

# The art of laser marking

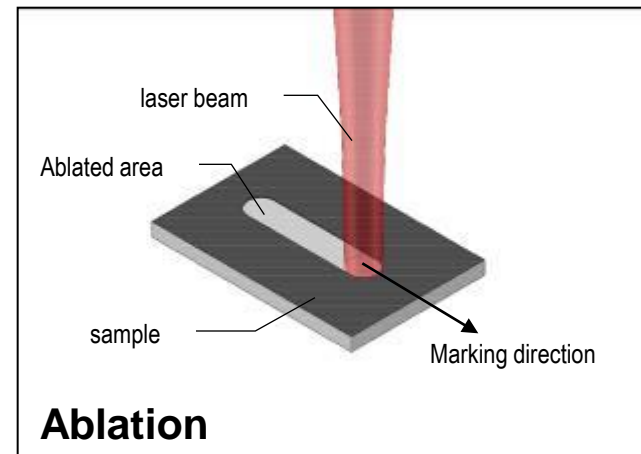
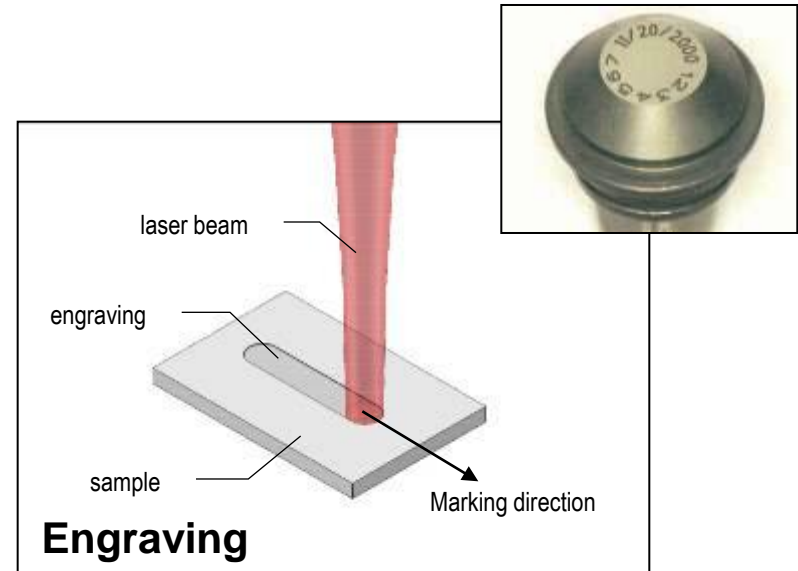
- There is a growing need in the industry to track and trace product during production or during its lifetime. As the product identification needs to last its entire lifetime the marking must be permanent. Laser marking is by far the best and most applied method to generate permanent marks on a wide variety of materials.
- For a readable mark the laser marking process generates visual contrast between text and background. The contrast can be achieved in two ways, either a change in color or by change in specular reflection. One can distinguish several laser marking processes for marking on a wide variety of materials, like engraving and ablation, annealing, color change (carbonization, bleaching) and foaming.

	Engraving Ablation	Annealing	Color change Foaming
Materials	<ul style="list-style-type: none"> <li>• metals</li> <li>• plastics</li> <li>• ceramics</li> <li>• labels</li> </ul>	<ul style="list-style-type: none"> <li>• ferro metals</li> <li>• titanium</li> </ul>	<ul style="list-style-type: none"> <li>• polymers</li> </ul>

	Metals	Ceramics	Polymers
Ablation	Reflection, normal contrast	Reflection, poor contrast	Reflection, poor contrast
Annealing	Color change, high contrast		
Color change			Color change, high contrast
Foaming			Reflection, normal contrast

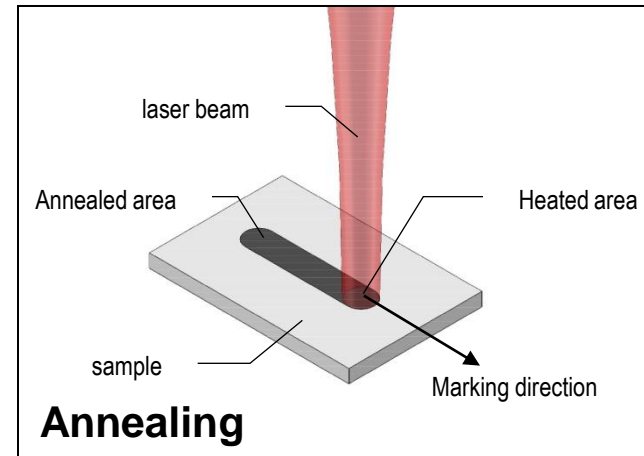
# Engraving and ablation

- General
  - Basic settings for engraving or ablation laser marking are high peak power with short pulse durations to achieve power densities that evaporates or decomposes the material
- Engraving
  - Engraving laser marking removes the material from the surface, resulting in change of specular reflection. This process is typically used for metals.
- Ablation
  - Ablation laser marking removes coating layers or lacquer layers from the base material. Typical example for this type of laser marking is ablation of the oxide layer of anodized aluminum.



# Annealing

Some materials change color at increased temperature. The laser beam heats up the surface to certain temperature where the marking appears due to oxidization. The composition and thickness of the oxide layer determines the colored appearance.



# Color change/Foaming

- Color change
  - Marking on plastics is done by locally heating the sample material. Due to the increased temperature and/or interaction with the laser beam some plastics become darker (e.g. carbonization) other plastics become lighter (e.g. bleaching). The type and composition of the polymer depicts if the material blackens or bleaches.
- Foaming
  - At foaming the marking becomes visible due to local change in height of the sample material. The laser beam heats up the polymer at such temperature that some elements of the polymer start foaming. Due to change in volume the sample material bulges outward and the marking is visible.

