc.
	Polystyrenics	**ABS**	Automotive parts, household appliances, medical equipment, etc.
	Polyvinyl	**PVC**	Piping, various coatings (floor, pool, etc.), doors and windows, etc.
	Polyester	**PET, PETP, PBT**	Bottles, textile fibers, automotive components, electronic components, etc.
	Polyoxymethylene	**POM, POM-C**	Automotive electronic components, industrial components (gears, bearings, etc.), etc.
	Polyacrylic	**PMMA**	Glazing, display panels, screens, packaging, etc.
	Polyamides	**PA**	Textile fibers, automotive components, industrial components, etc.
	Polycarbonate	**HDPE, PS, PC**	Food packaging, pipes and ducts, medical components, automotive components, etc.

However, the **composition of plastics** within each sub-family is not fixed.
The same range may contain materials with different properties and compositions!

3. Variations in composition within thermoplastic sub-families

The ratios of components used to produce a thermoplastic vary according to the **manufacturer** and the **final properties desired** for the product.

This is the case, for example, with **ABS**, a material composed of acrylonitrile, butadiene and styrene.

- It is **more rigid and solid** when its formulation contains a high percentage of styrene.
- But it is more **flexible and impact-resistant** when rich in butadiene.

No single product: this multiplicity of combinations broadens the range of ABS available on the market.

The same applies to other types of thermoplastic. It would be impossible to detail the variations in formulation for each of them - it would take too long. That just goes to show the diversity of this material!

Note that the principle also applies to "new plastics", such as **recycled plastics** or those composed in part of **organic materials**. Their production processes differ from those of standard thermoplastics. The same applies to their composition... and their reaction to laser marking.

The impact of thermoplastic composition on laser marking

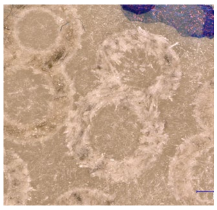
Of course, the **composition of a plastic affects its reaction to laser marking**. Take into account the percentages of the materials it contains before taking the plunge.

Even so, there are thousands of different thermoplastics. Whatever laser technology you use, the possibilities for marking your plastic parts are endless!

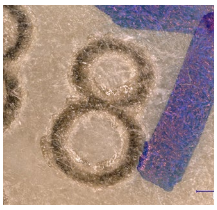
Good to know

The plastic of your choice isn't suitable for laser marking? In general, it can be modified to **make it suitable for laser engraving** with a suitable **additive** or masterbatch.

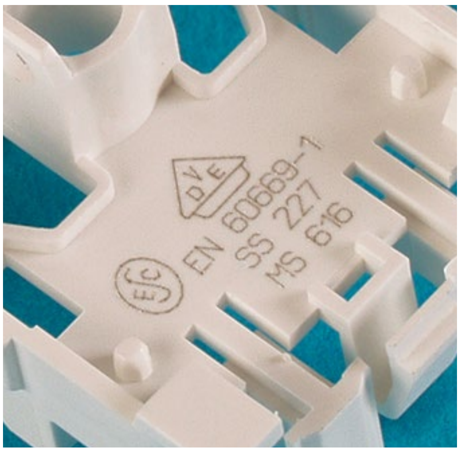
The addition of color pigments, for example, can influence the plastic's suitability for laser marking.

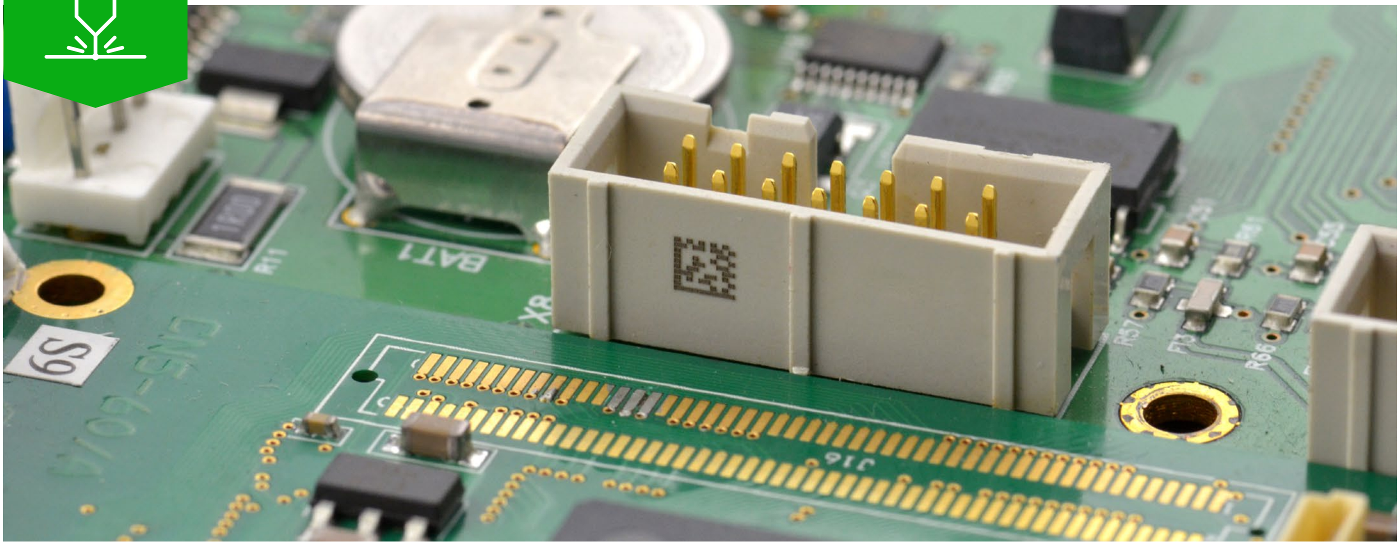


Before additive



After additive





Types of laser sources

The French plastics industry association Polyvia and Gravotech teams worked together to carry out a series of laser marking tests on polymers supplied by Polyvia. These tests produced the following results.

The green DPSS* laser

This is the ideal solution for plastic marking, for several reasons.

- Results were excellent for 45% of polymers tested (only 15% of plastics failed to react).
- Their **shorter wavelength** compared to other lasers allows a **better absorption rate** by certain light-colored or transparent plastics, and therefore **marking.**
- Their **thermal stress is lower** than that of CO2 lasers. The fact that they generate less heat means they can engrave **heat-sensitive plastics**, reducing the risk of material deformation or thermal damage.
- Their smaller laser beam spot size enables **greater precision** and marking resolution.

Is a green DPSS laser the best solution?

It all depends on your project. To guarantee quality marking, pay attention to two key points:

- Your **choice of material**: the green DPSS laser is not suitable for all applications, as some plastics react better to other wavelengths.
- **How you use** the technology: the laser's power, scanning speed and energy density... all affect its performance

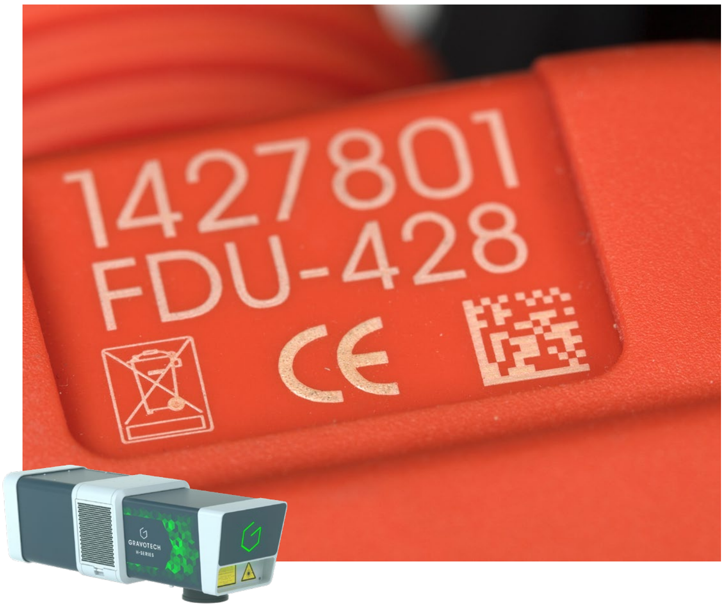
Another point to consider: your **budget**. The green DPSS laser remains a more expensive solution than the others.

** Diode Pumped Solid State Laser*

Fiber laser

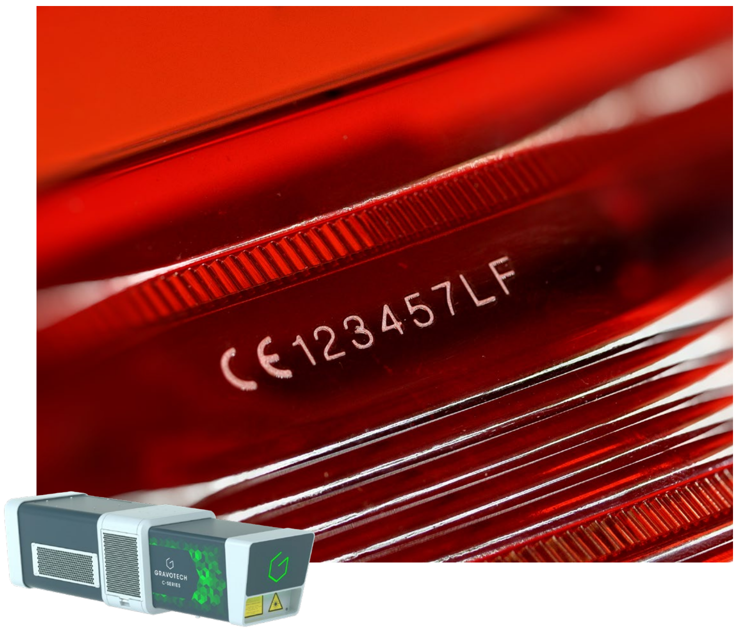
Fiber technology is powerful, and marks metals particularly well. You can also use it on **most plastics,** with decent results.

Note that results vary greatly depending on the polymer you use. For example, only **42% of polymers** are marked with **contrast**.



The DPSS hybrid laser

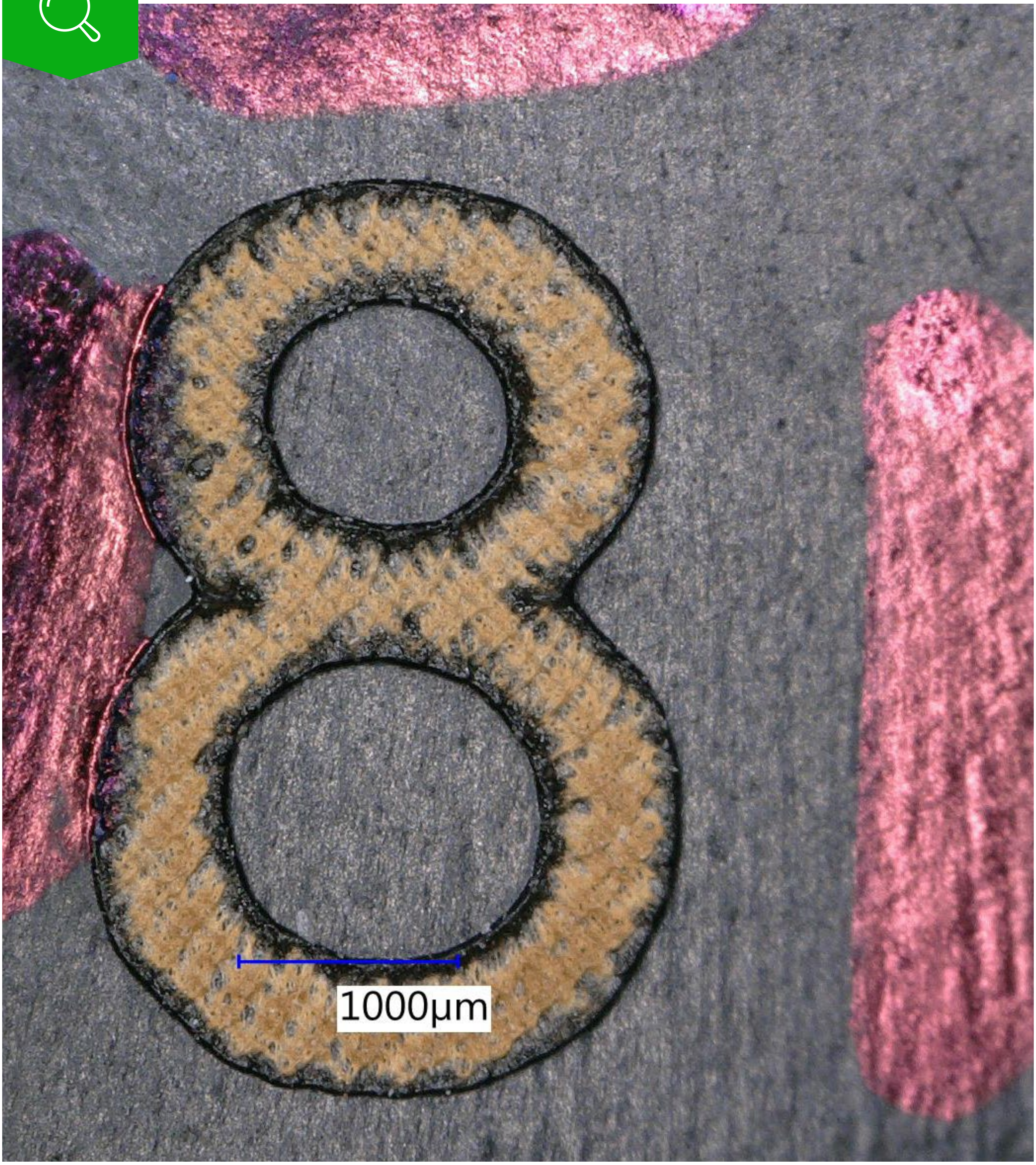
These lasers are far **more precise** than fiber technology, and feature a **shorter laser pulse duration.** They therefore deliver **better marking** marking results: while 30% of the polymers tested by Gravotech's teams did not react, 30% showed **excellent results.**



CO2 laser

CO2 lasers can also mark plastic, but **without contrast.** It is therefore more often used for engraving organic parts (wood, glass, leather, ceramics, etc.).

Transparent plastics are an exception. In fact, the CO2 laser is very useful for engraving this type of material, on which the marking stands out well.

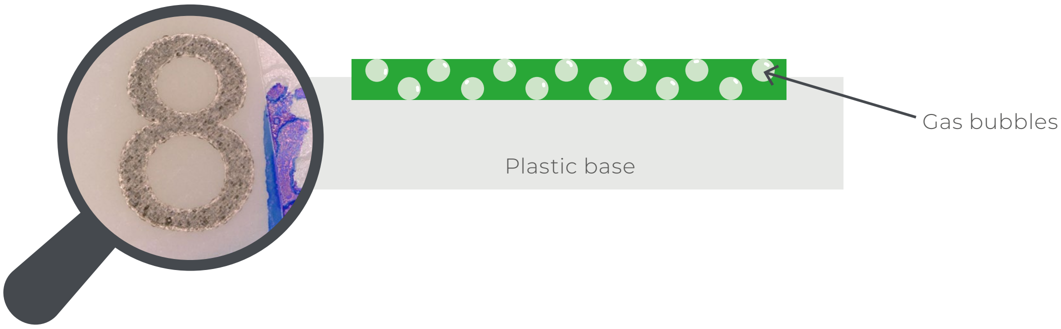


How laser marking
laser marking of plastics

Possible interactions between polymer and laser

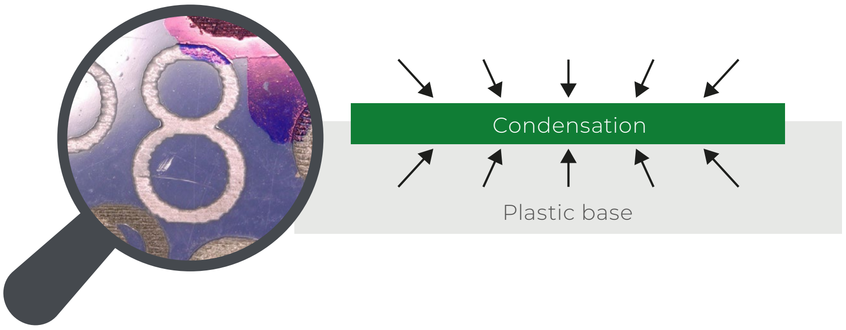
The effect of lasers on plastic differs according to the laser source used and the properties of the material to be engraved. Discover the **5 ways** in which plastics react to laser marking - all technologies considered - and the resulting rendering.

Gas bubbles or foaming



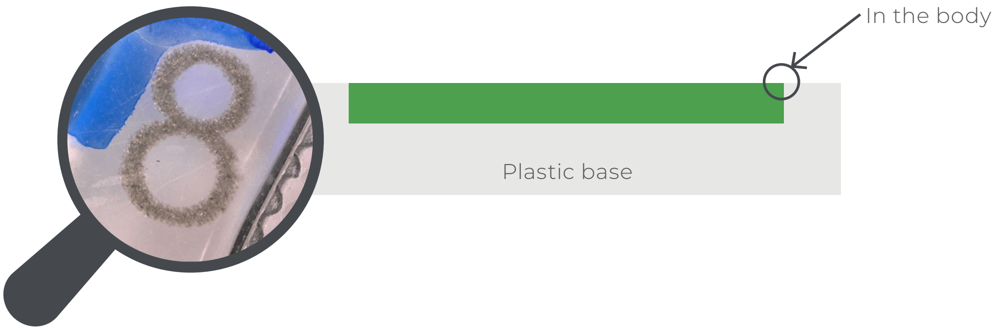
The laser vaporizes volatile components in the plastic. Bubbles or small cavities appear on the surface. In this case, the marking appears **brighter** on **dark plastics.**

Surface colorization



Here, the laser does not deeply mark the plastic. Instead, the laser's heat **interacts with the pigments or additives** present **on the surface** of the polymer. It then causes a **color change** on the thermoplastic, which can be useful if you want to create **visual contrasts** or to create **colored marks.**

Body colorization

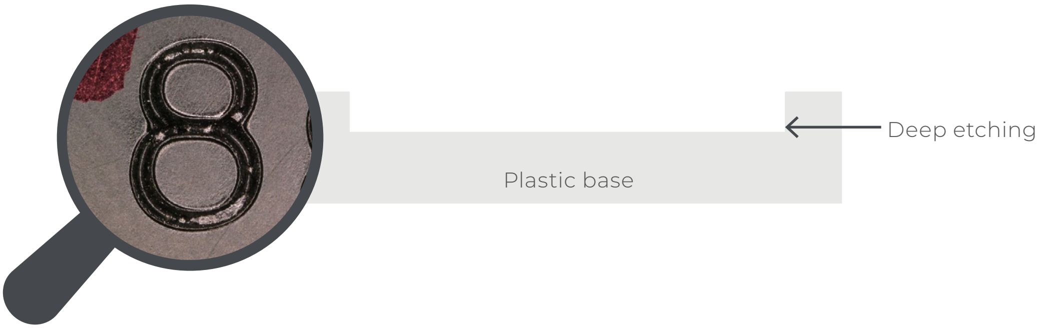


The principle is similar to that of surface colorization. The difference: here, it's **the chemical structure of the material itself** that the heat of the laser modifies. The color change is not limited to the surface of the material - it takes place within the body itself.
This reaction, like the previous one, makes it possible to produce **contrasting markings**. It also preserves the **shape of the surface:** no "bumpy" deformation, it remains flat.

Carbonization

This occurs when the laser temperature is particularly high. In such cases, the plastic decomposes thermally. The result is the appearance of **carbonized residues.**
Carbonization produces **black or dark marks** on the plastic.

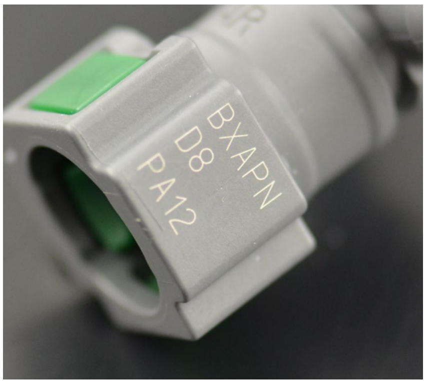
Sublimation



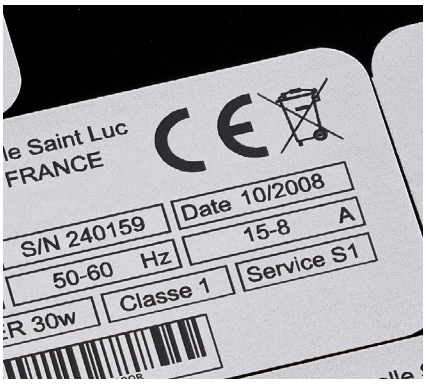
This is another possible reaction of plastic to a high-temperature laser beam. The marked area is sublimated: the laser **scratches** the surface. This marking method is used in particular for multi-layer plastic components or automotive laminates.

Types of plastic marking possible with laser technology

The laser can be used for all types of marking, including those requiring a high level of detail. For example, you can produce :



Alphanumeric characters



Logos and drawings

Codes (1D, 2D, flashcode, QR code, barcode...)

What's important is that your choice of laser source and the use you make of it are in line with the plastic you're going to mark.

The need for testing

Virtually infinite thermoplastic compositions, various laser source options, different ways of using machines... Laser marking of plastics is subject to **many variables**.

To achieve the desired effect, you'll need to carry out **tests** which, without experience, can be time-consuming and irrelevant. How can you **guarantee their effectiveness**? You can rely on **Gravotech experts** to accompany you through the testing phases.

The advantages of laser marking

In addition to the number of materials it can mark and the variety of possible finishes, laser marking on plastic offers **4 major advantages.**

Durability

Laser marking is **permanent** and as **durable** as the polymer itself. It is resistant to:

- oils ;
- aggressive products, to a certain extent - i.e. until the polymer itself degrades ;
- aging.

Reliability

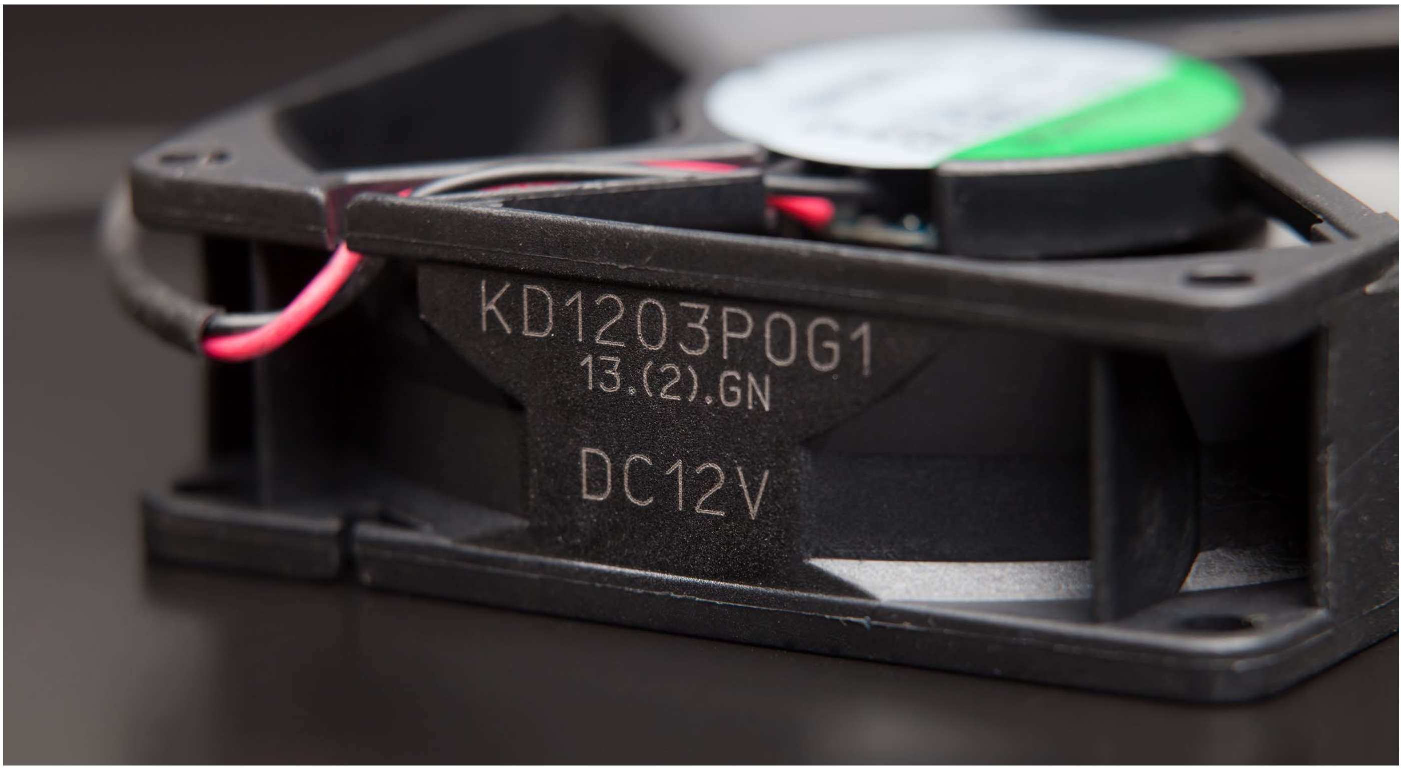
Laser marking requires no tools or products other than the laser itself - no use of chemicals, inks or labels...

Non-contact marking

The laser marks plastic without touching it. Some of the benefits are obvious - **no tool wear,** less debris and dust... But it also makes it possible to mark surfaces impossible to engrave with other technologies, such as very small electronic components or delicate medical equipment.

Respect for the material

The laser rarely alters the plastic part outside the marking zone, unlike mechanical engraving, for example, which hollows it out by removing the material with a milling cutter.



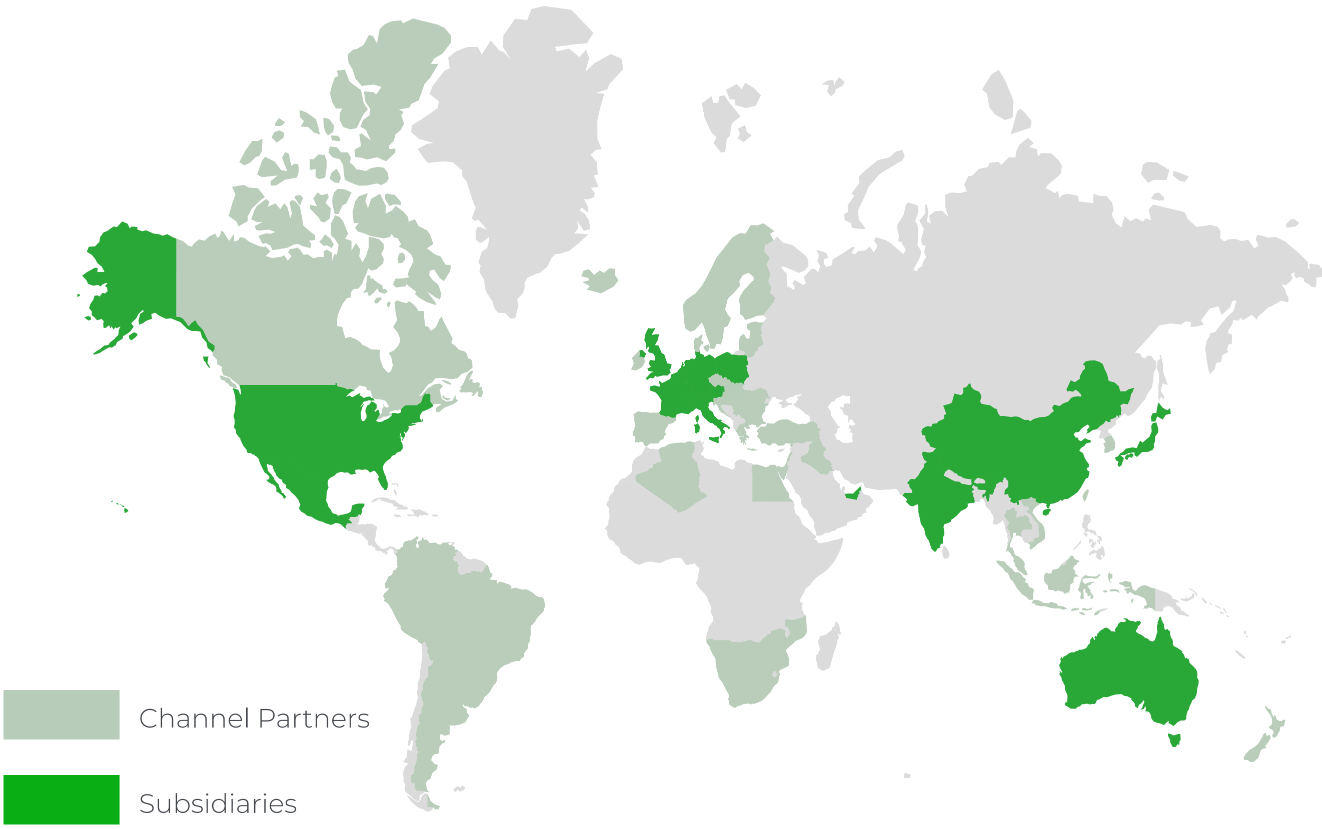
There are many constraints when it comes to laser marking of plastics: the composition of the material, the hardness of the part, the desired finish and other requirements in your specifications... Depending on your level of expertise, the choice and handling of a laser marking solution may require specific expertise and support.

Are you looking to mark polymers? Gravotech can help you determine which laser is best suited to your project. Benefit from test phases to identify the right technology, as well as customized parameterization by experts.

Contact the Gravotech teams to guide you through the process.

Contact a Gravotech expert

Gravotech, leader in permanent marking solutions



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