trotec

Trotec eBook
The laser machine as an alternative to the milling machine

SETTING NEW STANDARDS

Laser technology is a future-proof technology that enables new business models, additional sales, high quality and productivity. The advantages of the laser machine are particularly evident when processing acrylic. This eBook explores the “milling” and “laser cutting” technologies. The advantages and disadvantages of the two methods are explained below.

Before we compare the technologies with a specific example, let’s introduce the function of the laser machine.

The laser machine as an alternative to the milling machine.

1 / How does a laser machine work?

"LASER" is an acronym and stands for "Light Amplification by Stimulated Emission of Radiation".
In simple terms: Light particles (photons) excited with current emit energy in the form of light. This light is bundled into a beam, the laser beam.

All laser machines consist of three components:

- an external pump source,
- the active laser medium and
- the resonator.

The pump source guides external energy to the laser machine. The active laser medium is located on the inside of the laser machine. Depending on the design, the laser medium can consist of a gas mixture (CO_2 laser) or glass fibers (fiber laser). When energy is fed to the laser medium through the pump, it emits energy in the form of radiation.
The active laser medium is located between two mirrors, the "resonator". One of these mirrors is a one-way mirror. The radiation of the active laser medium is amplified in the resonator. At the same time, only a certain radiation can leave the resonator through the one-way mirror, namely in bundled form, the so-called laser radiation.

Laser radiation has three fundamental properties:

1. Monochromatic. This means that the radiation consists of only one wave length.
2. High coherence and thereby phase coincidence.
3. The waves of the laser machine are approximately parallel due to the coherence.

Due to these properties, the laser light is used in many areas of modern material processing. The intensity is preserved for a long time due to the coherence and can be bundled even further through lenses. Where the laser beam hits the material surface, it is absorbed and thus the material is heated. This heat development leads to material removal or complete vaporization of the material. A cut, an engraving or a marking is created.

Laser sources - how to differentiate between laser machines

Today, there is a wide variety of laser machines available on the market. One way to differentiate between them is the laser source built into them. The main laser types used are CO_2lasers or fiber lasers. Each type of laser has its own advantages and disadvantages and is suitable for processing different materials.

A CO_2 laser is suitable for processing wood, acrylic, glass, paper, textiles, plastics, foils, leather and stone. The fiber laser is ideal for marking metals by means of annealing, for metal engraving or for high-contrast markings on plastics.

Inventor of the laser

The American physicist Theodore H. Maiman developed and built the first working laser machine in 1960. At that time, a ruby crystal was used as a laser medium. Albert Einstein provided the theoretical basis for the laser more than four decades earlier – with his principle of stimulated emission.
But only in the course of time did it become clear what is possible with the “magic” laser beam: engraving, marking and cutting a variety of materials.

2 / The two types of processing: Milling versus laser cutting

A practical example

The letter “t” from the Trotec logo with a height of approx. 300 mm is cut from a 10 mm thick acrylic sheet measuring an area of approx. 2 x 3 meters. This is implemented using the two technologies of milling and lasering.

Implementation with the milling machine

A milling machine can automatically manufacture workpieces using control technology with high precision, for complex shapes such as lettering and from different materials.

The machine operator carries out several steps before processing:

- The milling cutter is checked for sufficient sharpness
- The 2 x 3 meter acrylic sheet is placed in position by 2 employees.
  The sheet is fixed into position because forces act on the material during processing with the milling machine
- When creating the program or when preparing and checking all parameters for milling, attention must be paid to the minimum size of the components. If a component is smaller than approx. 50 x 50 mm, it must be provided with links, as the suction power of the vacuum table is not sufficient to secure the workpiece during the milling process.

Four steps are carried out during the multi-stage process:

1. First, the roughing is done with an immersion depth of 5 mm
to roughly create the contours

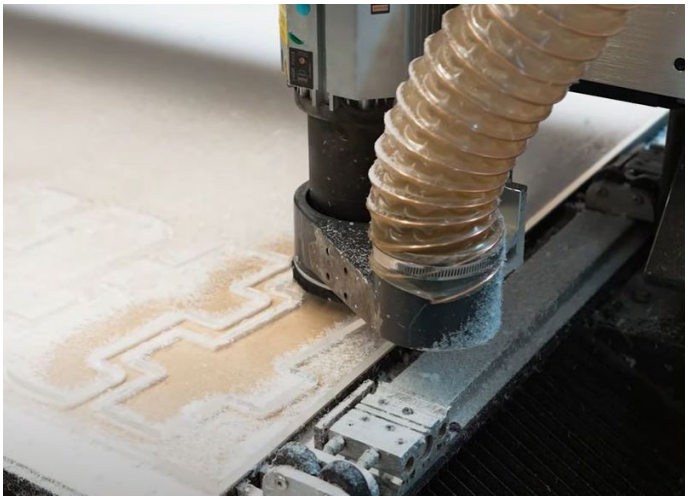
2. In the second step, the 10 mm letter is completely milled.

3. Now a tool with a 4 mm diameter must be used for the corner radii on the “t”. The smallest radius that can be achieved is 2 mm.

4. In the fourth step, polishing is carried out with a diamond cutter
in order to produce the crystal-clear edge. Despite the polishing cutter,
depending on the type of clear base material, you will not get a clear cut like with lasering; clear cores almost always have to be reworked.

After processing – cleaning the milling machine

In the next step, the machine should be cleaned and freed from chips, and new tools should be upgraded if necessary. The service life and sharpness of the tools must be checked after each milling process.



The entire preparation process including cleaning takes 50 seconds

Implementation with the Trotec Laser SP3000

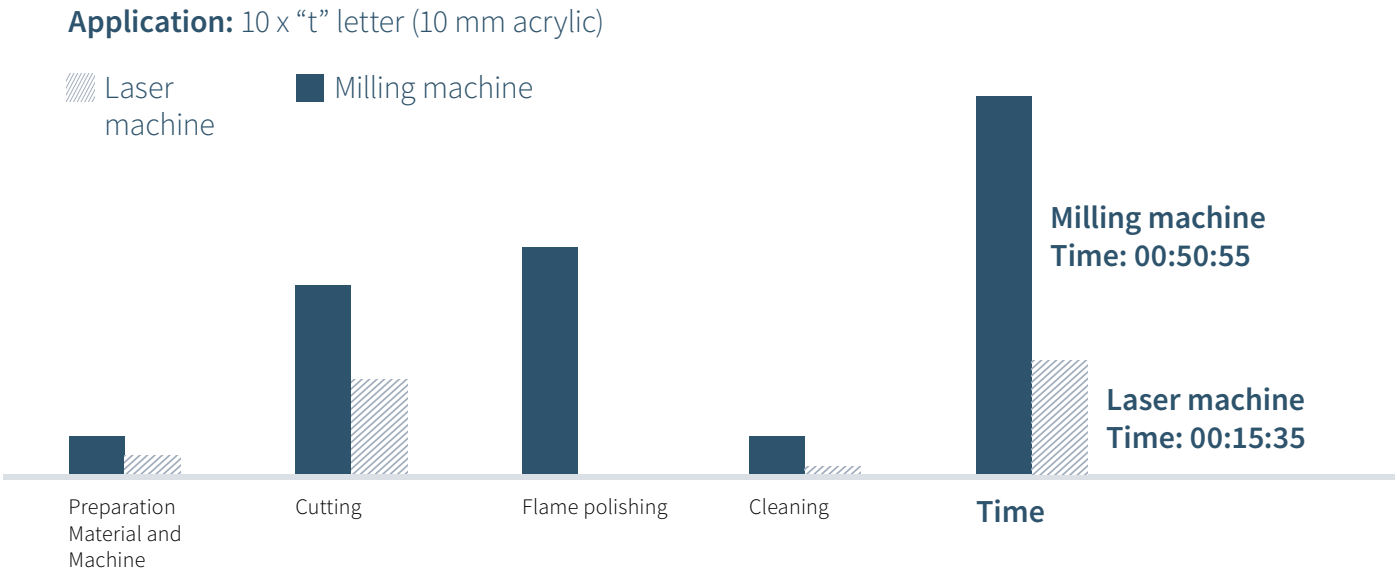
Before processing:
The acrylic sheet is placed in position by 2 employees. The ergonomics of the Trotec SP3000 laser machine are very good: rounded edges, accessible from all four sides and large sheets can be easily loaded. The laser cutter works without contact with the workpiece and therefore has no mechanical wear on the tool. This means that there's no need to check the tool.

During the processing
The laser machine completes the process in approx. 15 seconds and the smallest radius of approx. 0.2 mm can be implemented without changing tools.
The closer nesting saves material. The letters can therefore be nested tightly, because only minimal forces act during processing. The typical minimum spacing is 3-5mm depending on the sheet thickness. Laser cutting automatically creates a crystal-clear edge and no reworking is required. Contours can be produced unchanged as in the design.

After the processing
In this step, the machine doesn't need to be cleaned, just unloaded.

In total, all work steps with the SP3000 laser machine only take 15 seconds.

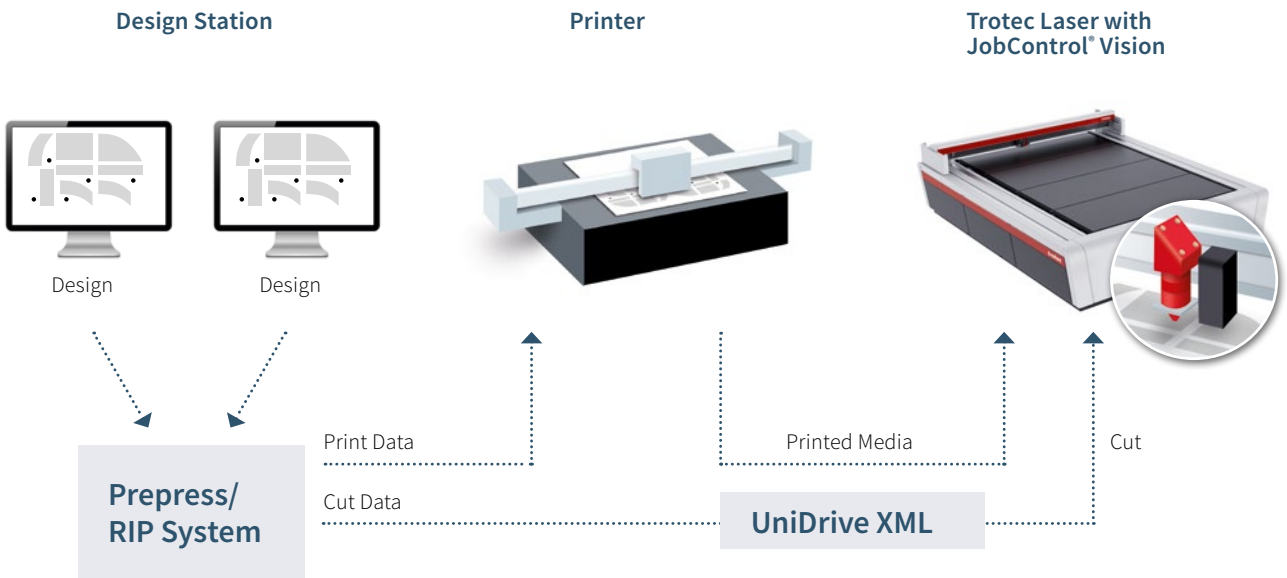
3 / A time comparison of the process steps of both technologies



4 / What are the clear advantages of the laser machine over the milling machine?

No set-up times, no tool changes: saves work steps and thus time.
Precise cut edges, finest geometries and at high speed: small cuts are also possible, clean edges are produced immediately during laser cutting; in contrast to the milling machine, no post processing is required.
Lasering is almost silent: the low noise level is an essential factor for the staff and their occupational health.
Less material is used: With the laser machine, the motifs can be set and cut very close to one another - with a spacing of up to 4 mm! This optimizes and reduces material consumption. 25% of material can be saved annually thanks to the lower waste per sheet. The lower material consumption also protects the environment.
Clean work: the technology of material heating means that the material is vaporized and no chip residues are produced.
No cleaning of the laser machine: required after material processing.
Seamless integration into your data workflow: the integration of the laser cutter into your data workflow is seamless thanks to RIP and CAD compatibility. The fully automated PDF interfaces allow data from the pre-press or work preparation to be sent to the laser cutter. Time-consuming preparation or parameterization of the cutting data is not necessary.
Economical manufacturing: whether it's a single piece or a series – the laser technology works economically.

Seamless integration into the data workflow



5 / What are the advantages of a milling machine?

A milling machine has advantages when creating components into which grooves or steps are to be milled.
Just like with a laser machine, a wide variety of workpieces and materials such as wood, acrylic and metal can be processed with a milling machine.

Compared to modern laser technology, milling has disadvantages in terms of processing:

- Even if you use a polishing cutter,
  depending on the type of clear base material - you won't get a cut as clear
  as with lasering.
- Flame polishing carries the risk of damaging material,
  resulting in defective products.

6 / What can you do with a laser machine – what are the fields of application?

With a laser machine you can cut, engrave and mark different materials, even those that are large-scale,
in order to create a wide variety of products.

With a laser cutter you can process large-scale parts as well as creating delicate (architectural) models or refining paper. Laser cutting is also a popular manufacturing process when cutting large-scale materials or technical textiles in the automotive industry – for example, when cutting car seats or interior linings.

Products in **advertising technology:** LED fully acrylic letters, profile letters, illuminated banners, signs, pylons – these and other applications can be implemented using the laser machine.

In **the packaging sector** the versatility of laser cutting is used: Paper or cardboard can be easily and flexibly perforated or scored.

Laser cutting is a simple process, without complex preparation and post-processing. Laser cutting is done with high precision and speed. With certain materials, e.g. acrylic, there is no post-processing.

For which industries are laser cutters interesting?

Advertising technology and digital printing: POS displays, neon signs and advertising signs or acrylic letters are produced with crystal-clear cut edges
Electronics industry: Laser cutting of foils and membrane keyboards made of plastic such as polyester, polycarbonate, polyethylene terephthalate and polyamide

Creative sector: Toys, puzzles, craft supplies made of wood
Fashion, design & handicraft: Natural leather, artificial leather, cotton, linen, felt (clothing, jewelry, decorations)
Packaging industry: Used in packaging prototypes

Printed displays in unusual shapes

Manufacturing inexpensive partitions for sales counters

Flame-polished cut edges for cosmetic displays

Contour cutting of printed signs

Laser-cut letters for indoor or outdoor advertising

Value creation with print & cut applications

7 / How do large-format laser machines of the Trotec SP series work for large-scale materials?

The laser cutters of the SP series are CO_2 laser machines for large-scale materials. The highly-efficient laser plotters (flatbed lasers) are perfect for demanding cutting applications, e.g. with plastic or acrylic glass, textiles, wood and other materials.

SP series

Laser type:	**CO_2 laser**
Work area:	**1245 x 710 – 2210 x 3210 mm**
Max. workpiece height:	**50 – 112 mm**
Laser power:	**40 – 400 watts**

The laser cutters of the SP series are designed for the fast and precise processing of large-format materials.

The sophisticated features ensure a simple, productive workflow:

- **Four-sided access** to the laser processing area: The open design allows quick and ergonomic loading and unloading even during processing.

- **Tandem Assist:** By dividing the work area into two virtual areas, while laser processing on area A, area B can, for example, be emptied and filled with new material.

These two features combined with high cutting speed result in maximum productivity. The entire work area is used without any idle time. The laser cutter can be seamlessly integrated into your automated workflow thanks to RIP and CAD compatibility.

Four-sided access

Tandem Assist:

8 / What materials can a laser machine process?

A wide variety of materials can be processed with laser machines. Laser cutting is possible for plastics (acrylic, polyamide, etc.), organic materials (e.g. wood, leather, paper) and metal foils. This table provides an overview of materials that can be cut and engraved. We're also happy to provide individual samples of your material.

Plastics	**Cutting**	**Engraving**
Acrylic (PMMA)	●	●
Acrylonitrile butadiene styrene copolymer (ABS)	●	●
Engraving materials (laminates)	●	●
Polyamide (PA)	●	●
Polybutylene terephthalate (PBT)	●	●
Polycarbonate (PC)	●	●
Polyethylene (PE)	●	●
Polyester (PES)	●	●
Polyethylene terephthalate (PET)	●	●
Polyimide (PI)	●	●
Polyoxymethylene (POM) e.g. Delrin®	●	●
Polypropylene (PP)	●	●
Polyphenylene sulfide (PPS)	●	●
Polystyrene (PS)	●	●
Polyurethane (PUR) foam	●	●
Foam material (PVC free)	●	●
PETG (modified PET)	●	
SAN	●	
Fabrics		
Polyester (PES)	●	
Felt	●	●
Microfiber	●	
Spacer fabrics	●	
Leather	●	●
Artificial leather	●	●
Natural fiber (e.g. cotton, linen)	●	●
Wool	●	
Silk	●	
Aramid	●	
Various		
Wood	●	●
Cardboard	●	●
Paper	●	●
Cork	●	●

Can I cut metal with the laser machine?

Cutting metal requires a very high laser power; flatbed lasers typically don't have this. Furthermore, pure oxygen under high pressure must be used for metal cutting. Systems that are optimized for this are again not suitable for plastic cutting due to the high risk of explosion.

Nowadays, almost no CO_2 lasers are used for metal cutting. These have been completely replaced by fiber laser systems. With Trotec laser machines that contain a fiber laser source, you can engrave and cut thin metal foils made of aluminum, brass, copper or precious metals up to 0.5 mm

9 / Which materials can NOT be processed?

Please note that there are materials that you should not engrave or cut even with an SP laser machine. The reason for this lies in the materials themselves. They contain ingredients that are released during processing in the form of gases and dust, jeopardizing both the user and the functionality of the machine.
Important: You should also be wary of materials specified as "flame retardant". This special property is achieved through use of bromine, which is then released during processing.

These materials include, among others:

- low-grade leather (chromium VI)
- Carbon fibers (carbon)
- Polyvinyl chloride (PVC including synthetic leather based on PVC)
- Polyvinyl butyral (PVB)
- Polytetrafluorethylenes (PTFE /Teflon®)
- Beryllium oxide
- Materials that contain halogens (e.g. fluorine, chlorine, bromine, iodine and astatine), epoxy or phenolic resins

10 / What can a laser cutter do for your business – how can this be expanded?

New products – a variety of creative ideas With a laser machine you can quickly and easily expand your range – use additional materials, implement a wide variety of shapes and geometries. This enables you to expand your customer base and cover additional demand with your larger selection.

Differentiation in order to compete - increase competitiveness
Laser machines have the advantage over milling machines that they don't require any tool set-up time, they optimize material consumption and no post processing is required on cut edges, thus minimizing costs. This results in
clear competitive advantages over competitors.

Increase profitability & productivity
Many companies want or need to increase their productivity in order to cover additional demand and order volumes. Delivery deadlines and agreements must be adhered to in production, which requires reliable and stable manufacturing processes.
A laser machine is often the logical addition to an existing machine portfolio.

11 / Why is laser cutting profitable?

Laser cutting is significantly more cost-effective than other cutting processes, as processing steps are omitted compared to e.g. milling machines. Up to 50% of the processing time can be saved. The higher acquisition costs of the laser cutter amortize over the course of a year and turn into a significant cost advantage as early as the 2nd year of use.

Here is a calculation example:

Cost type	Milling	Lasering	Difference
Clamping material & creating vacuum	€ 10,500 (€ 35 / h * 300 h)	€ 0	
Edge finishing (flame polishing)	€ 70,000 (€ 35 / h * 2000 h)	€ 0	
Other set-up time and machine cleaning	€ 3,500 (€ 35 / h * 100 h)	€ 3,500 (€ 35 / h * 100 h)	
Filter costs	€ 0	€ 3,000 (60 kg activated carbon)	
Work head	€ 6,000 (€ 30 * 200 heads p.a.)	€ 4,000 (1/2 refill p.a.)	
	€ 90,000	**€ 10,500**	**79.500 €**

Cost advantage of a Trotec laser machine

Cost/yield type	Milling machine	Laser machine	Difference
Investment costs	€ 29,000	€ 115,000	- € 86,000
Process costs p.a.	€ 90,000	€ 10,500	€ 79,500
Additional profit contribution p.a. (new application acrylic engraving, etc.)	€ 0	€ 10,000	€ 10,000
Cost advantage after 1 year of production			**€ 3,500**
after 2 years of production			**€ 93,000**
after 3 years of production			**€ 182,500**

12 / Are you thinking of starting a laser business? What should you consider when buying a laser machine?

If you're interested in using laser technology, we can offer you an in-depth consultation. We'll talk about applications, operating equipment and financing so that you know what to expect, what advantages you can expect from the technology and how you can optimally integrate it into your workflow.

Make a clear plan internally or in consultation with us, set a goal that you want to achieve.
Our "10 questions before buying a laser" offers you a good guide as you enter the world of laser technology.

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