

# 4 SUR *faces*

The Laser Technology Magazine by 4JET

## **SCANNECT**

*Total Tire Traceability*

## **TOUCHLESS**

*Non-Ablative  
Glass Cutting*

LASER | SYSTEME | SERVICES

# 4JET

## Editorial

Over 1.2 billion tires from well over 1,000 factories end up in the hands of consumers every year.

1.2 billion tires, of which manufacturers are hardly aware of who uses them when, where, and how. A mountain of rubber, steel, and plastic that brings along with it the potential issues of warranty, liability, or disposal. And a staggering market volume, which could be replaced in a few years if you only knew who the end customer is ...

Customer retention and product traceability in the tire industry are still capable of further development. The marking technologies used are too inadequate, the trade levels and their IT systems too fragmented. Still.

Our vision: In a few years, the origin and life of a tire will be traceable on a smartphone or a computer in seconds. Using a camera phone and an app, customers will be able to scan a laser marked QR Code and with a few more clicks, order a fitting spare tire online. Fleet managers can keep an overview on the usage, retreading, or loss of the used tires at any time. Car makers and their service providers will work with standardized systems for logistics, installation, and the rare case of a recall. Legislators will mandate the individual marking for reasons of environmental and consumer protection (keyword „illegal disposal“). A „Universal Tire Identification Number“ will be applied to all tires, issued the same way across all manufacturers and in all countries.

Does this sound unrealistic? Maybe, but so did ISBN numbers for books, European Article Number (EAN) codes for groceries, or the Green Dot for recycling at one time.

We will see if our outlook comes true. It will not fail on account of technology, as you can read in our special on SCANNECT – our latest innovation.

I hope you enjoy the new issue of 4SURfaces

Jörg Jetter  
CEO

**PUBLISHER** 4JET Technologies GmbH, ViSdP Jörg Jetter  
**PHOTOGRAPHY** Stion Corporation, Cognex, Olaf Rohl, Kira von Gradowski, Anas Moalem, Klaus Schiffer, Tabbea Jorde, Dennis Tummer, Tobias Knüttel, kumbabali – fotolia acht ideen | Bürogemeinschaft für Gestaltung (SCANNECT-Zeichnungen)  
**DESIGN** www.scribble-werbeagentur.de  
**PRINT** Printed on chlorine free paper.

Imprint



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# SEPARATING *glass*

*using a non-ablative laser process*

**For the past few years, 4JET has been providing production solutions for the laser drilling of glass. While laser ablation is ideally suited for the manufacture of small inner contours and through-holes, outer contours require a quicker method with the least possible damage to the edges.**

Thin and ultra-thin glass is used today for scratch-resistant mobile phone displays, flexible solar cells, organic light-emitting diodes (OLEDs), electro-optic printed circuit boards, and battery applications. For these applications, it is essential for glass materials to have favorable thermal, electrical, and optical properties. In comparison to alternative materials, durability and weather resistance are also distinctive features. Separating thin glass with laser radiation yields high potentials for improving quality and cutting costs during processing.



Lablator HP

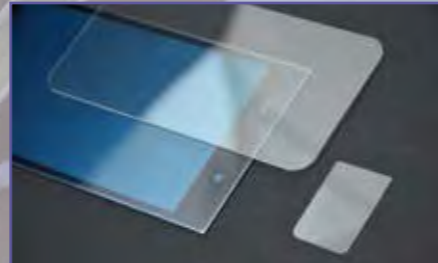
Compared to the cutting of semiconductor materials, where the use of lasers has become the norm, additional requirements must be met when cutting thin glass in order to facilitate the subsequent application. For example, displays and photovoltaic modules have relatively large dimensions and must withstand mechanical stress. Because the fracture behavior of the glass components depends on the character of the edges, the cutting edges must satisfy particularly high demands. Micro-cracks or chips lead to premature failure of the glass component.

4JET works with a dedicated team focused on the development of new cutting processes and systematically combines theoretical and experimental analyses. In doing so, 4JET also utilizes extensive analytical equipment, including scanning electron microscopy, laser scanning microscopy, and polarization microscopy, as well as digital bending testers. Based on the Lablator machine platform developed by 4JET, the processes are developed with widely customizable machine architecture, and at the same time fulfill specifications close to production.

4JET is working on an innovative solution for the separation of flat glass substrates. The method is based on the principle of controlled crack inducement. Through suitable introduction of the laser radiation, the crack contour is guided through the glass substrates in a controlled manner along the target contour. As a result, the cutting process is comparatively quick and virtually free of particles. Due to

the extremely flexible adjustment and control capabilities of the laser processes, significantly better edge qualities are achieved in comparison to conventional cutting methods. Laser processes can also be scaled and parallelized in virtually any way.

Until now, with display glass of different materials and different thicknesses, contour cuts were possible at speeds between 40 mm/s and 400 mm/s. The figures at the bottom of this page show microscopic images of the cut edges. Depending on the selected process parameters, different roughness characteristics are achieved. For some glass types, like the Gorilla® glass shown here with a hard layer thickness of 40 µm and a total thickness of 0.7 mm, a roughness of  $R_a < 0.5 \mu\text{m}$  is achieved.



Cut display glass (Gorilla® glass)

The cutting process developed by 4JET is suited to many types of glass: Aluminosilicate glass, soda-lime glass, and borosilicate glass can all be cut by adjusting the process parameters. Depending on the glass and the extent of pre-stressing, the method is either self-separating or requires a final separation process.

Microscopic images of the cut edges with various process parameters (Gorilla® glass)

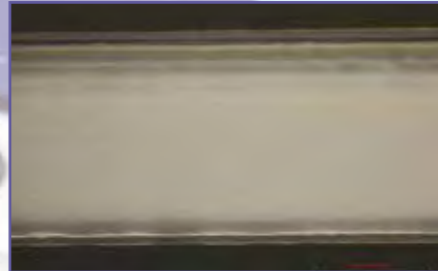


4

$R_a = 20 \mu\text{m}$



$R_a = 2 \mu\text{m}$



$R_a < 0,5 \mu\text{m}$

5

Cutting process

Under the

# MISSISSIPPI SUN

Stion, a leading American thin-film solar module manufacturer, uses 4JET inline process solutions for precise material removal in their process to create high-efficiency solar modules. Stion's factory, based in Hattiesburg, Mississippi, uses state-of-the-art equipment and highly optimized processes resulting in high-yield, low-cost manufacturing.

two symmetrical holes in the glass, which allows connectivity between the circuit and the junction box.

4JET inline process solutions were selected for their ability to meet Stion's strict specifications for precision, quality, and speed.

4JET enables Stion to deliver high-quality, low-cost solar modules in turn making clean, renewable solar energy the clear and economical choice for the world's energy needs.

The 4JET systems perform a series of processes to selectively remove semiconductor material from the surface edge and sides of the module. In addition, a 4JET laser glass drilling system drills



*The EDS Combifool by 4JET combines three process steps in the manufacturing of CIGS thin-film solar cells into one system.*

4JET offers new entrants into the CIGS technology a production capable pilot system that combines bus bar exposure, laser edge deletion and laser drilling of via holes into one platform.

The platform can be retooled to accommodate different module sizes as well as mini modules for R+D.

By switching to a single process operation, the tool can reach mass production tact times of below 60 s per substrate.

The "all in one" design is a cost efficient and compact solution that offers state of art processes. The installed laser sources and tools are identical to the proven 4JET solutions for mass production.



Laser Drilling Process



Customer Testimonial



# SCANNNECT

# TOTAL TIRE TRACEABILITY



Laser Engraving on a tire sidewall

### Scan and connect!

A solution to individually mark every tire with a unique and permanent QR (quick response) Code could be a game change for traceability and customer relationships in the tire industry.

The novel SCANNNECT laser marking process developed by 4JET can engrave an individual matrix code in tire sidewalls. The high contrast engraving can be read using a regular smartphone or by most handheld barcode scanners.

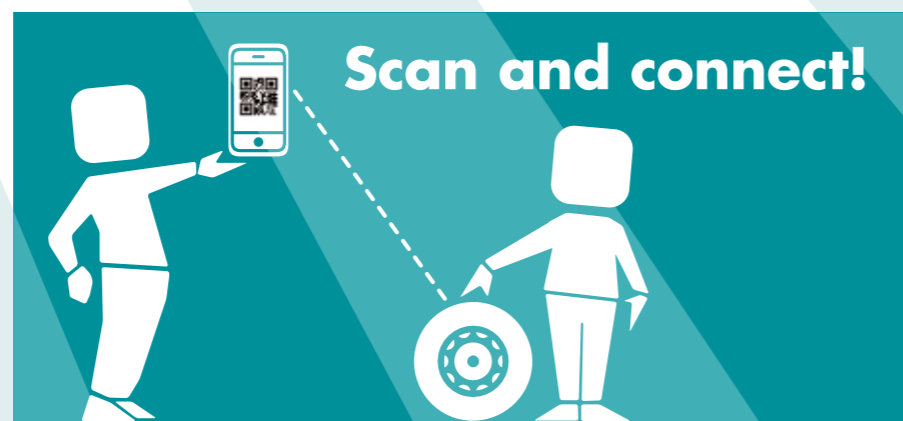
The SCANNNECT solution – short for “scan and connect” – enables a long standing wish of the tire industry: being able to trace tires through their life cycle and to get in closer touch with its end customers. Other than paper barcodes that have a limited lifetime, molded information that is not unique, or RFID tags that require specific reading hardware, the SCANNNECT solution enables a one of a kind product identification that can directly link each tire to a web based CRM database.

SCANNNECT provides advantages for all stages of the tire value chain:

- Manufacturers can address their end customers with specific marketing campaigns, such as warranty extensions, winter tire promotions or social media campaigns. Offering additional benefits or interesting content that is accessible via the SCANNNECT QR Code the tire manufacturer can get to know the tire user and may collect tire usage data. A direct communication with the end customer building a lasting relationship and improving customer retention is facilitated.
- SCANNNECT QR Codes can be employed as a means of assuring traceability and reducing the impact of product recalls.
- SCANNNECT marking can serve as distinct security feature protecting the tire maker from product piracy. Besides

the technical hurdle of the laser marking SCANNNECT QR Codes can embody a 128 bit encoded digital identity certificate that proofs tire authenticity. Finally the visible copy protection feature will promote the intrinsic value of the tire brand.

- Car manufactures will benefit from the SCANNNECT QR Code by being able to track and trace tires or mounted wheels through their production. Additional information can be provided for the car OEM with the tire, such as quality information e. g. tire uniformity data.
- Commercial fleet managers can use laser markings to organize inventory, track usage and prevent theft.
- Tire manufactures, trailer rental companies or full leasing providers can support their fleet service contracts that are based on a flat rate per kilometer.
- End customers can retrieve valuable



**8 Why Marking?**  
Individualizing a tire with 4JET

technical and commercial information about their tire specs, suitable replacements or quickly enter online market places for replacements or to sell used tires.

### QR Codes – How they work

Different to the one-dimensional barcode that is designed to be scanned by a narrow beam of light, a QR Code is detected by a two-dimensional digital image sensor and then digitally analyzed. The three distinctive squares at the corners of the QR code image are localized, using a smaller square (or multiple squares) near the fourth corner to normalize the image for angle of viewing, size and orientation. The small dots throughout the QR code (the so-called modules) are in turn converted to binary numbers using an error-correcting algorithm to compensate potential damages of the code.



QR Code, „www.4jet.de“

The amount of data that can be stored in the QR Code symbol depends on data type (the input character set, e. g. alphanumeric or numeric), the so-called version (indicating the resolution or number of modules), and error correction level.



QR Code with 11 alphanumeric characters  
Level H (highest) error correction



QR Code with 207 alphanumeric characters,  
Level H (highest) error correction

QR Code sizes depend on the number of data they represent. The highest version is capable of storing up to 4,296 alphanumeric characters while version 1 will code up to 25 alphanumeric characters only.

### SCANNNECT – How marking works

Unlike other organic materials the tire surface does not change its color upon heating or engraving with a laser. Carbon black as the main color medium simply is to chemically stable as to undergo color changing chemical reactions.

However “black” is a relative description. While an ideal (physical) black body absorbs all incident electromagnetic radiation, a surface will appear as “black”, if it absorbs the majority of the visible light.

Regular tires meet this requirement by absorbing around 95% of the visible light of all wavelengths.

With 4JET SCANNNECT laser marking the tire surface will be provided with a special surface structure in the dimension of a few micrometers. This structure consisting of small dots and grooves with a high aspect ratio prevents from direct reflection of visible light from the surface. Instead most of the light is “trapped” between the structure elements. A big percentage of the reflection can only take place indirectly after two or three reflection steps. As a result the reflection can be reduced by a factor between 2.5 and 4. The structured

surface appears dark black and the contrast between the original “tire black” and the “SCANNNECT black” is sufficient to be detected even with the small camera systems of modern smartphones. This unique approach of engraving a rubber surface is patent pending.

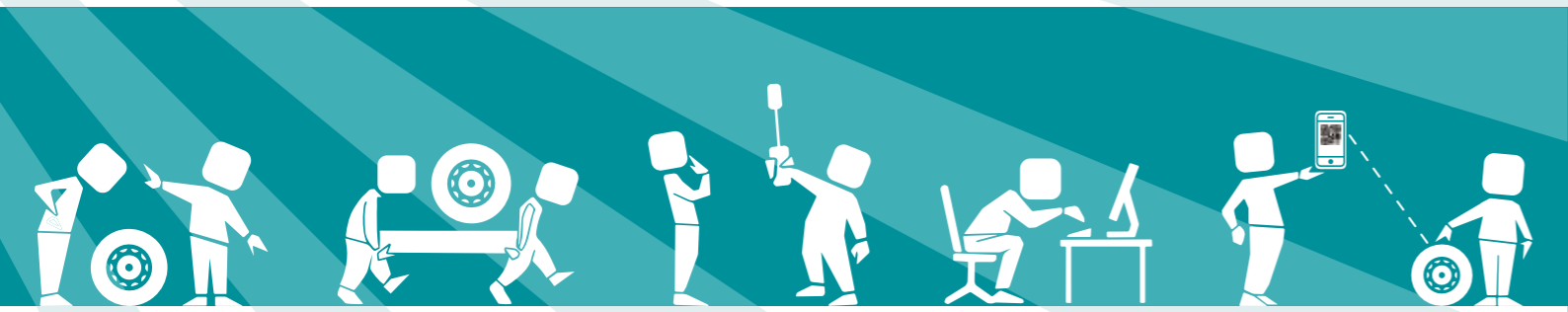
Marking is performed by the latest version of 4JET’s proven line of T-Mark systems that are widely used in new tire and retread tire manufacturing worldwide. The laser markings are applied after curing of the tire, either in the tire factory, further downstream in the car/wheel assembly or at the point of sale.

The SCANNNECT marking can be combined with a human readable serial number. Furthermore logos as well as other customer or country specific engravings can be added during the same production process allowing for increased production batches and/or reduction of stock.



### Reading SCANNNECT Codes

The reading principle of SCANNNECT QR Codes is identical to an ordinary printed QR Code – namely based on contrast between the individual modules of the QR Code. Hence **9**



T-Mark Compact

like any other QR Code it can be read with a standard QR Code reading device, be it an industrial QR Code imager or a camera-equipped mobile phone running on Apple iOS or Google Android apps. Like printed QR Codes the readability of the SCANNNECT Code depends on a number of different parameters, some of which are relying on the Code itself like contrast, resolution and size. Other important parameters are type and capability of the reading device and the lighting conditions.

4JET has intensively tested with several modern reading devices and smartphones/apps. In total the tests proof an excellent readability with the tested industrial devices over a broad range of QR Code sizes and data capacity required. Older smartphones or smart-

phones with reduced camera capabilities show a satisfying reading performance with some limitations depending on lighting conditions.

Laser engraved QR Codes are recessed into the surface of the tire and hence protected from wear. However as damages or contamination cannot be excluded for a used tire for any consumer related application the highest error correction level allows for 30% loss.

4JET's SCANNNECT software engine enables QR Codes with maximum error correction and information capacity sufficient to link to an individual serial number on a website on a 1 cm<sup>2</sup> surface. Smaller sizes can usually not be read with all smartphones due to the limitation of the optics of those devices. In an industrial environment with lower requirements for data capacity and error resolution and devices capable of reading Micro QR Codes (readable with dedicated vision

solutions) the QR Code size can be further reduced.



QR Code readable by a smartphone camera

**Systems**

The proprietary process, comprising special optics, laser parameters and control software integrated in 4JET's standard marking systems is now commercially available in the latest version of 4JET's proven line of T-Mark systems.

4JET SCANNNECT is now also available for the handheld T-Mark Compact.



T-Mark

# Identifying tires with SCANNNECT & DataMan

End customers can read out the codes marked with SCANNNECT using a smartphone app. Professionals gain more transparency in the industrial process with the handheld readers of the DataMan 8000 series by Cognex.

The new possibilities for tire marking are only as good as the readability of the codes by the user. While private end customers will be able to scan their tires in the future using their smartphone camera and the integrated illumination, an industrial solution is required for mass utilization in the tire plant, during tire installation, or for fleet customers.

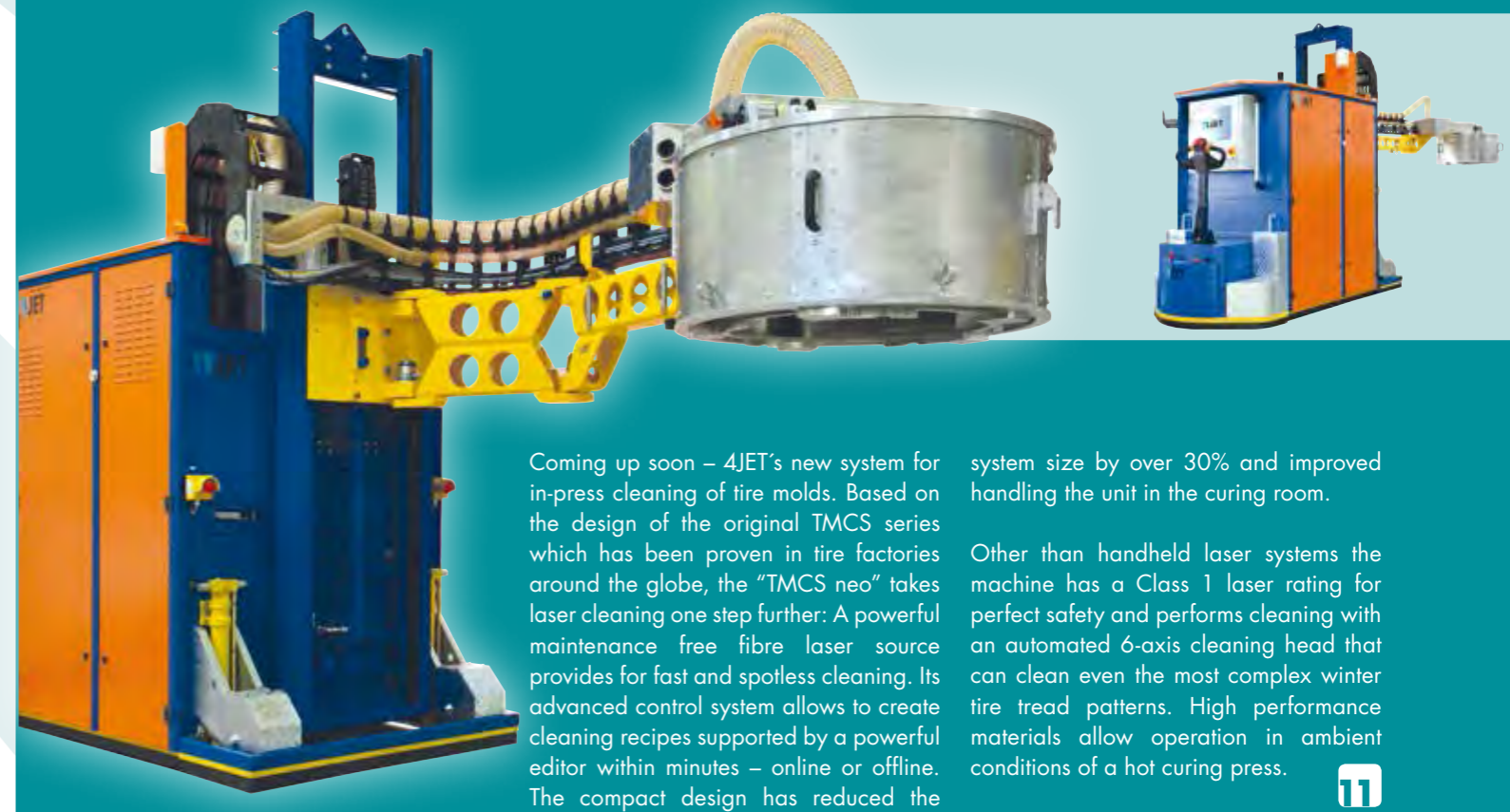
The handheld readers of the DataMan 8000 series are particularly suited for use in production and logistics owing to their read distance of up to 100 m away and their large memory capacity. In this way, codes can also be read offline and outside of the immediate workspace. The base station comes standard with a built-in replacement charger and is compatible

with all common Ethernet, USB, and RS-232 cables. Via Cognex Connect, the high-performance handheld readers can easily be integrated into the plant network. It is particularly simple to integrate the portable code readers by Cognex using the DataMan user interface. The reader can be set up quickly and easily with the intuitive software.



Identification at the touch of a button: Handheld readers of the DataMan 8000 series by Cognex detect and read 2-D codes quickly and reliably

## TMCS neo – Sneak Preview



Coming up soon – 4JET's new system for in-press cleaning of tire molds. Based on the design of the original TMCS series which has been proven in tire factories around the globe, the "TMCS neo" takes laser cleaning one step further: A powerful maintenance free fibre laser source provides for fast and spotless cleaning. Its advanced control system allows to create cleaning recipes supported by a powerful editor within minutes – online or offline. The compact design has reduced the

system size by over 30% and improved handling the unit in the curing room.

Other than handheld laser systems the machine has a Class 1 laser rating for perfect safety and performs cleaning with an automated 6-axis cleaning head that can clean even the most complex winter tire tread patterns. High performance materials allow operation in ambient conditions of a hot curing press.



**Innovative welding or bonding processes in automobile manufacturing request perfectly pre-treated surfaces. Depending on the task, separating agents and oils must be removed or the areas must be provided with a specific roughness in order to produce a reliable joint. The use of lasers provides a dry, precise, and wear-free alternative to the conventional wet chemical or abrasive blasting methods.**

**Solid welding thanks to lasers**

4JET has developed a system platform for welding preparation of gear components, which is particularly suited for rotationally symmetrical parts. In this process production residues and oxid layers are removed from the joining surfaces. This takes place in a touchless manner and without substrate abrasion, because a consistent cleaning quality is achieved by a homogenous beam profile on the component surface. In addition,

the energy can be set precisely, so that only those organic layers that negatively influence the welding process are removed. The surface of the component remains unchanged, because the required energy density for removal is significantly below the ablation threshold for metals.

Using a scanning beam deflection, in which the focused beam of a pulsed solid-state laser is guided over the rotating surface at a speed of several m/s, the

surfaces to be cleaned can be processed in a defined manner. The processing speeds here are within the range of some 10 cm<sup>2</sup>/s depending on the laser power used and the nature of the layers.



Welding preparation by selective laser cleaning

	Laser	Wet Chemical	Abrasive Blasting (sand, plastic media)	CO <sub>2</sub> -Dry Ice Blasting
Layer Selectivity	↑ yes	↑ yes	↓ no	↑ yes
Substrate Abrasion	↑ low	↑ low	↓ high	→ med
Repeatability / Yield	↑ high	↓ low	→ med	→ med
Operation and Consumable Cost	↑ low	↓ high	→ med	↓ high
Automation	↑ inline	→ batch	→ inline/batch	→ inline/offline
Environmental Effect	↑ dry process	↓ solvents	→ blast dust recycling	↓ noise

# PREPARING JOINTS

with pulsed solid-state lasers

**Bonding preparation**

In addition to the gentle cleaning, the laser can also specifically structure or activate a surface by changing its morphology. Many bonding processes for metals, plastics, and composite materials require improved roughness on the joining surfaces. Owing to the superb focusing capability of the fiber lasers used, high intensities can be generated in the workspace, which cause the material to vaporize locally, and

thereby enable the creation of small bowl-shaped cutouts or a grooved structure. A surface modified in this way features improved mechanical adhesion. New material combinations are also facilitated by laser processing: so, for instance, sealing foams can also be applied to materials such as ABS plastics or die-cast components that were previously unsuitable in terms of process capability.



Laser preparation



Adhesion improvement by laser preparation

Selective, flexible laser preparation for welding and bonding preparation takes place in enclosed, fully automatic systems which can be integrated into linked production and assembly lines. Modular automation solutions allow for loading and unloading on the basis of workpiece carriers, by robots, or by hand.

**Process control for perfect results**

The 4JET systems are equipped with efficient process and performance monitoring. Integrated online monitoring of the laser power thereby ensures steady processing parameters at all times. At the same time, a process control checks the shift in color change or gloss level of the component surfaces.

The control system collects extensive operating data, which can be transmitted to the main computer at the customer's plant and, at the same time, allows for remote support and fault analysis via a VPN connection.



# Perfect GRIP



Partially cleaned inner liner

Bonding preparation is a key application of the 4JET surface cleaning process. Release agents and oils can be removed with laser radiation, and bonding areas can be prepared precisely. The method is also used today in the manufacture of modern tires and enables the applying of additional layers or components after the vulcanization process.

In doing so, the release agents and other lubricants on the inner surface of the tire – the so-called „inner liner“ – used in the production process are removed with laser radiation without compromising the structure of the tire.

The surface cleaned in this way enables the introduction of insulating foam for reduced tread noises, sealants for self-sealing tires, or the installation of RFID transponders.

The Tire Cleaning System (TCS) facilitates the fully automatic, dry, and contact-free cleaning of the inner liner. The variable angle of the processing head ensures gapless processing. Compared to conventional wet chemical cleaning, the process saves on consumable and recycling costs for the cleaning agents and requires less footprint in the factories.

The system demonstrates more than the usual benefits of laser systems, such as

high process stability and low operating costs: Control of the 4JET system is based on a patent-pending intelligent recipe editor. The system automatically detects the tire dimensions relevant for processing and generates a fitting recipe. This innovation dramatically reduces the ramp-up phase in the factory and thereby shortens the return on investment period.

The system concept enables simultaneous loading and processing, providing for a particularly high utilization ratio of the solid state laser source.



TCS – Tire Cleaning System

## Speed of LIGHT

With the “Speed of Light” team, 4JET headed to the starting line at the Actimonda BusinessRun. The event with over 2,000 runners led through some of the athletic landmarks of Aachen such as the equestrian arena and the Tivoli football stadium. In the end, of course, they were a couple minutes over the speed of light, but everyone still had a great time and was cheered on by their colleague fans at the finish line after 5 km.



## HIGHWAY TO 4JET



World-class universities and research institutes, as well as numerous innovative companies such as 4JET, together form the technological region of Aachen. To draw the attention of visitors and through traffic to this technological cluster, 4JET – together with other companies from the region – is financing prominent signs on the A4 and A44 motorways. Over 100,000 drivers pass the sign daily as of now, which is being constructed as part of the North Rhine-Westphalia industrialized state campaign.



The illustration on the motorway signs is fitting for the new 4JET system for laser cleaning of gear parts

MIXEDzone

## BEAUTIFUL VIEWS...



... were enjoyed by the 4JET team during their hiking day in the “Eifel”.

An outdoor barbecue was waiting at the end of the route along the shore of Rur Lake.

Many thanks to the nearby pub that saved our evening with a 50-l beer keg!



