

Tire identification technology

Unique identification codes can be used to encode individual tires with a wealth of specific information, which can then be used by all levels of the industry

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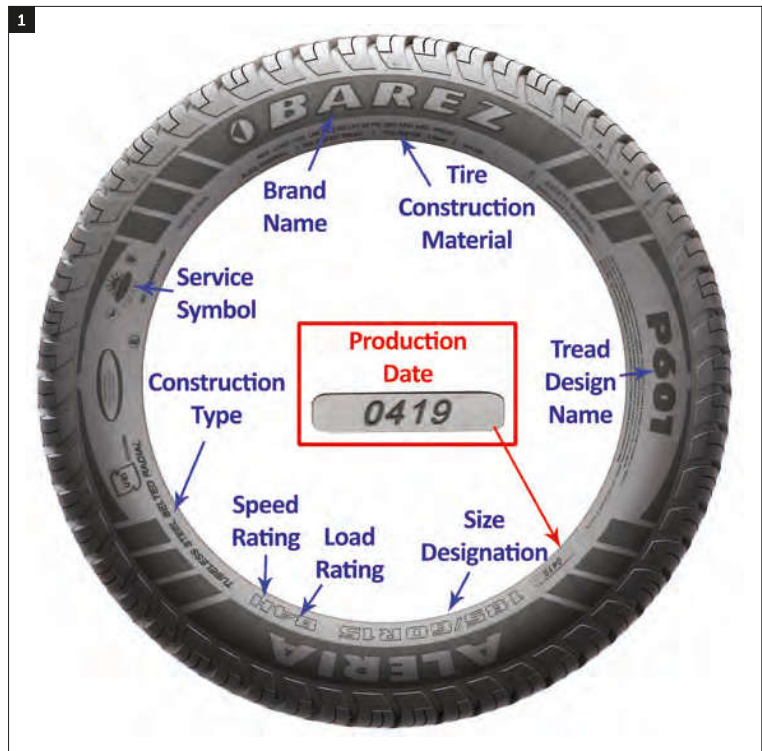
The needs of today's tire industry, especially in companies with global sales markets, make it vital to track and record product information

across the whole product lifecycle. Tires are identified by a four-digit code that indicates the week and year of production; however, they do not have a unique identification code. Therefore, the limitations of marking information on the tire, and the problems caused by the lack of transparency in identifying and tracking tires throughout their value chain, have led to a need for solutions such as barcodes, radio frequency identification (RFID) and laser engraving. In laser-engraving technology, a unique mark – including a numeric code, barcode, QR code and data matrix code (DMC) – is engraved on the tires. This paper explores this technology, its detail and the methods used in the tire industry, particularly by the Barez Industrial Group.

Advances in technology across all aspects of the industry have made it easier to perform different tasks. The need to know the status of the product and the ability to track and trace different products, especially after leaving the company and reaching the customer, is very important for planning production. As a result, many industries are trying different tools to create a control network and track their products.¹ Due to its importance in vehicle

Figure 1: Information on the tire sidewall

Figure 2: A sample of the soft-edged groove in the tire surface as a result of laser engraving⁵



safety, the tire industry is monitored and controlled by standard organizations from many different countries, which track products and their lifecycle transparency. For this reason, marking product information, tracking it from the raw material and production site to the customer, and tracing the status and possible flaws of the final product to their origin are among the areas considered by tire manufacturers.

Unique tire identification is always a big challenge for the industry. As a standard, a four-digit code is inserted onto the body of each tire – the first two digits indicate the week of production and the next two indicate the year (Figure 1). Therefore, it is impossible to identify tires produced during the same week. With the development of technologies such as barcode² and RFID,³ tire manufacturers are attempting to develop methods to register product information on tires. Each of these methods has

advantages and disadvantages. For example, a barcode on a tire, despite its ease of use, only provides unique identification until it reaches the consumer because the barcode is detached from the tire at the point of rimming or use. Therefore, this method will not be applicable for the entire lifecycle of the tire. Laser engraving is a permanent method and can be used by manufacturers, sellers and consumers.⁴ Using this method can provide more information, including manufacturer, operator, terms of use and any additional details.

The capability and advantages of laser engraving technology have led to its widespread use in the tire industry. As shown in Figure 1, the tire sidewall contains a lot of information that can be inserted using a laser.

Laser engraving technology

Marking the required information on the tire, along with the ability to



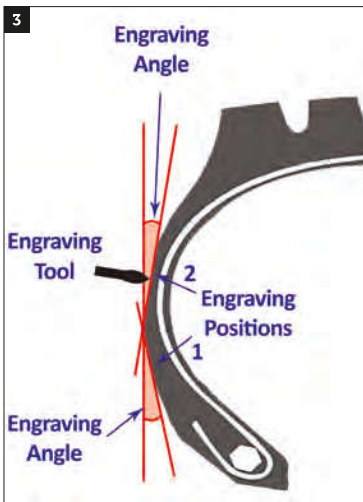


Figure 3: The convenient positions of QR code engraving on the tire; position #1 is preferred

Figure 4: The QR code (mirrored) engraving on the sidewall of the Barez tire using a fiber laser

Figure 5: The QR code (not mirrored) engraving on the sidewall of the Barez tire using a CO₂ laser



register it in a database at different stages, makes it possible to provide practical information. Different items (such as numbers, QR codes and even complex symbols) can be engraved on the tire. The benefits of laser engraving for different parties can be considered as follows:

For tire manufacturers, it offers a unique, low-cost method of implementing permanent numbering and registration.

For tire assembly providers, it can ensure the accuracy of assembly and compliance of parts.

For OE car tire plants, it can provide 100% traceability.

At car/tire dealerships, the data can be invaluable to end customers.

For fleet managers, laser engraving can help to prevent theft, help in scheduling replacements and keep track of inventory.

For private customers, it can be used to check the tire history and test reports and order replacements.

The advantages of laser marking include permanent and forgery-proof engraving of all tire types, offering the flexibility to engrave letters, numbers and graphics, and enabling 100% traceability even after years of tire usage. A comparison of different identification methods is presented in Table 1.

Table 1: Comparison of different identification methods

Characteristic	Laser engraving	RFID	Barcode	Molding
Machine-readable	Yes	Yes	Yes	Conditional
Human-readable	Yes	No	Conditional	Yes
Durable	Yes	Yes	No	Yes
Individual information	Yes	Yes	Yes	No

It should be noted that laser marking leaves a soft-edged groove in the tire surface that does not affect the tire integrity. Based on reports, this process has been applied to more than 200 million tires and is proven.⁵ This soft-edged groove can be seen in Figure 2, which shows that the depth of the engraved groove is negligible compared with the thickness of the tire.

With each additional marking, the process cost of laser engraving is significantly reduced and the total cost is slightly increased, indicating a high share of the cost of automation and infrastructure implementation. Furthermore, for hundreds of existing marking stations worldwide, the cost of any additional marking is less than €0.01 (US\$0.012) per tire.⁵

It should be noted that consideration of parameters such as heat and residual stresses is very important when using laser technology. Therefore, it is vital to pay attention to the type and power of the laser. Studies show that two types of fiber and CO₂ lasers are used for tire engraving. The other important note is that most tire companies use a CO₂ laser system with a wavelength of 10.6µm. The type of engraved element is often a QR code or data matrix code. In addition, the optimal size for this element is reported to be 12.6 x 34.8mm with up to 60 numeric characters. Optimal engraving depths for passenger tires (PCR) and truck and bus tires (TBR) are reported to be 700µm and 900µm, respectively.⁶

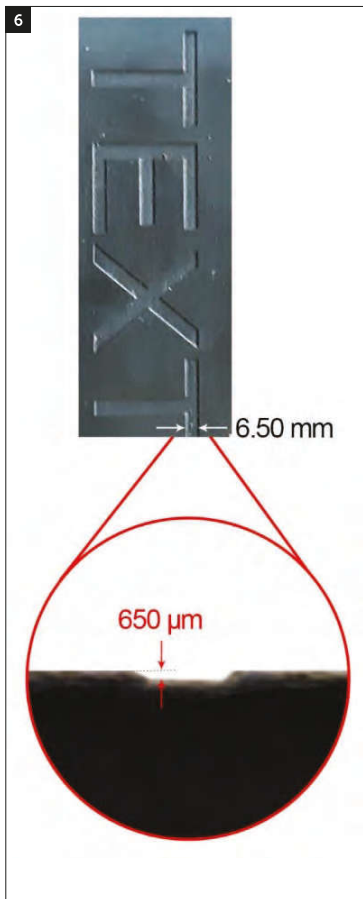


Figure 6: The dimensional specifications of the final engraved QR code on the Barez tire

Figure 7: Two examples of inappropriately engraved QR codes. (Right) High laser power: a) high depth of engraving and distortion of engraved walls; (Left) Improper adjustment of engraving parameters: b) inappropriate formation of walls, c) inappropriate formation of boundaries

The best protection for the QR code when the tire is mounted on the car will be provided when the code is positioned as closely as possible to the rim, as shown in Figure 3.⁵ Furthermore, for easy readability the QR code area should be as perpendicular to the tire axis as possible and should not be too curved. For good readability, absolute engraving angles must be below 30°. In addition, to position the QR code on the tire sidewall, a unique reference area is required. The precision of the machine when positioning the QR code on the tire sidewall depends strongly on the distance of the reference area from the engraving position. The maximum distance on the tire radius is 20°. The other important note is that the code requires an empty dedicated space without design elements, flash, venting marks or color markings such as balance points, and the tire surface should be homogeneously black and smooth.

Laser engraving applications

As stated, unique identification of tires has always been a big challenge for manufacturers, and tracking and tracing of the final product are

very important. Barez Industrial Group is committed to applying the latest technologies on its production line, so a full consideration of all the different aspects of using this technology is vital. Barez’s goal is to collect complete information – including raw materials, production date, batch number, model of the tire building machine and operator details – and register this data in its ERP system. After assembling the semi-final products, combining their data creates a unique code, which is assigned to each product. This code is engraved on the tire and linked to the Barez website and application. As a result, sellers and consumers can see this product information. In addition, tracking and tracing of tires, even after years of usage, will be possible for Barez. In order to achieve this, several parameters – including quality, time and cost of engraving, as well as minimizing the thermal effects and the residual stress – are important.

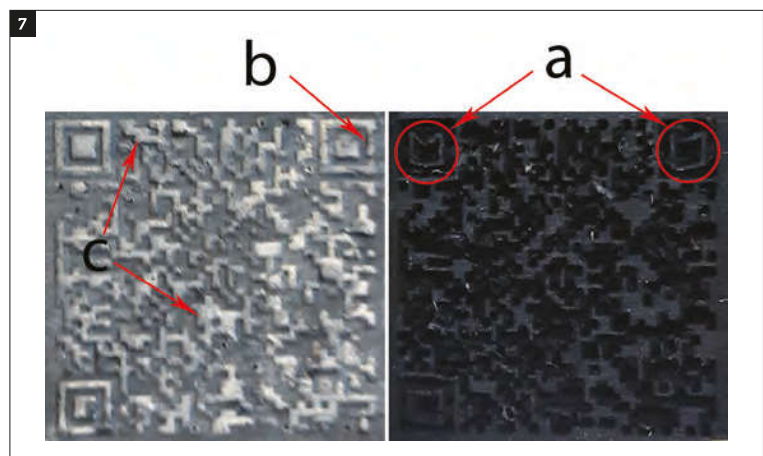
To investigate different approaches, two types of fiber and CO₂ lasers with a power of 30W were used to engrave a QR code on the sidewall of Barez PCR tires. To ensure good readability, this code was designed and prepared in a vector form, and the content was modified in such a way to create a suitable image for engraving. It is clear that marking a large volume of information will cause the element to become smaller and the engraving process to be longer. Furthermore, a high-precision machine will be needed. In addition, the separated parts of the engraved tire have a darker color. Therefore, to make the QR code readable by the software, the final form of the QR code must be mirrored and engraved in such

a way that it is placed inside three black squares. In Figures 4 and 5, QR code engraving by a fiber laser and CO₂ laser (respectively) on the sidewall of Barez PCR tires are shown. It is clear that these codes have standard dimensions and their walls and boundaries are well formed. For better reading, Barez has developed some software as part of the company’s application to ensure codes are read successfully.

One of the most important challenges in the engraving process, after adjusting the parameters of the device, is setting the location of the device with respect to the slope of the tire sidewall. Considering this issue, after making the necessary adjustments and proper positioning of the tire, several samples were engraved with different parameter settings. Then, the engraved sections were cut to investigate the effects and depth of the profile. The dimensional specifications of the final engraved QR code are shown in Figure 6. As seen, the depth of 650µm is in accordance with the standards.

Figure 7 shows two QR codes engraved on the sidewall of Barez PCR tires that do not have sufficient quality. On the right, due to the use of high laser power, the engraving depth has increased and caused a defect in the tire. As can be seen in this case, the engraved walls are distorted. However, on the left, the engraving parameters are not set correctly. In this case, the walls and boundaries of the engraved QR code do not have appropriate formations.

To prevent a reduction of the tire thickness and creation of residual stress in the tire during the engraving process, the Barez Industrial Group suggests dedicating a special place



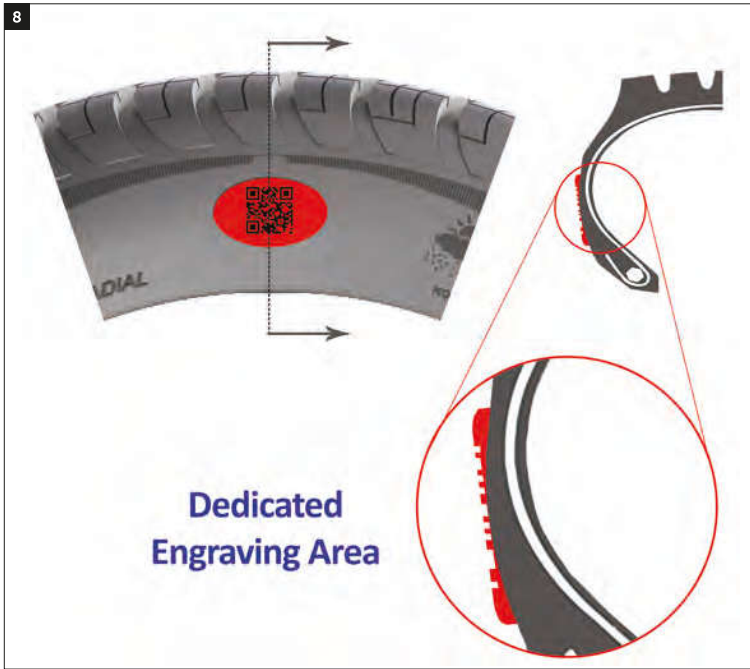


Figure 8: The dedicated engraving area on the sidewall of the tire

on the tire mold for engraving. This area provides a smooth surface and will serve as a guide for the operator or machine. In addition, it helps the customer find the engraved area. This dedicated engraving area is shown in Figure 8.

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