



**Matthews
Marking Systems™**

Direct Part Marking Using Laser Marking Solutions

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WHITE PAPER

Direct Part Marking Using Laser Marking Solutions

How latest advances in laser marking technologies are improving direct part marking requirements for the Automotive Industry

► Parts Use & Lifecycle

According to Consumer Reports, the average life expectancy of a new motor vehicle is approximately 8 years or 150,000 miles. If properly maintained, some well built vehicles can last up to 15 years or 300,000 miles.

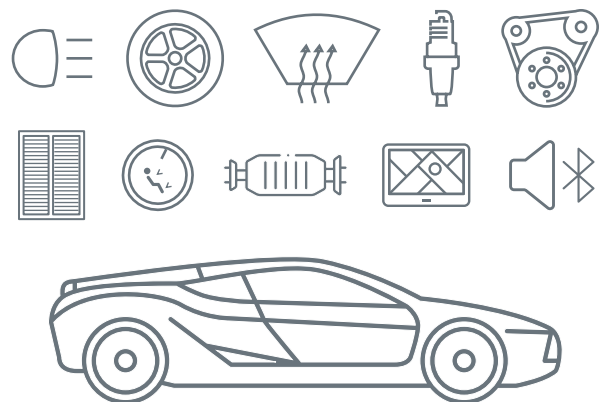
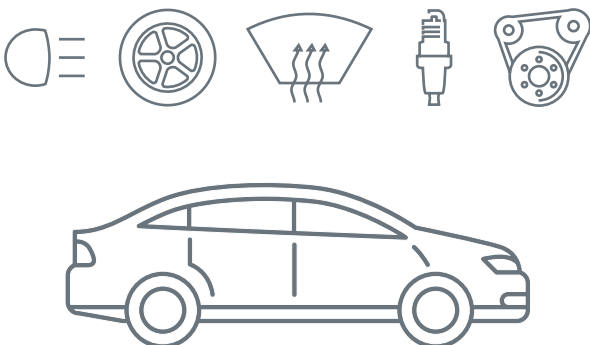
The complexity of production built vehicles and the supply chain has increased over the past decade. Today, there are twice as many parts used in a vehicle as there were then. Furthermore, automotive parts are produced by a global network of OEM suppliers rendering part identification and traceability of critical importance.

For full lifecycle traceability, parts must be identified as individual components, sub assemblies and final assemblies. These parts are marked with Human Readable Interpretation (HRI) text and/or automatic identification data capture methods (barcode). Part identification data that is marked directly on the part can be categorized into three areas; brand information, barcode data and human readable text.

2X

DOUBLE COMPLEXITY:

THE NUMBER OF COMPONENTS PER VEHICLE HAS DOUBLED OVER THE LAST DECADE



► Direct Part Marking

Direct Part Marking is the process of identifying parts or final product assemblies with serial numbers, part numbers, date codes, and barcodes so that future activities such as maintenance, repair, overhaul and safety recalls can accurately identify the parts of concern and the work performed can be permanently tracked.

Parts produced for automotive assemblies are constructed from a variety of materials and can be represented in many different colors. These parts may have unique geometries and textures. Having a single solution to permanently mark all these items can be a real challenge. New developments with laser source wavelengths, drive pattern waveforms and power options have made it easier to mark a wider range of materials to be compatible for use with laser marking systems.

TYPES OF DATA MARKED DIRECTLY ON PARTS:

 Matthews Marking Systems™ Made by MMS SAE/DOT Approved  MMS1850-11-JUNE2019	BRAND COMPLIANCE LOGOS & TEXT CODES
	AUTOMATIC IDENTIFICATION & DATA CAPTURE (AIDC) 2D CODE
	HUMAN READABLE INTERPRETATION TEXT

Brand or compliance logos and text codes are known in the industry as Non-Human Readable Interpretation Non-Human Readable (Non-HRI) text. This information does not need to be encoded into the barcode. HRI text is data that will be encoded into the barcode.

Direct Part Marking (DPM) of machine-readable codes, such as the use of 1D or 2D barcodes, reduces the need for manual data entry at the time of manufacturing to ensure the capture of exact part matching data for the identification purpose. A parent-child relationship is developed by marking unique part ID's on the components (child) that all belong to a master level VIN number (parent).

VEHICLE IDENTIFICATION NUMBER (VIN)

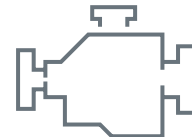
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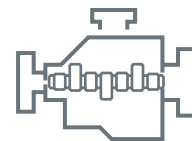
BARCODE
MARKING



COMPONENT
MARKING



SUB ASSEMBLY
MARKING



SUB PRODUCT
MARKING



FINAL ASSEMBLY
MARKING

► Part Identification

The survival requirements of the part identification mark is an essential function to determine what marking system or method is best used.

Most common marking methods used by part manufacturers are inkjet, label, dot peening, and laser marking. Other methods outside of these main four exist, but they are typically manual methods that don't offer the ability to encode the HRI data into a barcode.

Due to the varying materials and size of parts that need to be marked, it is important to select a marking technology that is capable of marking a barcode with high-resolution and of a size that fits into the allowed marking field zone. Also take into consideration mark quality, contrast, and survival as it is exposed to heat, hydrocarbons and other elements.

MARKING METHOD	RANGE OF MATERIALS	BARCODE SCANNABLE	MARK SURVIVAL
INKJET	Good	Poor	Poor
LABEL	Poor	Excellent	Poor
DOT PEENING	Poor	Poor	Excellent
LASER	Excellent	Good	Excellent
ELECTRO-CHEMICAL ETCHING	Poor	Good	Good

► Auto Identification & Data Capture

When considering all the direct part marking technologies available, laser marking systems produce the highest resolution for 1D or 2D barcodes and deliver the best mark survival life rate. For barcodes to be successfully read using a scanner or vision system camera, the image contrast between the 1D bars or 2D dots against the native part material is critical. Laser marking systems offer control over the level of etching or annealing to produce scannable barcodes.

1D barcode symbologies require too much part real estate and don't have any data redundancy built-in for error checking. 2D barcodes were later introduced to condense the necessary footprint required while encoding up to 100 times more data versus a conventional 1D barcode. For automotive applications, the ECC200 Data Matrix 2D barcode has become a popular choice due to its simple "dot" format that is easily produced by most marking systems.

2D BARCODES PRODUCED BY DIFFERENT MARKING SYSTEMS:



LASER



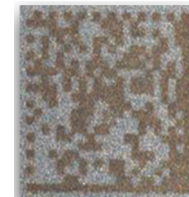
DOT PEENING



INKJET



LABEL



ELECTROCHEMICAL
ETCH

► Marking Considerations

There are many different marking technologies available to directly mark parts. Not all marking technologies are equal when it comes to delivering good mark performance with plastics, metals, glass or rubber. The end user requirement for marking will drive the type of marking system required for the direct part marking task.

CONSIDERATIONS WHEN LOOKING AT DIRECT PART MARKING SYSTEMS:

MARK SURVIVAL - How long must the mark survive on the part.

MARK RESISTANCE - What elements will the mark be exposed to during its typical life.

CODE CONTRAST - Can the code be easily read once applied to the part and during part use?

MARK RESOLUTION - Can the marking system print multiple lines, logos and barcodes?

AIDC CAPABILITY - Can the marking system encode a 1D or 2D barcode to meet GS1 standards?

PART STRESS OR CORROSION - Will the marking method impact the part's intended lifecycle?

VERSATILITY - Is the marking system capable to mark many different parts?

INTEGRATION - Does the part ID data come from an external device? Is a vision system needed?



REQUIREMENTS



RESISTANCE



AIDC COMPATIBILITY



SURVIVAL



CONTRAST

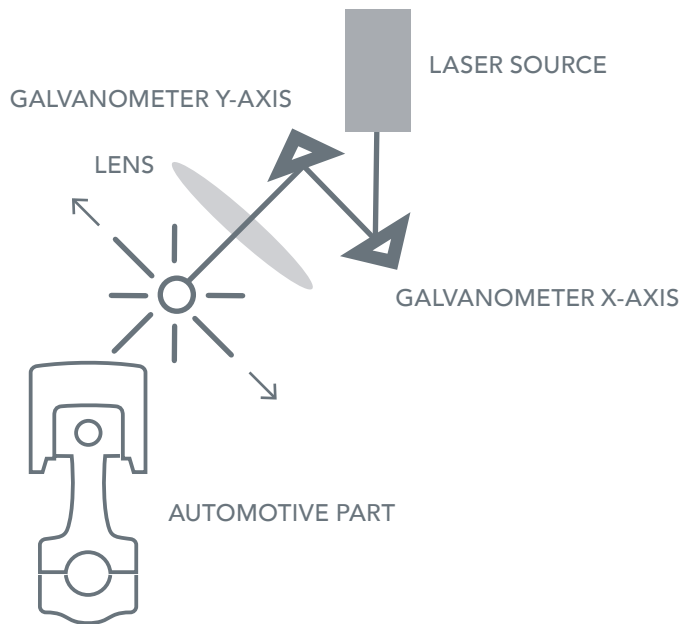
► Marking Attributes

Once you take into consideration your marking requirements, now it's time to select the most appropriate direct part marking system technology. Not all marking systems deliver the same results or have the same initial investment outlay. Below is a table that represents the most common direct part marking technologies and their corresponding system attributes.

	LASER	CONTINUOUS INKJET	DOT PEENING	LABELING	ELECTROCHEMICAL ETCHING
NON-CONTACT OR CONTACT MARKING	Non-Contact	Non-Contact	Contact	Contact	Contact
MATERIAL RANGE COMPATIBILITY	Extensive	Average	Average	Extensive	Minimal
EQUIPMENT INVESTMENT COST	High	Average	Low	Low	Low
INTEGRATION FLEXIBILITY	Easy	Easy	Average	Average	None
MATERIAL THERMAL OR CHEMISTRY STRESS	Likely	None	Likely	None	Likely
MARK SURVIVAL	Strong	Weak	Strong	Weak	Strong
MARKING INLINE OR IN-POSITION	Both	Inline	In-Position	Both	In-Position
BARCODE & LOGO MARKING	Both	Both	Both	Both	Both
GS1 COMPLIANT BARCODING	Yes	No	No	Yes	Yes
MARKING FIELD SIZE	Large	Narrow	Large	Large	Large
SPEED OF MARKING	Fast	Fast	Slow	Average	Slow
CONSUMABLES	Extractor Filter Lens Cleaner	Inks Solvents Fluid Filters	Styluses Air Filters	Labels Ribbons Printheads	Screens Chemicals

► How Laser Systems Work

The most common laser marking method for direct part marking is the scribing laser method. A scribing laser works by moving a directed laser beam that is emitted from a laser source via vector paths using two-axis mirrors. The highly reflective mirrors are mounted on an electromechanical galvanometer. Galvanometers are fast responsive electronic electro-mechanical instruments of high precision and are controlled by the laser computer system to render the mark image onto the part.



The laser marking system must have a laser source (light emission) that is suitable to mark the part material properly. These laser sources may be branded with trademark names by the OEM's or be referred by the laser wavelength in micro or nano meters.

► Laser Wavelengths

Lasers are capable of permanently marking many different organic and inorganic materials. Material composition and desired quality of mark will qualify the laser source wavelength needed to carry out the direct part marking task. There are three types of lasers that may be considered:

CO₂

CO₂ is a sealed mixed gas laser that is suitable for marking organic material such as rubber, paint/anodized coatings, glass and plastics. The life of the CO₂ laser source can reach 30,000 hours. Mark contrast is limited unless the laser is ablating/etching materials to expose an underlying contrast.

CO₂ wavelengths range from 9.2µm to 10.6µm and the power options range from 10 watts to 100 watts.

FIBER

Fiber laser uses a rare earth element doped fiber optic cable as an active gain medium. Fiber lasers are more efficient in electrical to optical power when compared to CO₂ lasers. Fiber lasers are suitable for marking inorganic material such as alloys, high density plastics, and give high contrast to materials that contain pigments or carbon. The life of a fiber laser source is typically 100,000 hours.

Fiber laser wavelength is 1.06µm and the power options range from 20 watts to 100 watts.

DIODE PUMP SOLID STATE (DPSS)

DPSS lasers use a solid state medium that is excited (pumped) using a diode light. DPSS lasers are suitable for marking inorganic material such as alloys, high density plastics, and give high contrast to materials that contain pigments or carbon. Laser source life of DPSS is approximately 20,000 hours.

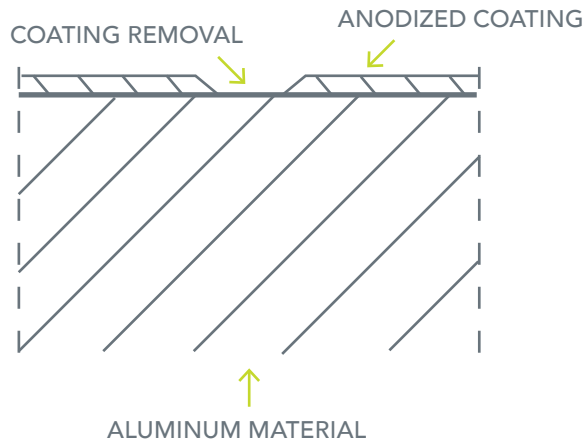
Fiber laser wavelengths are 355nm, 532nm and 1.06µm. Power options range from 1.8 watts to 30 watts.

► Laser Marking Effects

CO₂ lasers can alter the material in one of five (5) different ways.

COATING REMOVAL/ABLATION

The laser is absorbed by the surface coating which it vaporizes to reveal a contrasting substrate underneath. See the chassis identification image below for an example of the anodized coating removal from the aluminum chassis identification plate.

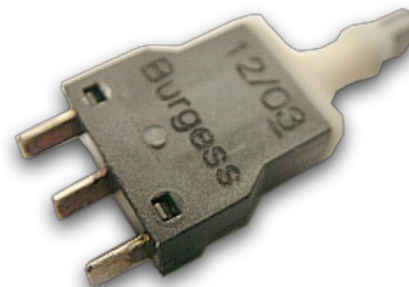
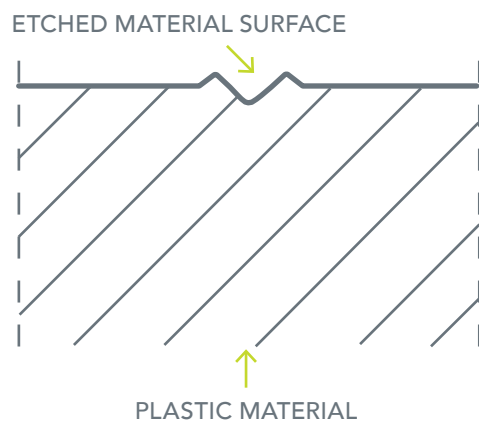


CHASSIS.ID PLATE

ETCHING

When using CO₂ lasers to mark plastic material, the laser produces an Etching effect.

The laser vaporizes material from the surface of the substrate without producing any color change. The resulting mark looks similar to an embossed mark that is produced in the plastic mould process.

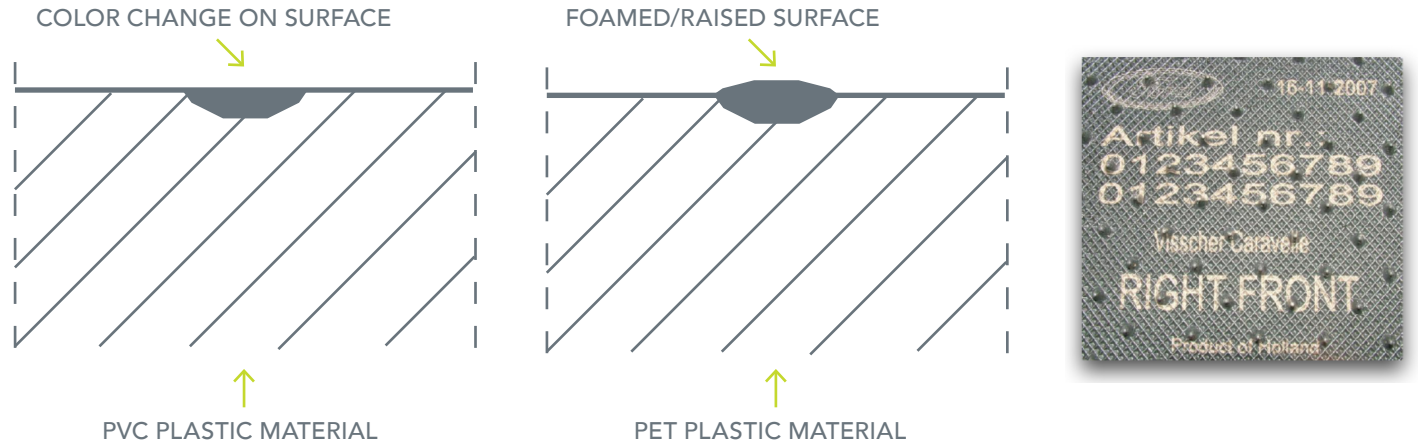


ELECTRICAL SWITCH BODY

THERMOCHEMICAL

A thermochemical effect occurs when using CO₂ lasers to mark plastic materials.

The laser changes the material by heating it to a sufficiently high temperature to break molecular bonds. The new material formed by this process may have a different color or depending on the plastic, it might be foamed and slightly raised.



MICRO CRACKS

When marking glass material using a CO₂ laser, the laser energy will produce Micro Cracks to provide a contrast appearance.

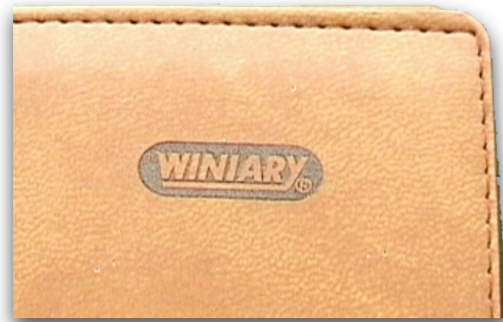
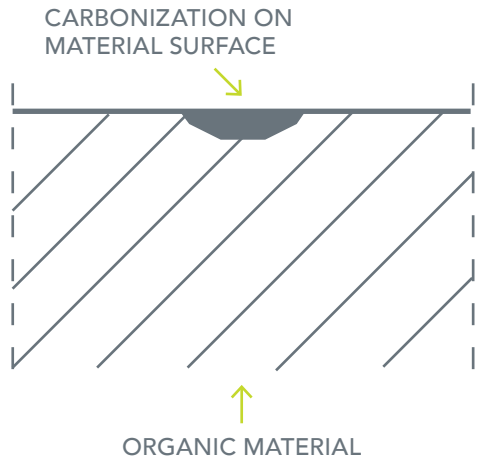
High rapid pulsed laser energy that is focused super heats the glass material. Upon cooling the process, micro cracks will appear that represent the contrasting mark.



CARBONIZATION

Organic materials such as pressed paperboard, leather or natural fibers can be marked with contrast using the Carbonization effect with a CO₂ laser.

The laser energy heats the material leaving a brown or black trace of the laser path. This effect is similar to the touch of a hot branding iron. Settings are critical to balance the right amount of laser energy and time on material to produce a contrast without producing a fire risk or excess product removal of material.

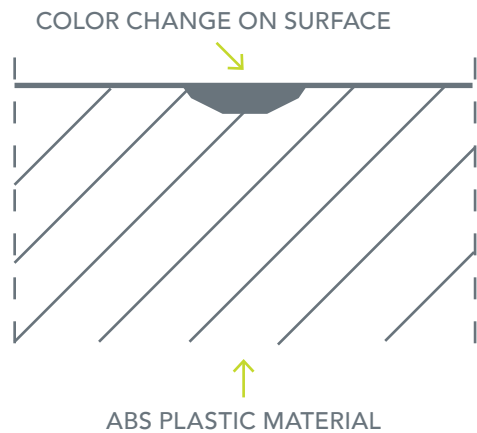


LEATHER MATERIAL WITH LASER MARK

THERMOCHEMICAL

Fiber lasers produce contrasting marks using a thermochemical effect on high density plastic materials that a CO₂ laser typically cannot mark.

The laser changes the pigment or carbon material by heating it to a sufficiently high temperature to break molecular bonds. The new material formed by this process may have a different color.



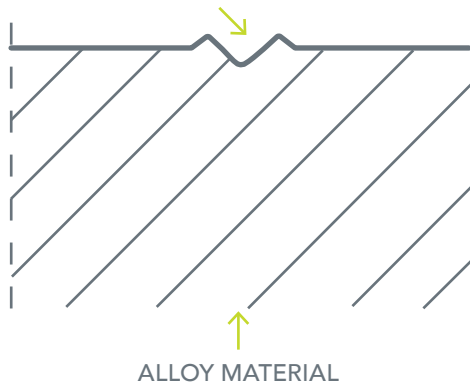
ABS PLASTIC PART WITH 2D CODE

ETCHING

We now explore Fiber lasers and their marking effects. Unlike CO₂ lasers, Fiber lasers are capable of producing an etching effect with contrast on alloy materials.

The laser vaporizes material from the surface of the substrate to produce a color change. The resulting mark looks similar to an engraved mark that is produced by a cutting tool in a CNC or milling machine. The laser scribing speed and output power can be set to deliver a precise quality mark each time and control the contrast.

MATERIAL ETCH ON SURFACE



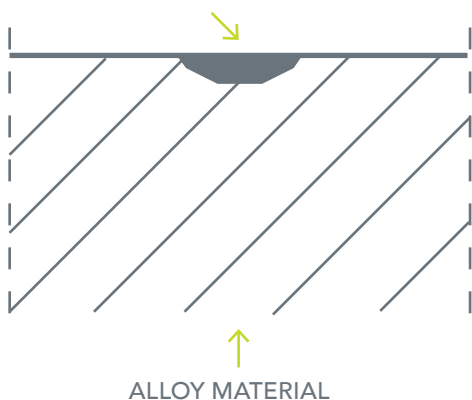
ALLOY PART WITH
HUMAN READABLE
& 2D CODE

ANNEALING

Fiber lasers and very high power CO₂ lasers are both capable of annealing material surfaces. A Fiber laser is highly recommended to produce the annealing effect as it can mark these materials much faster and with less power versus a CO₂ laser.

To anneal material using a fiber laser, the laser should be slightly set outside of the focal tolerance to widen the laser spot size. The heat energy is sufficient to super heat the material to modify the material color but there is not enough focused energy to etch and remove the material surface.

ANNEALED MARK ON SURFACE

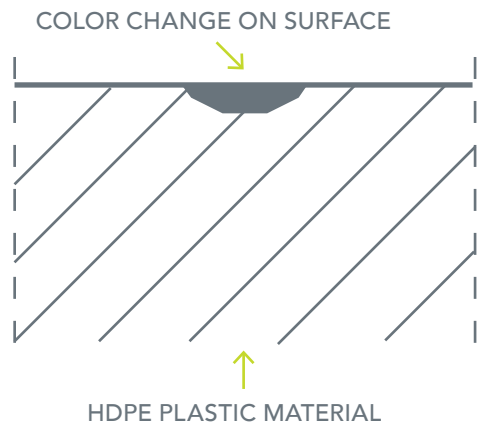


SCREW PART WITH
ANNEALED LASER CODE

THERMOCHEMICAL

DPSS lasers provide contrasting marks using a thermochemical effect on high density plastic materials that Fiber and CO₂ laser typically cannot mark.

The DPSS laser wavelength and high pulse energy reacts with the material to breakdown molecular bonds. The modified material formed by this process alters the color of the material surface.



HDPE PLASTIC PARTS

► Success Using Laser

Laser marking systems are capable of marking a wide range of part materials and produce a precise mark every time. There are no consumables such as inks, labels, chemicals, or dot peening stylus' to replace so the cost of operation is very low. Lasers do expose the part to thermal stress during the marking process and that may alter the structural integrity of the part.

Lasers need to be safe guarded when in use around operators to remove the risk of thermal and ocular injury. The installation should include part access doors that are electrically interlocked to prevent the laser from activating when parts are being inserted or removed.

A filter extraction system is necessary to remove particulate matter or vapors while the part is being laser marked.

Depending on the part material, a specific kind of filter is required for materials like PVC or glass. The filter extraction system can be integrated with the laser electrical controls to automatically turn on when the laser is only powered up. This prevents idle use of the filter media and extends the interval for the filter media changeout period.

Lasers require minimal scheduled maintenance; these typical maintenance tasks range from a simple lens cleaning, extractor filter replacement, to dust removal on the CO₂ laser tube heatsink.

A marking laser system will give you a very long life of continuous performance with indelible mark quality that other marking systems simply cannot match.



SAFE CLASS I
WORKSTATIONS



MOBILE CLASS I
WORKSTATIONS

► Matthews Marking Systems

In 1850, John Dixon Matthews came from his native Sheffield, England to Pittsburgh, Pennsylvania where he opened a small engraving shop. Matthews' first products included military stamping dies, branding irons and stamps for wooden crates. By the early 1900s, wooden crates were being replaced by corrugated shipping boxes and, always an innovation leader, Matthews' produced the first vulcanized rubber stamps and plates for printing on cardboard. Today, Matthews Marking Systems continues to lead the pack with innovative inkjet, laser and automation solutions for marking on packaging and industrial materials.

BEYOND PRINTING

With Matthews, your printing and coding systems are paired with innovative software, superior service and quality inks. This means you can operate with fewer interruptions, faster changeovers and better results.

Why Work With Us

- + 160+ years of marking expertise
- + Worldwide sales, service and distribution network
- + One-stop shop, easy to do business with