4SURfaces

Issue 2

The Laser Technology Magazine by 4JET

LASERDRILLING
of Thin Film Solar Glass

LASER CLEANING
of Tire Molds

LASER | SYSTEME | SERVICES
4JET

Editorial

Oops – that was fast. It feels like only a short time ago since we were a start-up company and all of a sudden we celebrate our 5th anniversary.

And five crazy years we had: A roller coaster ride in our tire business and a rocket launch in the solar market. A world financial crisis and relocation of the entire company. New colleagues – recently one new face every 4 weeks. New products, developed for new applications in new markets. New partnerships with research institutes, distributors and suppliers. And strong, profitable growth since Day 1.

All that is nice and was a lot of fun. However, most important are our new customers that add reason to our work. To satisfy them is never easy, sometimes impossible and always a challenge that we like to take on. Also in the next five years.

By the way – already today customers in 20 different countries rely on our production solutions for cleaning, marking or structuring of surfaces using laser technology. 4JET equipment processes ten thousands of solar panels, tires or other parts - every day. Precise, environmentally friendly and cost efficient.

You will find a few examples on laser applications in this issue of 4SURfaces.

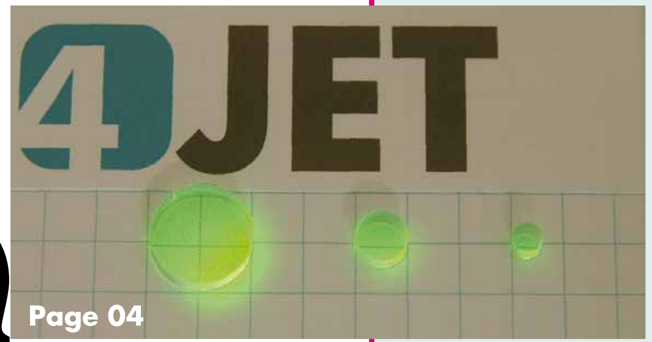
Enjoy reading,
Yours

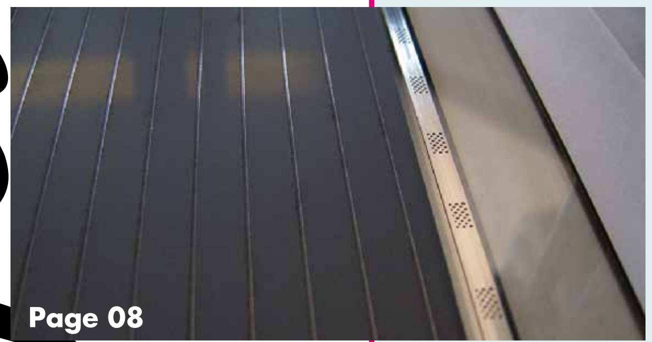
JÖRG JETTER
CEO

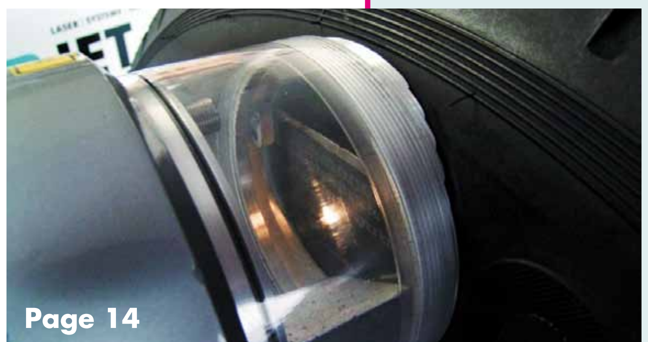
Imprint

PUBLISHER	4JET Sales+Service GmbH, ViSdP Jörg Jetter
PHOTOGRAPHY	Kira von Gradowski Dr. Marco Lentjes Dr. Klaus Spira Pirelli Deutschland GmbH Author photos: private
DESIGN	www.scribble-werbeagentur.de
PRINT	Printed on chlorine free paper.

4SURfaces







Content

LASER DRILLING *of Thin Film Solar Glass*

Lasers are widely used for different kind of glass machining processes like cutting, marking, welding and glass inside engraving. Drilling of solar glass by laser is a very new approach with several advantages over conventional drilling techniques used in the thin film PV industry. Drilled holes are needed to feed the wires connected to the bus bars through the glass to the backside of the panels. At the backside of the panel these wires are connected to a junction box or just to connectors. Depending on the thin film layer structure (CdTe, a-Si/µ-Si, CIGS) the holes are drilled through the cover or through the coated substrate glass. Both variants are possible by laser drilling as described in this paper. Fig. 1 and Fig. 2 show divers geometries drilled by laser into float glass and into a coated glass substrate. Due to the flexible technique various three dimensional shapes are feasible like rectangles with conical edges.

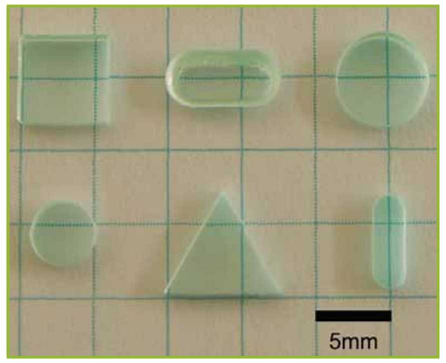


Fig. 1, float glass with different hole geometries drilled by laser

Advantage of laser drilling

Conventional methods to drill holes into solar glass are mechanical drilling and sand blasting. Both techniques are non contact free methods inducing stress to the substrate during the process. Mechanical drilling often needs a liquid to cool and lubricate the drilling process which has to be followed by a washing process. In case of sand blasting the geometry mask has to be changed frequently (<50 panels) since the sand grains are very aggressive to the mask. This leads to varying hole geometries during production. The size and shape of hole 1 will be different as the shape of hole 20 blasted through the same mask.

The laser has the advantage that it is a contact free and dry method inducing minor mechanical stress to the glass substrate. Laser drilling does not effort any post processing like washing. Further advantages are: the laser drilling process is highly reproducible, the process is stable and the shapes of the holes are freely programmable.

From the economical point of view the initial investment for a laser drilling system is higher than the investment for a mechanical or sandblasting system. However, the total cost of ownership is lower than the cost of ownership for mechanical drilling or sandblasting systems. This advantage will pay back the investment during mass production. The laser glass drilling system needs low-maintenance and has almost no consumable parts in comparison to the other two methods.

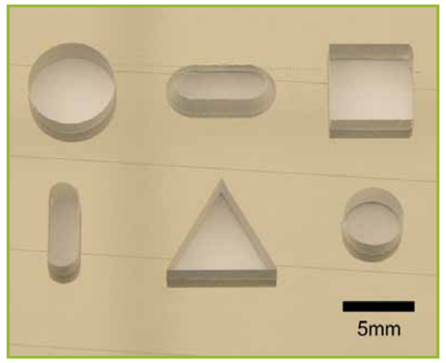


Fig. 2, Mo-CIGS-TCO coated glass substrate with different hole geometries drilled by laser

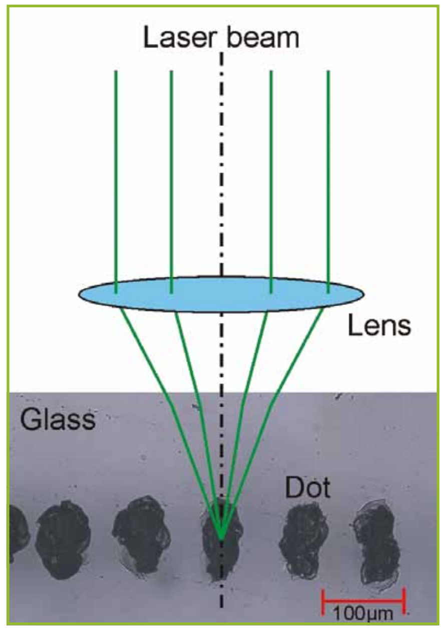


Fig. 3, principle of inducing single dots inside glass by focused laser beam

Process principle

At low intensities glass is transparent for visible wavelengths. This enables focusing of green laser light inside bulk glass. However, if the intensity exceeds the threshold for non-linear absorption (range of GW/cm²) the glass starts to absorb the laser light. In our process the intensity exceeds this threshold in the focal area and the light is transferred into heat. This leads to melting and evaporation of a small amount of glass. Due to the stress induced by the melting and evaporation process micro dots with a size of approximately 100 µm occur (Fig. 3). To achieve the needed intensity for non-linear absorption 4JET uses a green short pulse diode pumped solid state lasers with high beam quality.

The next step to a drilled through-hole is lining-up overlapping multiple single dots, layer by layer (Fig. 4). For spatial movement of the focus a scanner with focus shifter is used. The process direction is from the underside of the glass to the upside of the glass. The distance between the single dots is one of the key-parameters of the laser drilling process and is defined by the speed of the scanner and the frequency of the laser. One layer consists of multiple contours with a spatial distance (dc) as shown in Fig. 4 top view. The number of layers is defined by the thickness (t) of the glass and the optimal distance between the single layers (dl).

This layer wise flexible ablation process allows the creation of endless hole geometries by free spatial placement of dots inside the glass substrate. For example a conic shape hole can be drilled by starting with small circles at the underside of the glass and ending with larger circles at the upside of the glass (Fig. 5 B). Holes with a high aspect ratio (Fig. 5 A) and holes with changing cross sections (Fig. 5 C & D) are other possibilities of this drilling method.

In case there is a coating on top of the glass (e.g. CIGS solar panel) this coating has to be removed before drilling. Local removing of the coating can be done by the drilling laser as well.

Table 1,
process parameters for 3 mm float glass

Glass thickness [mm]	3	3	3
Hole diameter [mm]	3	5	10
Process time [s]	3,5	5	12

Processable glass types

The method described in this paper can be used to process float glass with various thicknesses at high speed and with high quality. Table 1 shows the time needed for cylindrical holes with different diameters through 3 mm float glass.

Unique is the possibility to drill holes into semi-tempered glass which is not feasible with conventional techniques (Fig. 6). Conventional methods induce stress to the substrate which results in breakage of the glass.

Tests demonstrated that the breaking strength of glass with laser drilled holes is higher than glass with mechanical drilled holes. Fig. 7 shows the relative breaking strength of laser and mechanically drilled glass in comparison to undrilled float glass.

System description

4JET's laser drilling systems are custom configurable as stand-alone system or available as submodule of 4JET's thin film processing line. The stand alone system can be easily integrated into a production line and equipped with or without conveyer belt. The drilling system is provided with user friendly software which enables programming of different hole geometries by the user.

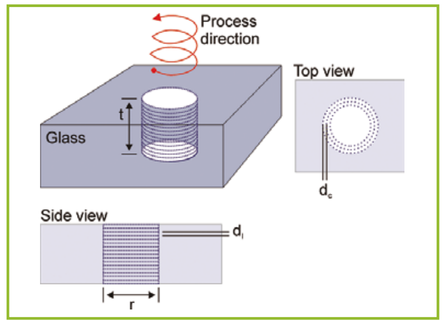


Fig. 4, Schematic of laser drilling of a cylindrical hole with radius r by three dimensional lining-up of single dots

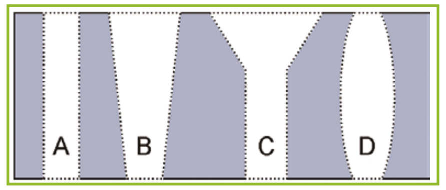


Fig. 5, examples of different through-hole geometries in glass (cross section view)

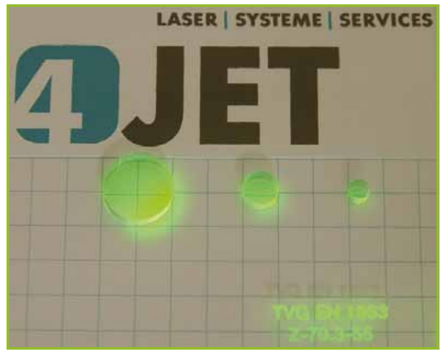


Fig. 6, holes with 3 mm, 5 mm and 10 mm diameter in 4 mm thick semi-tempered glass

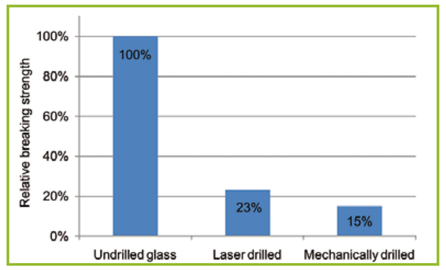


Fig. 7, breaking strength of drilled in comparison to undrilled glass, 100 mm x 100 mm x 3 mm float glass, 5 mm hole diameter

Dr. Marco Lentjes,
4JET Sales+Service GmbH,

Dr. Lentjes studied Engineering Physics at the Rijswijk University and graduated with a specialization in photonics. He received his doctor's degree for his work on "Controlled Laser Cleaning of Artworks via Low resolution Plasma Spectroscopy and Linear Correlation" from the University of Twente in the Netherlands.

marco.lentjes@4jet.de

Product Update

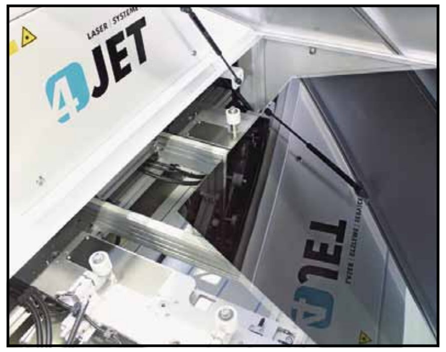
INLINE

Systems for Laser Edge Deletion

The dynamics in the PV solar industry can be seen in the pace at which production equipment is developing. In less than three years, 4JET has already presented the third generation of machines for the edge deletion of thin-film solar cells. The successful INLINE platform has been the basis for the latest machine generation. A round-up of the bestseller´s highlights

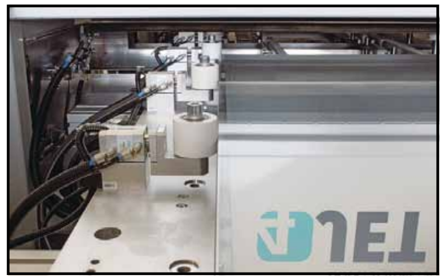
Automatic Beam Control – the fairly strong waviness of solar glass eliminates the advantages of Top Hat beam profiles created by square fibres widely used in the industry. For this reason, 4JET has developed a system for regulating the standoff distance, similar to an autofocus in a camera. The system is extremely fast and can even compensate for steep angles on substrate corners.

At the same time, the typical format tolerances in the glass industry are being equalised by a sensor system and software control, thus ensuring dimensional and repeatable operational results.



With verified mass production takt times of 23 seconds for 11 mm wide margins for a 120 x 60 cm CdTe module, the INLINE could well be today's quickest edge deletion system. To be fair, attention must be drawn to the sometimes substantial differences in operating times, depending on the type of thin-film and TCO layer.

Apropos differing layer stacks – for manufacturers of CIS/CIGS solar cells, 4JET supplies an optional integrated, mechanical stripping head for exposing bus bars or isolation scribes in the equipment.



Additional options include the integrated testing of transmission and isolation, the measurement of laser performance at the laser head and at the processing location, as well as the incorporation of a beam profile measurement.

Ready for technological progress is the flexible platform design, that also allows to integrate tomorrow´s laser sources. Both fibre-coupled and shorter pulsed lasers with rigid beam delivery can be installed in the system. The platform is also suitable for new applications where a full area processing is required, such as for the production of semi-transparent BIPV modules, or the laser processing of TCO layers. 4JET's comprehensive application know-how, and its well equipped laboratory help in the selection of the appropriate laser.

All the industry's established format sizes can be handled with the identical platform, and can be converted within a short time. This not only increases the future compatibility of the investment, but also reduces production costs and lead times.

In order to simplify transport and commissioning, the whole of the equipment is contained in a solid welded construction, which can be crane-lifted, and was adapted to meet container dimensions. So, unpacking, assembly, alignment and start-up in the customer facility is possible within a few days.

Advantages
of Laser Edge Deletion

- Increased Module Efficiency due to Reduced Dead Zone
- Touchless Process without Glass Damage
- Environmentally friendly, Dry Process without Blasting Media or Chemicals
- Effective Deletion of TCOs, Semi-conductors and Back Contact
- No Post Processing Required
- Repeatable Results
- High Flexibility of Deletion Areas
- Integrated Process Metrology

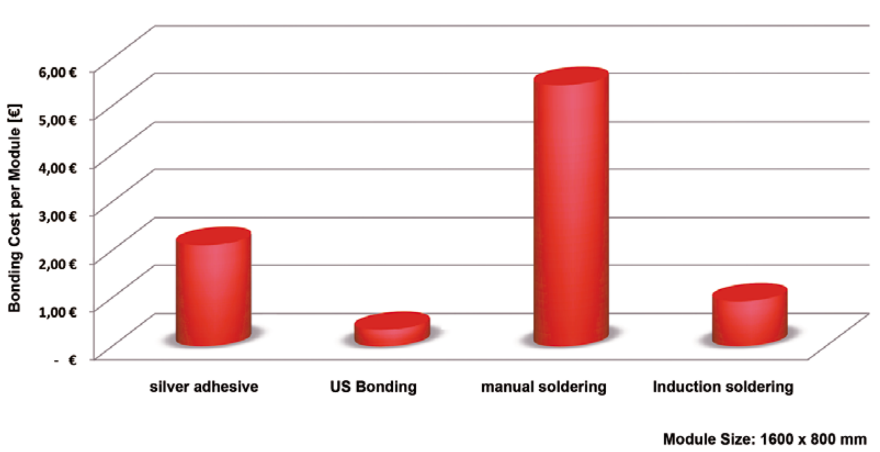
BUS BAR ULTRASONIC BONDING of Solar Modules

A number of leading manufacturers of thin-film solar cells are using theMEX equipment developed by 4JET for the exposure of bus bar pads. In a downstream process, the bus bars must be securely contacted with the conductible molybdenum layer. In his article, Dr. Klaus Spira explains the advantages of the ultrasonic process.

International competition and economies in the promotion of solar energy in accordance with the EEG amendment, force the manufacturers of thin-film solar modules to further reduce costs. For this, the contacting of bus bars using ultrasonic technology has great potential.

Today's available technologies for Bus bar contacting are glueing, soldering and ultrasonic bonding; whereby glueing is, with 90% market share the most commonly used followed by inductive soldering. The important advantages of ultrasonic bonding, such as the metallic, flux-free joins, are currently undergoing intensive testing, and are being considered highly attractive due to their cost and quality advantages.

The gluing process, using silver-conductive adhesive, compensates for many of the processing errors in upstream processing stages. Surfaces which hold the remaining residual particles of the absorber layers, will be consolidated and stuck together by the sealed adhesive layer. Albeit that these residual particles may lead to a negative isolating effect in the bonding, this will be, to a great extent, compensated by the complex, continuous surface. This compensation for the disadvantages is achieved at the very high price of adhesives, adhesive consumption, and handling costs during the production process.



Costs of Bus bar Contacting

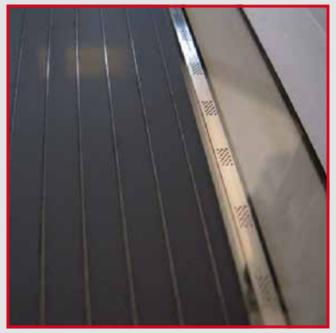
The Ultrasonic bonding process produces a metallic joint between the basic material and the bus bar material to be contacted. Tests at the ZWS Institute in Stuttgart have shown that the power losses during the transition from module to ribbon are reduced by a factor of five. Apart from the technological advantage of the improved power transfer, the low per-module costs are also an asset which makes a notable contribution to its competitiveness.

The connection mechanisms in US bonding are based on the fact that, due to the normal power and the high frequency relative motions of the surfaces, an electronic exchange takes place in the contact surfaces, and that, as a result, an irreversible contact is created.

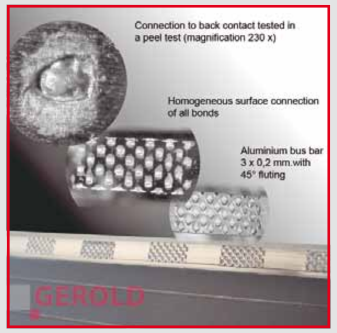
Residual particles on the contact surface can have two totally different effects.

Metallic oxides, such as Al_2O_3, may positively help the establishment of the connection because of their hardness; whereby a break-up of the oxides occurs, so that metal free interfaces make contact. By a suitable design construction of the tips, the oxide residues will be stored in the intermediate chamber of the fluting during the bonding process.

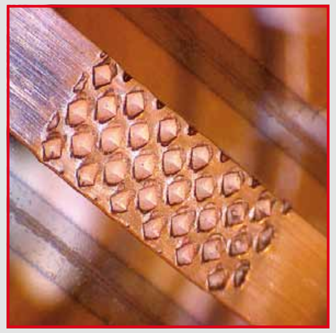
Absorber residuals, such as sulphur or selenium, which get into the joint with the molybdenum, and thus have very high gliding and adhesion properties, are totally different. These special properties inhibit a downstream convergence of



Solar Module with an Aluminium Bus bar



Contacting Analysis



Bonding Characteristics

Specific Contacting Values

the interfaces, and such elements also demonstrate a very high insulating effect.

By a coordinated cleaning process, combined with a laser process, or, if appropriate, an additional mechanical refurbishing of the contact surfaces, such layers can be successfully removed. Practical experience has shown that the targeted and complete transport of such residual particles into the depths of the fluting cannot take place using the ultrasound process. The unavoidable result is reduced bonding effects and defective joints. It is not possible to increase the normal force during bonding in order to avoid flaws such as punctures.

It is clear that the surface preparation is of special importance for the downstream contacting process. If such a coordinated processing procedure is carried out, then one can attain the bond characteristics shown in the picture using ultrasonic contacting processes.

The constructive completion of the fluting must be considered as a necessary criterium for the Peel Test. Stress concentration during the Peel Test will cause the contact band to tear if the blade tips are oriented towards the Bus bar. Constructionally divided blades lead to an almost closed point contact, and to substantially improved Peel results. Optimal bonding connections may, during a Peel Test, result in a separation of the molybdenum from the glass and more rarely, to the severance of the aluminium-molybdenum layer.

Maschinenbau Gerold GmbH & Co. KG (Nettetal) has developed a bus bar bonding system which has two or three ultrasonic bonding heads, appropriate for each module design. These can be geared to each size of modules automatically in its Y coordinates. The module is centered in the machine, measured and gripped tight on a vacuum table. Depending on the actual location, the bus bar will be laid on it, and bonded by the bonding heads on the moveable bridge.

During the bonding process, the Bus bar will be subjected to continuous pre-tension. The Bus bar cassettes will be manually attached, and, with the belt change, automatically pivoted into the changeover position. Alternatively, the bonding process may be carried out in the energy, power, and time regulation mode.

Many of the developments in the solar industry can be traced back to the semi-conductor industry's lessons and experience. Here ultrasound bonding is a key technology, without which no processor chip and no miniature circuit could be efficiently manufactured. The solar industry would be well advised to build on this know-how and to make targeted use of the many advantages of ultrasound bonding for module production.

Gerold's Bus bar Bonding Facility

Dr. Klaus Spira studied Engineering at, and graduated from, the Rhineland-Westphalia Institute of Technology (RWTH) in Aachen. Since then, he has worked on Automation Technology, applying the broad technological experience he acquired in the household appliance and glass industries to solar technology.

@ klaus.spira@gerold-mb.de
www.gerold-mb.de

Solar Technology Report

4FLEX LASER SYSTEMS

for the R2R Structuring of Flexible Electronics

Flexible, printed and organic electronics promise tremendous potential. Future electronic devices have to be lighter, more efficient and cheaper to produce. The range of applications increases rapidly. Think about rollable displays, printed radio frequency tags, OLEDs, printed buttons….. Also the solar industry follows this trend. Several solar cell companies are working on flexible solar cells based on organic or inorganic absorber layers.

Fig. 1, Printed flexible electronics

While the manufacturing of conventional rigid thin-film and crystalline solar modules has long reached the mass production stage, flexible solar cells only contribute to a small amount of todays installed base. However, the promise of having light weight, flexible and low cost solar panels with a higher conversion efficiency in low light conditions is intriguing. Potential uses could be mobile applications as well as installation on low load industrial rooftops. Also specific niche markets, such as tents or clothing may open up.

The multiple technological approaches to "flexible solar cells" include metals or polymer substrate materials (such as PET) as well as absorber systems ranging from CIGS over amorphous silicon to organics.

One of the many examples for technical challenges in the manufacturing of these cells is to create monolithically integrated modules by interconnecting single cells through mechanical or laser processing. While this is a commonly used process in the manufacture of thin-film solar panels on glass substrates, there are few laser patterning systems used in the flexible solar arena so far.

Typical Laser Applications for Flexible Electronics

The most common processing tasks known today in the laser processing of flexible electronics include:

- cutting larger foils into multiple single cells
- creating a serial connection by P1,P2 and P3 scribing
- selective layer exposure
- edge deletion and isolation cuts

The new 4Flex system platform

4JET is now leveraging its know-how in laserbased and mechanical processing of solar thin-films and offers a new machine platform aiming at high volume industrial manufacturing. The new system, dubbed "4Flex" is available for the entire range of laser processing applications on flexible solar materials. In order to provide such flexibility, all kinds of state of the art laser sources could be integrated, including short pulsed solid state lasers for ablation and CO_2 lasers for foil cutting, as well as mechanical scribe tips. The first commercial application of the new system is P1 scribing of PET substrates and utilizes an ultrashortpulsed laser.

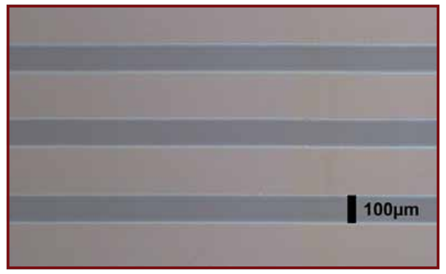


Fig. 2, 100 µm scribes trough ITO (P1)

The patent pending beam delivery design processes the foil on the fly in a true "reel to reel" approach with up to 32 individual laser beams working in parallel. By installing multiple of such beam delivery modules, foil widths of up to 1 meter can be processed. A mechanical system assures a constant standoff distance between the foil surface and the beam output. For high position precision and a minimized dead zone between scribes, the system is equipped with a tracking system that either follows the edge of the foil, previous scribes or position marks.

4JET cooperates closely with leading R2R system supplier COATEMA Coating Machinery GmbH, Dormagen, Germany (www.coatema.de) in the development of the new platform.

4JET's R2R laser structuring system is available as standalone machine or OEM version for integration in third party production lines. The modular design allows the integration of additional cleaning or processing steps, metrology features, vision systems or data matrix code readers/writers.

Reel to Reel Processing of Flexible Foils – 4JET Laser Technology and COATEMA Handling Equioment

SHORT*messages*

New ACCOUNT MANAGER *Solar*

4JET has further strengthened its sales team. Dr. Marco Lentjes has been appointed Account Manager for 4JET´s Solar/Thin Films business. At 4JET, he will support equipment sales to the photovoltaic, glass and electronics sector. Please see also page 4 - 5 for his paper on solar glass drilling

New from our Partners

INNOLAS *presents*

a new variation of the IMPALA*Series*

IMPALA System of InnoLas

4JET's cooperation partner, INNOLAS Systems GmbH (Krailing near Munich) is a leading supplier of laser structuring equipment for glass-based thin-film solar cells.

The IMPALA series, well-proven in industrial production, has now been expanded by a new variation - the IMPALA TTG for Through-The-Glass-structuring.

IMPALA / IMPALA TTG are designed as work stations for precise processing over a large area for processing panels up to 1200 x 1600 mm size. Modular in construction they can be tailored to customer requirements. Both laser processing and mechanical scribing are available. A variety of laser sources (Nd:YAG-, Nd:Vanadate-, Pico-Second laser at 355 nm /532 nm /1064 nm wave length) is available to machine different thin film technologies as CIS/CIGS, CdTe, aSi/µSi. Enhanced drive and handling concepts, automatic alignment based on precise machine vision systems as well as integrated solutions to compensate for glass waviness, provide the required accuracy and throughput. Machine precision minimizes distances between scribes in monolithic interconnections.

@ www.innolas.de

5 years 4JET - 5 years „LAW & ORDER"

A special employee celebrates her 5th year on the job in year 5 of 4JET. Husky-Chow-Backyard Mix Pepper, a 12 year old lady, "guards" the offices and facility of 4JET. Not always nice for delivery staff and the new colleagues that stumble in her territory, but loyal and reliable. **Congratulations, Pepper!**

Pepper during lunch break

MORE THAN CLEAN

Laser Cleaning of Tire Molds

4JET is the leading supplier of laser systems for cleaning of tire molds. The product line was further enhanced in recent years, so that the company offers the widest portfolio of cleaning systems today.

The Task

Tire molds require frequent cleaning after app. 1000 - 3000 tires were produced, in order to remove production residues and ensure an attractive appearance.
Today´s cleaning solutions in the tire industry range from high pressure blasting, the use of chemicals to the widely popular dry-ice cleaning.

Depending on product mix and production runs the molds and their sidetrays need to be cleaned in-situ or when dismantled. Specific challenges are the cleaning of sipes and vents.

Use of Lasers

The use of lasers is not new. The systems offered by 4JET are being used in numerous tire production facilities in Europe, Asia and North America. Lasers are mainly being used due to their high cleaning quality and their ability to clean molds in the press.

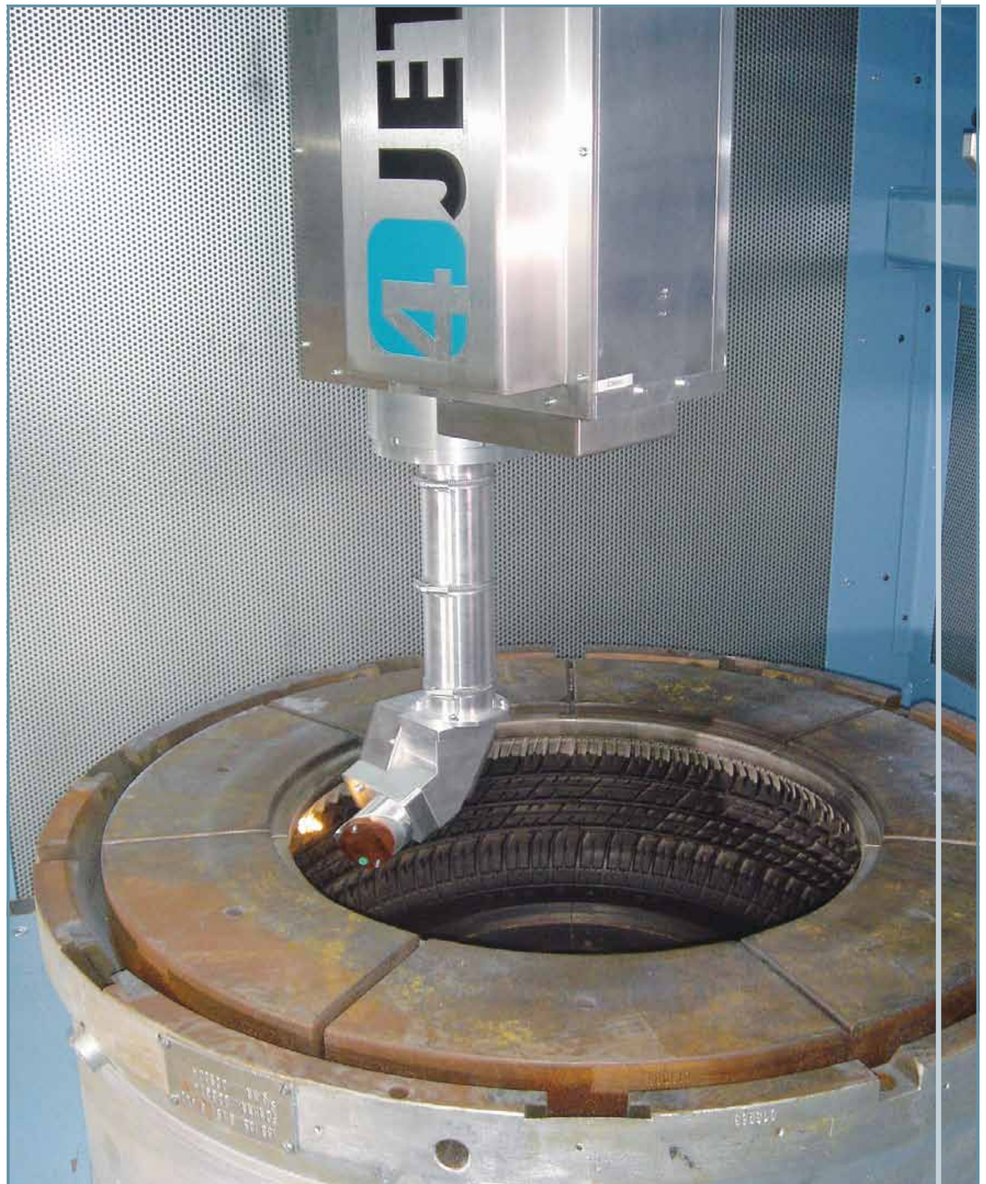
With the increasing environmental awareness of the tire industry and the struggle to find sustainable production processes, laser cleaning is becoming increasingly popular. Other than the widely used CO_2-dry ice cleaning systems, lasers create only a fraction of the CO_2-emissions and use significantly less energy.

Working Principle of Laser Cleaning

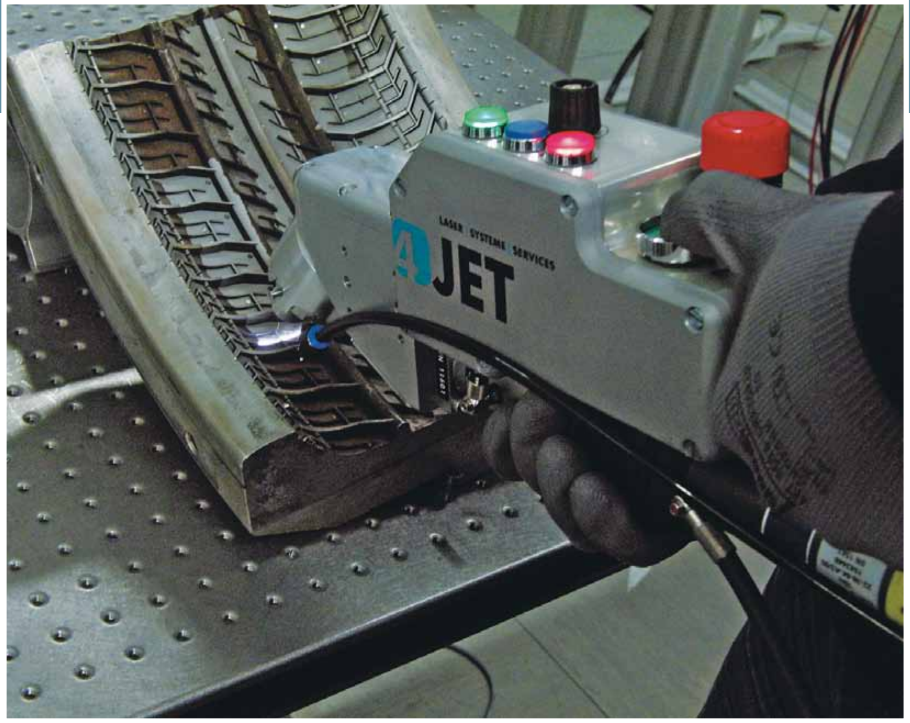
For cleaning, pulsed lasers including diode pumped solid state or fiber lasers, as well as pulsed CO_2-TEA lasers can be used. The use of shorter wavelengths in the 1µm region requires to run the process in a narrow window and an automated fashion in order to provide for an effective and still material friendly cleaning of the tool surface.

The pulsed light hits the contaminated surface with peak powers of up to several 10 MW. The abrupt induced energy cannot dissipate and blasts off the coating in a small area. The impact zone corresponds to the size of the laser beam spot on the surface. By repeating this process and aligning beam spots next to each other the surface is exposed pulse by pulse.

The ablated material – usually fine dust or gas – is locally exhausted and routed to a filter.



Laser Cleaning in Action



Cleaning of dismantled molds using a flexible end effector

S-TMCS System for automated offline cleaning of molds

In the short pulse duration the laser light is hardly absorbed by the substrate such as an aluminum vulcanization mold. This does not lead to any mechanical, chemical or thermal impact of the substrate.

Advantages of Laser Technology

Besides the material friendly cleaning, lasers convince by their low operation cost. The variable cost for one mold cleaning operation is below 3 EUR, while dry ice cleaning requires well over 20 EUR for ice pellets and pressurized air alone. This provides for a quick return on the higher initial investment cost of a laser.

Other than when using dry-ice systems, cleaning dismantled mold does not require energy intensive pre-heating of the tools.

The automated 5-axis scan heads of the 4JET tools provide for a consistent cleaning even of complex winter tire tread patterns.

The local evacuation completely captures all residues and allows for an environmentally sound disposal.

Equipment

4JET offers a variety of systems for cleaning tire molds.

For automated cleaning of molds in their curing presses, mobile TMCS systems are ideally suited and provide for the shortest press downtimes. Especially factories with high production runs of identical OE product take advantage of the increased press- and mold-uptime.
Dismantled molds can be cleaned offline using the S-TMCS equipment in a fully automated fashion.

A highly flexible and compact end effector allows integration in proprietary machine designs and robot integration.

Dipl.-Ing. (BA) Florian Schreiber studied mechanical engineering. He worked for a leading tire manufacturer as well as for a consumable supplier to the tire industry. Since beginning of 2010 Mr. Schreiber is responsible Key Account Manager for 4JET equipment sales to the tire industry.

LASER*Marking* of Tires

4JET supplies T-Mark laser systems to the world's leading tire manufacturers. Their use ranges from the identification of commercial vehicle tire retreads, over original tires for private vehicles, to special tires, such as prototypes or tires for Formula 1. In his op-ed, Ralf Fischer of Pirelli Germany explains the laser system's areas of application.

Pirelli Deutschland GmbH in Odenwald is a leading manufacturer of UHP tires. As such, we are the development partners of well known OEMs in many interesting projects, and provide our customers with many and varied tire prototypes for vehicle development and testing.

A particular need for the often incomplete identification of tire prototypes is the establishment of a reliable tire identification method during testing. Identification needs vary from customer to customer.

Either specification designations are manually engraved or burnt onto the tire, bar code labels and stickers are attached to the tire - before or after vulcanization - or special adhesive labels, so- called vulcanettes , are specially manufactured and vulcanized with the tire.

All these methods of identification require either a high level of manual input, or they run the risk – as with bar code labels and stickers – of becoming illegible during the testing programme, due to the test conditions or the mounting operations.

In order to be able to offer our customers a satisfactory solution, while at the same time fulfilling our quality, performance and efficiency standards, we began by testing various tire identification systems. Alternative concepts, such as RFID or staining/printing were rejected early on due to serious drawbacks, in favor of identification on the sidewall of the tire using a laser.
We investigated various systems and laser concepts with a variety of partners. 4JET's T-Mark Compact emerged as the winner.

Thanks to its small size, the T-Mark Compact is very flexibly deployable. The CO_2 laser's wavelength is excellently suited for rubber; the focusing unit and available scanning modes, when correctly set, provide an identification which causes no damage whatever to the sidewall of the tire.
Furthermore, a marking operation takes between five and fifteen seconds, depending on the extent of the marking, so that, with low energy consumption and maintenance requirements, our demand for efficiency is fulfilled.

With its on-site flexibility, and the programming flexibility the T-Mark Compact is predestined to perform beyond its planned uses, as a vehicle of choice for testing possible future applications; whether for the identification of tires using serial numbers, the treatment of surfaces for applying sensors, or the partial labelling of the tire sidewall.

To summarize - the T-Mark Compact and its crew deliver a performance which complies with our interpretation of "High-Performance".

Ralf Fischer heads Pirelli Deutschland GmbH's Process development division.

Contact via XING www.xing.com

BONDING PREPARATION BY LASER *Foam Sealants that Stick!*

Foam seals are increasingly being used to substitute elastomeric seals and O-rings for protection against damp, dirt and dust. Of particular advantage are single component PUR foams, which can be applied using automatic dosing equipment.

These foams already harden at moderate temperatures (90°C); thus the perfectly fitting seals can be produced directly on the component. In fact, this can be integrated into an assembly line.

Often problematic, however, is the adhesion of the foam compound to the surface. Production residues such as oils or release agents negatively affect the bonding, as do superhydrophobic plastic surfaces (e.g. POM).

Good adhesion requires clean, chemically activated surfaces. These can be achieved by the use of solvents and chemical bonding agents. However, it is difficult to integrate such environmentally hazardous procedures into an assembly line. Atmospheric pressure plasma processes are a slow alternative and have often proved to be unreliable.

4JET has developed a fast, laser-based process, which prepares complex surfaces of diverse materials for the application of adhesives and foams.

The fully automatic installation, with which housings made of POM plastics and steel plate are prepared for the foaming, allows the treatment of complex 3D components in a cycle lasting a few seconds. Essentially, the installation comprises a pulsed laser with beam shaping, scanner, and the peripheral components for operation and control, as well as a vapour evacuation system.

The scanner tracks punctiform the desired path of the adhesive beading. The track of the beading stretches over the steel plate, as well as over the POM surface of the component. It will be completed in a single step.

The laser pulse causes a strong, sudden, local heating of the surface and a microscopically small ablation of material. Thus, the laser causes the vaporising of volatile substances, the roughening of the surface and its chemical activation.

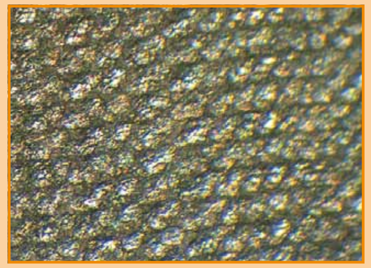
With this preparatory treatment, excellent adhesion of the foam seal is achieved. Stress tests show a cohesive failure of the seal and no detachment of the seals from the surface of the components.

With the installation, adhesion preparations at a feed rate of over 10 cm^2/s can be reached.

The installation is designed for 24/7 operation. It corresponds to Laser Class 1, and thus requires no additional laser-specific safety provisions.

Left– a fine structure is created on a metal surface, which improves adhesion. On the right the untreated metal.

Three different roughnesses on a POM casing. The parameters can be simply changed via the software.



Microscope image – The fine structure increases the component's contact surface.

Author Dr. Heinz Jetter has more than 30 years experience with laser technology. After graduating in Physics he has been working at the BATELLE Institut, the Max Planck Gesellschaft, SIEMENS AG and Rofin Sinar. He founded JET Lasersysteme GmbH in 1993. The company is today a consultant to 4JET.

@ heinz.jetter@jetlaser.de

4 JET | Konrad-Zuse-Straße 1 | D-52477 Alsdorf | **www.4jet.de**

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