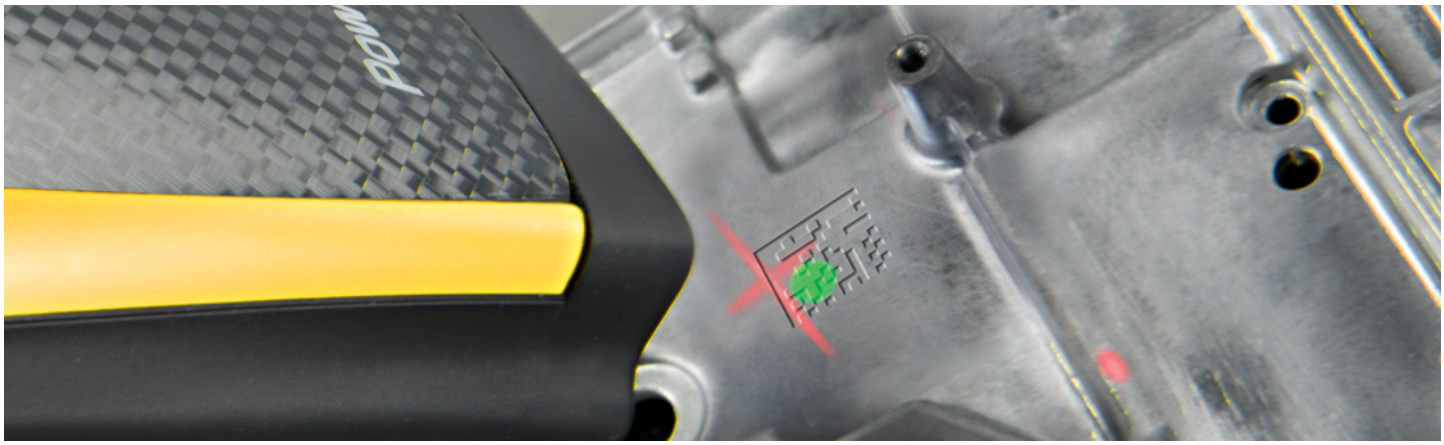

Permanent Labelling with Lasers

Introduction

This whitepaper will discuss the advantages of Laser Marking Systems, examples of use in the manufacturing industry and the decision criteria for choosing a laser marking product in comparison to other labelling methods. Laser marking device features, requirements and the technology behind different marking methods will also be discussed.

Laser marking is a permanent and flexible technology that can be used in a variety of applications such as expiration dates on water bottles, mobile phone branding, backlighted car dashboards and cattle tags. Whether batch, serialized number, best before date, official logos, or other data, consumer products and industrial items cannot exist without laser marking.

With its unique performance, laser marking guarantees extremely reliable, flexible and automated marking that is permanent and durable. Numerous industries such as automotive, electronic, fashion, food and medical rely on laser marking for reliable and counterfeit proof identification, labelling, branding, product security and backtracking purposes. Through the use of laser marking devices, manufacturers increase production efficiency, achieve precision quality and highly accurate labelling of work pieces. The resulting mark fully complies with the highest hygienic standards for manufactured goods and a better ecological footprint due to reduced waste and use of chemicals.

Laser marking delivers an economical and effective solution for permanent labelling of every type of surface. It withstands the most rugged conditions, guarantees backtracking over the entire product life cycle, allows individualization and assists in quality assurance and protection against

counterfeiting. Laser marking offers many advantages in comparison to other methods, but choosing to use it depends on many factors, including whether its advantages can be realized completely. This whitepaper provides information that can be used as a guideline for adopting a laser marking solution.

The Technology behind Marking Systems

Laser Marking

Laser marking delivers high speed permanent images with pinpoint accuracy. The power behind this incredible technology is light used as electromagnetic energy. Light visible by the human eye is in the wave spectrum 380 – 700 nanometer (nm). Laser marking systems generally use the intense light energy of visible or invisible wavelengths, such as infrared (> 800 nm) und UV (< 380 nm), for permanent modification of target object surfaces.

A collimated laser beam is precisely and accurately positioned and focused by moving mirrors and special optical devices on the surface of a treated object. Depending on the characteristics of the laser source, the surface is struck and modified by extremely intense optical power. Since there is no use of additional layers, labels or inks, this process is called Direct Part Marking (DPM). Information such as graphics, text, 1D and 2D codes are placed directly on the surface that needs to be marked.

Several specific marking processes are available with the use of different laser technologies and power levels, surface etching, engraving, surface color modifications, localized burning and carbonization, coating removal, etc.

Dot Peen

Marking by Dot Peen is accomplished by a mechanical movement of a hardened or carbide needle or peen. Each strike of the needle creates a dot on the surface. The placement of the dots is used to create alphanumeric text, bar codes, or other graphics. This method is only suitable for extremely robust working pieces such as steel and aluminium.

Stylus Marking

Stylus Marking of parts is similar to Dot Peen in that it uses a hardened or carbide needle to mark the surface of the part. Instead of creating individual dots, the stylus is dragged across the surface leaving a continuous mark. Alphanumeric text, bar codes, or other graphics are created by controlling where the stylus is applied to the surface. Stylus marking is used on metal, plastic, and other materials.

Printing Systems: Ink-Jet, Label, Thermo Transfer

Printing systems do not alter the surface of marked pieces. These methods place the desired data by means of a medium such as ink, label or thermal film on the working pieces. Ink-jet printing can be done directly on some parts or on a label medium which is then affixed to the part. Automated labelling machines usually perform this operation during the manufacturing process. Thermal Transfer printing rather, uses a thermal film instead of liquid ink to create the mark on the part or a label. Printing Systems can place a wide variety of graphics, alphanumeric text, and bar codes on parts. The limitation of these systems is often in the part being marked, its geometry, size of the marking area or where to affix the label.

Decision Criteria for Laser Marking versus Other Labelling Methods

The selection of marking technology for serialization, branding, or backtracking depends significantly on the specific marked surface, as not all methods work for all surfaces. Various procedures for laser marking and the different surfaces associated with the relative methods will be described below, along with their costs and limitations.

The technology behind laser marking is standardized and approved by major automotive, aerospace, military and defense organizations and industries. Other marking systems, such as stylus marking, dot peen, thermal transfer, ink-jet and label printing systems are also based on reliable standards. However, stylus marking, printing systems and dot peening have physical and technical constraints when it comes to very small inscriptions or machine-readable bar codes, while laser marking delivers high contrast marking with fine resolution.

Advantages of Laser Marking

Laser marking systems create single signs, complex graphics and bar codes that are permanent over the entire life of all kinds of objects. The advantages of laser marking include:

- Direct Part Marking – permanent on the work piece, stable, abrasion-proof, resists mechanical exposure, water, solvent, oil, temperature changes and UV exposure
- Marking on almost any kind of surface without any physical contact – from fragile to massive work pieces
- Flexible use as signs, text, codes or graphics
- Adheres to highest hygienic and aseptic design requirements
- Efficient production in high quantities through automation
- No extra cost, no consumables or tools that wear out
- Environmentally beneficial, uses no solvents or adhesives and creates no waste products
- Resistant to counterfeiting and cannot be removed

The automotive industry faces unique challenges for lifetime item identification requiring marking on smooth or rough surfaces with very little surface space. In these types of applications, laser marking devices offer an optimal solution by placing high density permanent marks directly on the component body. Precision ball bearings are an excellent example of high demands on marking technologies. Throughout their product life cycle they are exposed to harsh conditions including humidity, dirt, intense heat and salt. In times of mass product recalls, Direct Part Marking (DPM) guarantees end-of-life traceability of the marked items. Other marking technologies such as ink jet, printed label, thermal-transfer or pad printing do not stand up to these demands.

Today, requirements are more stringent than ever for tracking the production process over the entire supply chain. A car dashboard can be used as example: each backlit switch and instrument has been marked by a laser marking device with a thin dark layer exposing a light transparent background. The engine compartment of the car includes many items marked by DPM using laser marking. Almost every plug connector and socket have been laser marked for coding purposes.

In the food & beverage Industries, labelling by laser marking is also a diffused standard. Several items require individual best-before date marking. Products need individual marking on limitless types of surfaces such as paper, metal, glass, plastic or organic material. The benefits of laser marking are clear. In these applications, laser marking is flexible, individual, applied quickly and can be performed directly on the production line automatically, improving production efficiency and complying with strict hygienic requirements.

In medical device and human implant manufacturing, the adoption of the laser marking process fulfills the requirements of aseptic design, protection against forgery and high density of information, with no mechanical interaction, deformation of modification of the substrate material. Data Matrix codes can be placed on a variety of different surfaces in several geometric shapes with maximum resistance against cleaning alcohol and other harsh cleaners typical of medical and surgical environments.

A few of the many capabilities that make laser marking the preferred choice in several industrial activities are:

- Production efficient marking in the automotive industry
- Precise marking to the millimeter of industrial or automotive electronic components
- Flexible, software-controlled laser marking for food and retail industry packaging in the case of best-before date & manufacturing data
- Highly sterile, high-contrast, and precise marking of surgical instruments
- Continuous labelling of pharmaceutical packaging
- Microscopic size, durable marking of products to combat piracy
- Electronic component branding and personalization

Marking and Labelling Methods Comparison

	Laser Marking	Dot Peen	Stylus Marking			
				Continuous Ink-Jet Printing	Label Printing	Thermo-Transfer Pad printing
Stability	↑	↑	↑	↔	↓	↓
Contrast	↔	↓	↓	↑↑	↑↑	↑↑
Consumable free	↑↑	↑	↑	↓↓	↓↓	↓↓
Maintenance free	↑↑	↑	↑	↓↓	↑	↔
Safety Requirements	↑	↓	↓	↓	↓	↓
Environmental friendly	↑↑	↑↑	↑↑	↓	↔	↓
Process Time	↑	↓	↓	↑	↔	↑
Unit Cost	↓	↓	↓	↔	↑↑	↔
Initial Cost	↑	↓	↓	↔	↓	↔

Laser Surface Treatments vs Materials

	Iron/ Steel	Titan.	Metal	Thermo-plastics	Paper, Wood, Organic Material	Glass & Transparent Materials	All surfaces, depending on coating
Heat Treatment	X	X					
Laser Engraving	X	X	X	X	X	X	X
Laser Etching			X				
Pulsed Laser Deposition							X
Foaming				X			
Change in color, Nitrification, Bleaching				X			
Carbonation				X	X		
Inside Laser Engraving						X	

It is imperative that the correct laser with the appropriate wavelength must be selected for each material. For example, a CO2-Laser cannot engrave metal, but can engrave organic material. Likewise, a fiber laser cannot mark organic material but can mark metal.

For a long time, the main obstacles preventing the diffusion of laser marking was the initial cost of the apparatus. Now, despite the fact that laser marking devices are typically more expensive than label printers or than continuous inkjet printers, the TCO, (Total Cost of Ownership, that includes consumables, maintenance cost and downtime, waste disposal etc.) may offer a completely different outlook. This is possible due to increased production efficiency with almost zero consumption and maintenance costs.

Laser marking is not always the best technology choice for every application. At extremely high speeds and marking-on-the-fly applications, continuous ink-jet systems are still ideal, even if some manufacturers of specialty laser marking devices have become very competitive in this market.

Laser Marking for Various Materials

Depending on the material to be processed, various laser technologies are required for marking. The chart below lists several materials and the recommended laser system to be used for each. The corresponding Datalogic laser marking model is shown.

		CO2-Laser Datalogic: EOX	YAG-/YVO4-Laser Datalogic: ULYXE/ VLASE	Fiber-Laser Datalogic: UNIQ/AREX
Plastics	Polyethylene (PE)	++	++	++
	Polycarbonate (PC)	++	++	++
	Polypropylene (PP)	++	++	++
	Polyacetal (POM)	++	+++	+++
	Polybutylene terephthalate (PI	++	+++	+++
	Polyethylene terephthalate (PE	++	-	-
	Acrylonitrile-butadiene-styren	+	+++	+++
	(ABS)	+++	+++	+++
	Epoxide	+++	+++	+++
	Phenol	+++	+++	+++
	Polyvinyl chloride	++	+++	+++
	Polyamide (PA)	-	++	++
	Silicone			
Metals	Iron/Steel	-	+++	+++
	Aluminium	-	+++	+++
	Nickel	-	+++	+++
	Stainless steel	-	++	+++
	Copper	-	++	+
	Gold	-	++	+
Other	Ceramic	++	+	++
	Organic	+++	-	-
	Wood	+++	-	-
	Paper /carton	+++	-	-
	Glass	+++		-
	Rubber	+++	+	++

Legend:

- Not suitable for the material listed
+ Suitable for the material listed
++ Well-suited for the material listed
+++ Best suited for the material listed

Laser Marking Systems – the right solution for every requirement

Datalogic offers various laser technology solutions for individual applications as stand-alone systems or as integrations into production lines. About twenty thousand laser marking systems from Datalogic are currently in use worldwide.

Along with the hardware, laser marking software must be kept in mind when making a decision on the best solution to adopt. Datalogic offers a unique marking software suite, developed to work seamlessly with all Datalogic marking products regardless of the laser technology or system configuration used.

Lighter Software Suite allows advanced graphics editing and full control of all laser parameters, included axis control, programmable digital I/O and diagnostics. A powerful built-in script engine allows the software interface to be adapted to the user's specific needs or to the system environment. Interaction with common production databases or enterprise systems, such as SAP, or with bar code readers, mobile computers or image processing systems can be directly designed and implemented in a *Lighter Software Suite* environment.

Datalogic Laser Marking Product Range

	All-in-One	Controller & remote scanning head
Fiber Laser (1.0 µm)	**UNIQ** The first, ultra-compact 15 W All-in-One fiber laser marking device, easy to use, easy to install, light and very compact.	**AREX** Easy solution as Stand-Alone system or fully automated work center in production lines as 10 W, 20 W,30 W and 50 W fiber laser. Now available with new MOPA fiber source.
CO_2-Laser (10.6 µm)	**EOX 10 W** A 10 W All-in-One solution. Offers highest flexibility through integration in production lines and as a Stand-Alone-system.	**EOX 30 W** With 30 W, separate marking head and control system, this offers the highest flexibility for Stand-Alone-Systems or integration into production lines.
Solid State Laser (DPSS-Laser) (1064, 532and 355 nm)	**ULYXE** The smallest 6 W laser marking system. Ulyxe offers the best price & performance ratio on plastics and metal.	**VLASE-Series** Available in various wavelengths of 1064, 532, and 355nm for a performance range up to 20 W For high stability, hard to mark materials and process.

Datalogic Group is a global leader in Automatic Data Capture and Industrial Automation markets. As a world-class producer of bar code readers, mobile computers, sensors for detection, measurement and safety, vision systems and laser marking systems, Datalogic offers innovative solutions for a full range of applications in the retail, transportation & logistics, manufacturing and healthcare industries. With products used in over a third of world's supermarkets and points of sale, airports, shipping and postal services, Datalogic is in a unique position to deliver solutions that can make life easier and more efficient for people. Datalogic S.p.A., listed on the STAR segment of the Italian Stock Exchange since 2001 as DAL.MI, is headquartered in Lippo di Calderara di Reno (Bologna). Datalogic Group as of today employs about 2,500 members of staff worldwide distributed in 30 countries. In 2015 Datalogic Group achieved revenues for 535,1 million Euro and invested over 48 million Euro in Research and Development with a portfolio of about 1,200 patents and pending patent applications in multiple jurisdictions. For more news and information on Datalogic, please visit [www.datalogic.com.](http://www.datalogic.com)