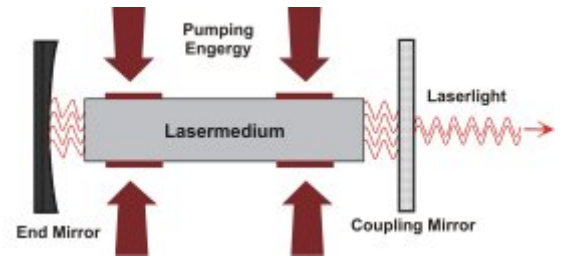


Laser Systems - The Basics

Generation of a Laser Beam

The term "LASER" is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. Lasers amplify light by absorbing and radiating energy. Laser radiation is created in a laser source by supplying a concentrated energy to a laser medium, such as a solid crystal (Nd:YAG, Nd:YLF, etc.) or a gas compound (CO₂, Helium-Neon, etc.), to stimulate or "pump" atoms to spontaneously emit light. An energy source is used to generate this concentrated energy such as a high intensity lamp, an electrical discharge, or even a diode laser. The laser medium is located between two mirrors, creating a laser resonator that amplifies light continuously and produces a specific wavelength of laser light. One of the mirrors, the coupling mirror, is partially permeable to this specific wavelength and allows some of the laser light to escape. Laser light is then passed through a lens to focus it into an extremely high energy density laser beam.



Laser Beam Performance

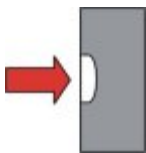
Due to the exceptional dynamics of the laser beam and its remarkable high energy density, it can be applied to process materials with excellent results. Laser processing can be accomplished through many methods by adjusting the parameters of the laser, although the most popular applications use vaporization or melting of the target material. Using positioning mirrors, the laser beam can be directed over large distances without any loss in efficiency. These mirrors are generally controlled by accurate X-Y Plotter mechanics or high speed Galvanometers. Trotec typically uses sealed-off CO₂ gas lasers and diode pumped solid state Nd:YAG lasers, because these types of lasers have been proven to produce high-quality, consistent results. The laser beam provides a universal, non-contact, wear-free production material processing solution that is economical to operate and simple to implement. A laser beam is ideally suited for engraving, marking, etching, scribing, and cutting operations.

Laser Techniques

Laser processing varies based on the absorption rate of the specific laser wavelength by the target material and the technique selected for the application. Trotec offers a wide variety of wavelengths to address the expansive range of materials available to today's manufacturers. By adjusting the parameters of the laser, it can be used to accomplish the following techniques:

- [Laser Engraving](#)
- [Laser Cutting](#)
- [Ablation](#)
- [Annealing](#)
- [Burning](#)
- [Foaming](#)
- [Color Change and Bleaching](#)

Laser Engraving and Laser Cutting

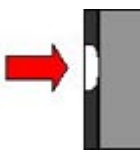


During the **laser engraving** process, the target material is essentially vaporized by the laser beam. To achieve this result, the intensity of the laser beam is set to exceed a specific threshold value. This threshold intensity is particularly high with materials that are electrically conductive, such as metals. The result is often a cone-shaped indentation influenced by the laser beam profile and the heat conductivity of the target material. The laser engraving technique is typically the fastest way of processing material.



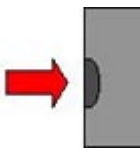
With **laser cutting**, a plate-type material is separated by a focussed laser beam. Basically, there is a choice between laser beam fusion cutting and laser beam sublimation cutting. With laser beam fusion cutting the material, e.g. acrylic, is melted or vaporised. With sublimation cutting, the material, e.g. wood, is vaporised by missing out the liquid phase.

Ablation



During the ablation process, a covering layer evaporates. Very thin covering layers such as color and/or anodizing layers are especially suited for laser engraving. High contrasts can be achieved with a small amount of laser power since these layers absorb laser radiation extremely well. With varnished plastics, a "day & night" design, e.g. for car dashboards, can be achieved by removing one color layer.

Annealing

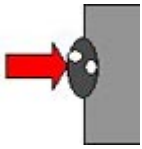


A contrasting mark can be created using an annealing effect on metallic target materials. The laser beam heats up the metal, creating structural changes in the surface. The color of the mark is determined by the maximum temperature attained in the metal, the properties of the metal, and the parameters selected on the laser. The annealing technique has a unique characteristic in that it produces a contrasting mark without disrupting the surface finish of the metal.

Burning

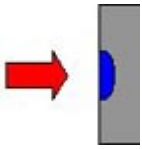


Metal engravings can be made by burning covering layers using ceramic powders ([Trotec MetalFix](#)). The covering layer is sprayed on and removed again after the laser engraving process. Using this procedure, metal surfaces can also be engraved with a high contrast CO₂ laser. In the case of metals, an oxidation process takes place on the surface. However, there is also a powder available on the market for glass engraving with a Nd:YAG laser.



Foaming

Sometimes the best technique to process a material is foaming. Most commonly used in certain plastics, foaming is easily recognizable because the surface of the affected area is raised. Melting occurs when the laser beam couples with the target material. During the process, gas bubbles form and get trapped as the target material cools, producing an elevated result.



Colour Change and Bleaching

This effect is only possible with plastics, and depends highly on the wavelength of the laser radiation used. In most cases, this effect is only possible with an Nd:YAG laser, or a specific type of Nd:YAG laser (double-frequency laser). During this process, the laser radiation penetrates the plastic and is absorbed by the color pigments. As a result, the pigments are chemically modified, resulting in a color change in the material. Since the laser radiation penetrates into the plastic, the surface remains almost undamaged. The color change achieved depends on both the pigment and the basic material used.