FUTONICS

Catalog 2020

2.0 µm Laser & Accessories

FUTONICS

CONTENT

ABOUT FUTONICS

MANAGING DIRECTOR

Dr. Peter Fuhrberg is the managing director of Futonics Laser GmbH. After studying physics at the Technical University of Hannover, he first worked in research and development at Spindler & Hoyer (now Qioptiq, Excelitas Technologies Company) and received his doctorate in 1988 in laser physics for research into new laser materials for the NIR region. In 1989, he founded Lisa laser products OHG, specializing in 2.0 µm lasers for medicine and industry. He managed the company for almost 30 years until it was sold to OmniGuide in 2018. In June 2018 Dr. Fuhrberg founded Futonics Laser GmbH.

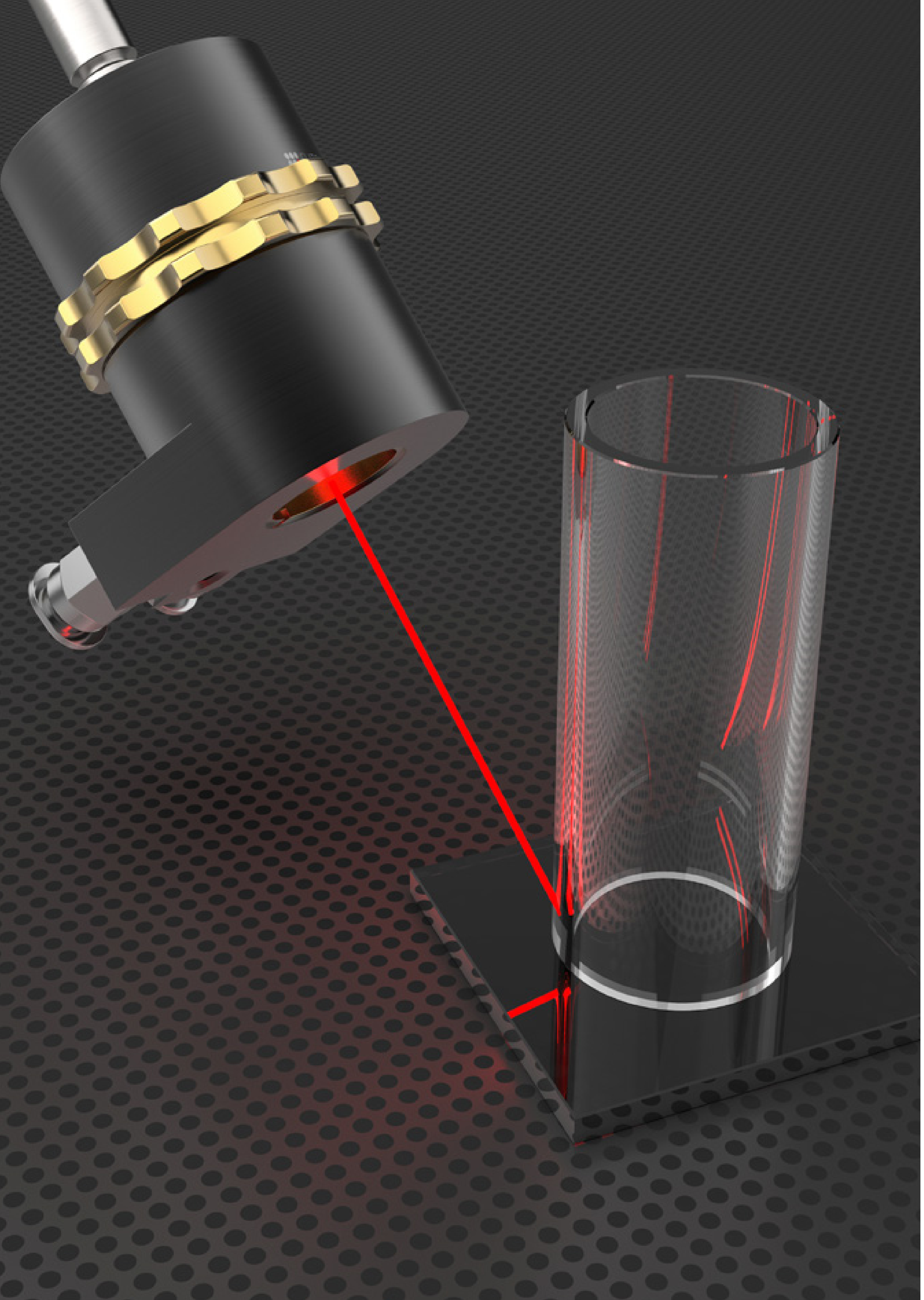
FUTONICS LASER GMBH

The employees of Futonics Laser GmbH can look back on over 10 years of experience in laser development of infrared laser systems for medical and industrial applications and many international research projects and cooperations. In 2003 Dr. Peter Fuhrberg received the European patent specification „Method and device for welding thermoplastic materials with laser light“ (PCT/EP99/05109) and was thus the first one worldwide to develop a device as well as an application for welding plastics at 2.0 µm wavelength. Futonics has in-depth knowledge of materials and their processing possibilities and developed the IFL product series on this basis.

The IFL product series consists of high-power polarized and unpolarized 2.0 µm thulium-doped fiber lasers with a beam quality of $M^2<1.1$, which allow continuous and modulated operation up to 10 kHz. The lasers are built in an „all-fiber“ configuration with single-mode fibers and Fiber Bragg gratings (FBG) to realize a robust and compact design. The user can choose a fixed wavelength between 1930 nm and 2050 nm, depending on the absorption of the materials to be processed.

There are numerous applications for 2.0 µm lasers in many scientific and technological fields. They operate in the „eye-safe“ wavelength range and are ideally suited for LIDAR, optical free-space communication, gas sensor technology or pump laser sources in the medium IR wavelength range.

In material processing, Futonics IFL lasers are perfectly suited for welding, cutting, drilling, structuring, marking and surface treatment of various materials due to their high energy yield, achieved by very small spot sizes and high output powers.



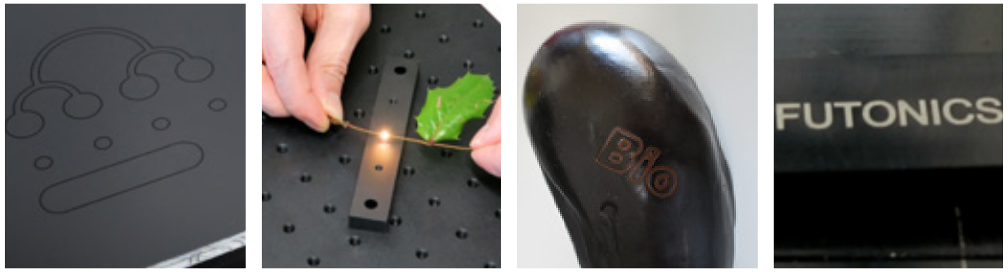
APPLICATIONS

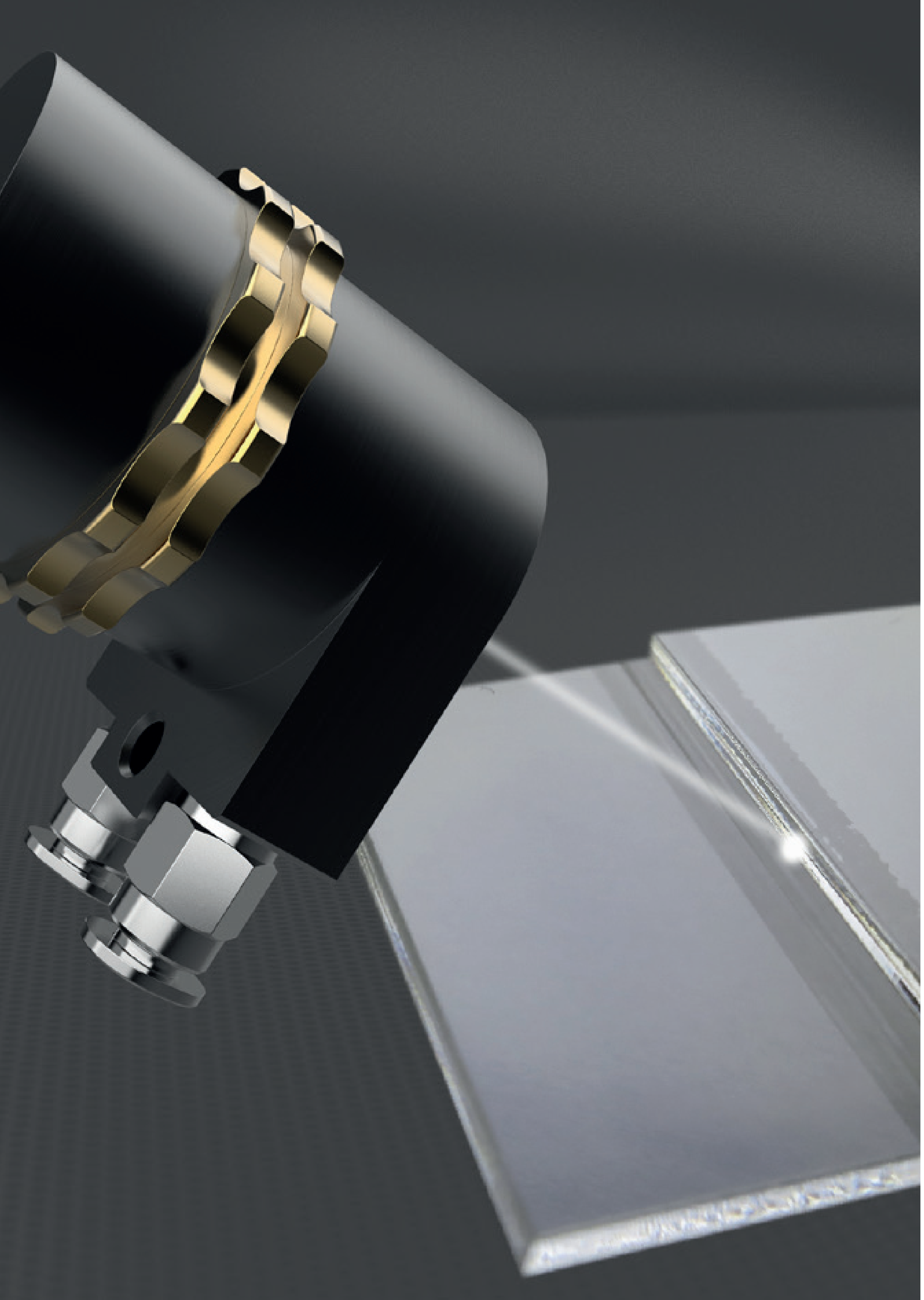
2.0 µm fiber lasers are ideal for welding, cutting, and marking a variety of commercially used plastics as well as for engraving metals, cutting botanical materials, and labeling food.

At a wavelength of 2.0 µm, the intrinsic absorption of most thermoplastics is high enough to weld or cut without the need for absorbing additives or coatings. Compared to commonly used near-infrared systems, welding with 2.0 µm lasers can improve heat distribution and gap bridging and enable the welding and cutting of complex materials.

The evolution towards the use of lighter and stronger materials in everyday products, from automobiles to consumer electronics, has led to several significant challenges in welding these structures, especially in large quantity production environments.
In consumer electronics, the need for lightweight structures with highly customized thermal and electrical properties is constantly driving the need for more complex designs, often using thin films, and joining dissimilar plastics. The medical device industry is also driving the need to join small plastic parts, often with dissimilar materials.

The growth of laser welding has continued for more than a decade, with the automotive industry - an early user of this technology - being the first to recognize the benefits of an automated joining process combined with the intrinsic advantages of fiber laser technology.





WELDING APPLICATIONS

2.0 µm fiber lasers are well known for their application in welding transparent plastics, such as polycarbonate (PC) or polymethylmethacrylate (PMMA). These materials are almost perfectly transparent not only in the visible, but also in the near-infrared wavelength range. At longer wavelengths, however, these materials inherently absorb parts of the laser radiation, so that a welding process without absorbing additives is possible. The wavelength range around 2.0 µm is particularly attractive for welding applications because the absorption is strong enough to allow sufficient heat to be generated for the welding process (in contrast to more common laser sources with wavelengths around 1.0 µm), but also sufficiently low to heat the plastic volumetrically (see Figure 1). This volumetric heat development enables the two most important processing variants, heat conduction welding and transmission welding, and is suitable for butt-joints as well as lap- and T-joints.

Absorption behavior and melt pool geometries

In an overlap weld at a wavelength of about 1.0 µm, the heat is generated almost exclusively in a thin layer on the surface of the absorbing part and spreads into the environment by heat conduction, resulting in a thin, lens-shaped melt pool. When a 2.0 µm laser is used, the increased absorption in the transparent part results in more distributed heat generation and a lower peak temperature at the surface of the absorbing part, thus reducing the risk of thermal degradation. In quasi-simultaneous welding, where the weld is irradiated several times in short succession, the changed heat distribution

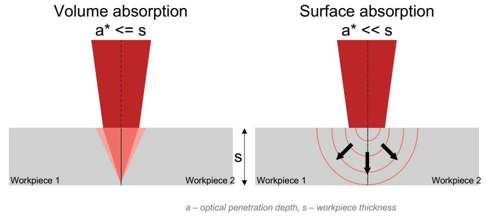


Figure 1: Volume and Surface absorption

together with the longer time frame for heat conduction can lead to completely different molten pool geometries, such as the drop-shaped molten pool shown in Figure 2.

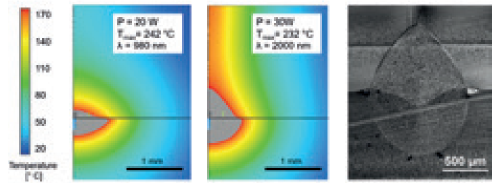


Figure 2: Wavelength-dependent melt pool geometries (Technische Hochschule Nürnberg Georg Simon Ohm)

A thermal process simulation of the quasi-simultaneous welding process using a 1.0 µm laser (left) and a 2.0 µm laser (right) shows the modified melt pool cross-section, molten material (temperature above melting temperature) is shown in grey color. In addition, it was demonstrated that the absorption coefficient of polymers filled with carbon black is also wavelength-dependent, which leads to a greater penetration depth of the radiation of the

FUTONICS

2.0 µm Tm-doped fiber laser. This further increases the heat distribution and reduces peak temperatures. As a result, the risk of thermal degradation of the absorbing material is greatly reduced and the heat-affected zone is enlarged. Both factors are advantageous regarding a major limitation of the welding process, the limited gap bridging capability.

Gap bridging

In conventional processes, the transparent part is heated by thermal conduction alone. When manufacturing tolerances, deformed parts, or local defects cause an air gap between the two components, the heat conduction between the two parts is greatly reduced and thus the transparent part is not melted, making a welded joint impossible. Since the laser energy cannot be transferred to an adjacent part, the absorbing part becomes hotter than intended and is likely to degrade or partially burn. When using a 2.0 µm thulium fiber laser, both components are heated directly by the laser radiation. They expand thermally and thus increase the chance of successful gap bridging. This is particularly important for plane-to-plane overlap welding, as used in microfluidics, for example. Figure 3 shows the result of welding tests with a quasi-simultaneous welding process for lap welds between two polypropylene (PP) parts, in which an artificial air gap of 130 µm was created with metallic spacers.

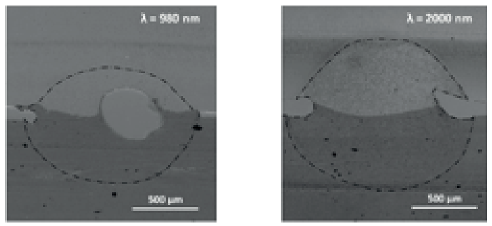


Figure 3: Gap bridging for quasi-simultaneous welding of PP (Technische Hochschule Nürnberg Georg Simon Ohm)

Both gaps were closed during the welding process, but at the shorter wavelength, the absorbing part is partially burnt, resulting in a gas bubble in the middle of the weld. In contrast, when using a 2.0 µm laser, the increased thermal expansion of both polymer parts contributes to successful gap bridging and no thermal degradation is observed. During cooling, the melt partially contracts, which leads to the observed „ribs" in the joining plane.

When T-joint configurations are welded quasi-simultaneously, the joining area can be specifically designed to have a fusion rib that dramatically increases the gap bridging capability. During the welding process, both parts are pressed together so that in the areas where there is no gap, the molten material of the rib is pushed out of the joining area and the two parts approach each other until all gaps are closed along the entire length of the weld. Interrupted weld seams can be avoided by this procedure.

Other laser sources, such as CO_2 lasers, which operate at about 10.6 µm, would result in direct surface absorption of the radiation, which drastically increases the heat concentration. This would result in a high risk of thermal degradation or material ablation instead of a controlled and efficient welding process. In contrast, the 2.0 µm laser welding of transparent polymers can be applied in various technical fields, such as the manufacture of medical and industrial devices or in polymer microfluidics, where the ability to produce precise hermetic welds without any additives is a key factor. Other applications can be found, for example, in the food industry for packaging fresh and ready-to-use food products.

Below are some examples of welds created during the welding of polymers. Laser transmission welding is particularly emphasized here. 2.0 µm fiber lasers are excellently suited for transmission welding due to the intrinsic absorption behavior of common plastics.

LASER TRANSMISSION WELDING

Benefits

- Hidden seams
- No particle generation
- No contamination
- Non-contact processing of the workpieces
- No mechanical stress on the joining partners
- No oscillating stress on the joining partners
- Can be used for both micro and macro applications
- Small heat-affected zone due to locally limited energy yield
- No thermal stress of sensitive component areas
- No surface markings due to the welding process
- Great design freedom of the components to be welded
- Good automation and integration in series production
- Welding of pre-assembled components possible
- Good external appearance for seams in visible areas

Requirements

- Polymer compatibility
- Optical properties
- Thermal contact

Many welding applications for plastics use the laser transmission welding process, in which a transparent part is arranged in an overlap configuration with a second absorbent part, which is usually colored black by the addition of soot to the polymer. Figure 4 shows a schematic diagram of the principle of laser transmission welding.

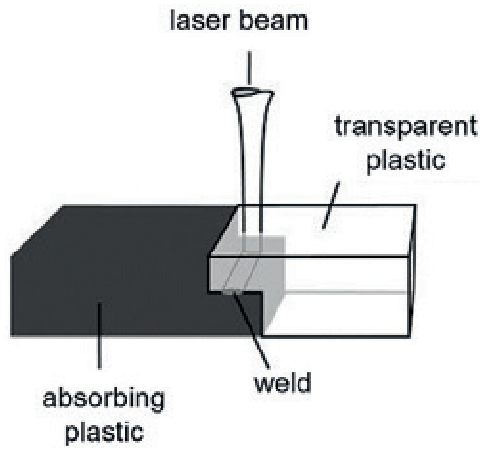
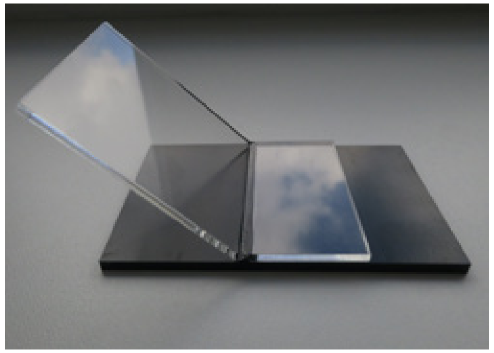


Figure 4: Principle of laser transmission welding

The joint is created directly in the contact zone by irradiating the surface of the absorbing part through the transparent component and heat conduction to melt the transparent part. This method is widely used in automotive or consumer goods production, e.g. for liquid containers or for joining transparent lids to the housing of lighting components. Even though this method does not require absorption in the transparent part, the use of a 2.0 µm thulium fiber laser proves to be advantageous for these applications. Not only does the fiber laser allow longer working distances and scanner-based beam guidance with smaller spot sizes than the commonly used diode lasers due to the higher beam quality, the wavelength-dependent material properties also lead to direct process improvements. The most obvious difference in properties is the absorption behavior.

The absorption properties are not the only important aspect in laser transmission welding. At least as important are the transmission properties of the transparent part so that sufficient laser energy reaches the joining zone between the two parts. The absorption in the transparent parts therefore limits the applicability of 2.0 µm laser radiation. For typical applications, however, the material thickness is in the range of a few millimeters, so that sufficient radiation reaches the interface between the two parts and enables the welding process. A major problem when welding with conventional lasers in the 1.0 µm range can be scattering in the transparent part. Additives in the transparent part or even just the crystallite structures in semi-crystalline polymers can lead to considerable scattering within the transparent part. This can lead to slightly increased weld seam widths and an increased demand for laser power for moderately scattering materials. With strongly scattering materials, however, the beam profile of the laser beam can be considerably impaired and in the worst case the laser radiation is isotropically scattered out of the joining zone, which makes the welding process impossible or severely limits the weldable material thickness. Since scattering processes are strongly wavelength-dependent, the application of longer laser wavelengths can enable the welding of materials that cannot be welded with conventional laser sources.



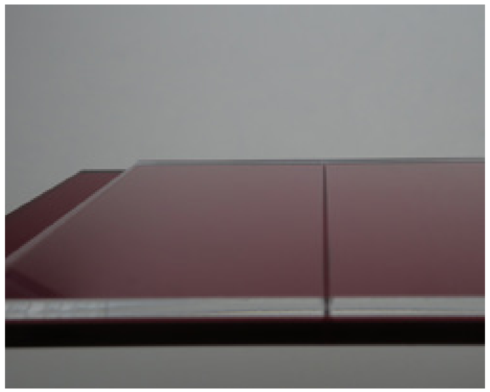


Figure 5: Examples for laser transmission welding

Figure 6: Microstructures in laser transmission welding

HEAT CONDUCTION WELDING

If the transmission of laser radiation of plastics at the wavelength of 2.0 µm is too low, butt welds can be realized by heat conduction welding. The high energy yield, achieved by very small spot sizes and high laser power, is applied to the surface of the workpiece, thus creating surface heating. Heat conduction allows a weld seam of a few millimeters penetration depth to be realized.

In heat conduction welding, the laser melts the workpiece along the intended seam. The melts of the joining partners flow into each other and then cool down to the actual welding seam. Welded joints can thus be realized faster and with less material distortion than with conventional welding processes. In addition, smooth and pore-free weld seams are produced that do not require any post-processing.

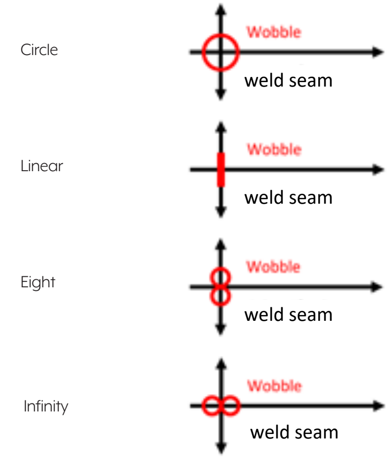
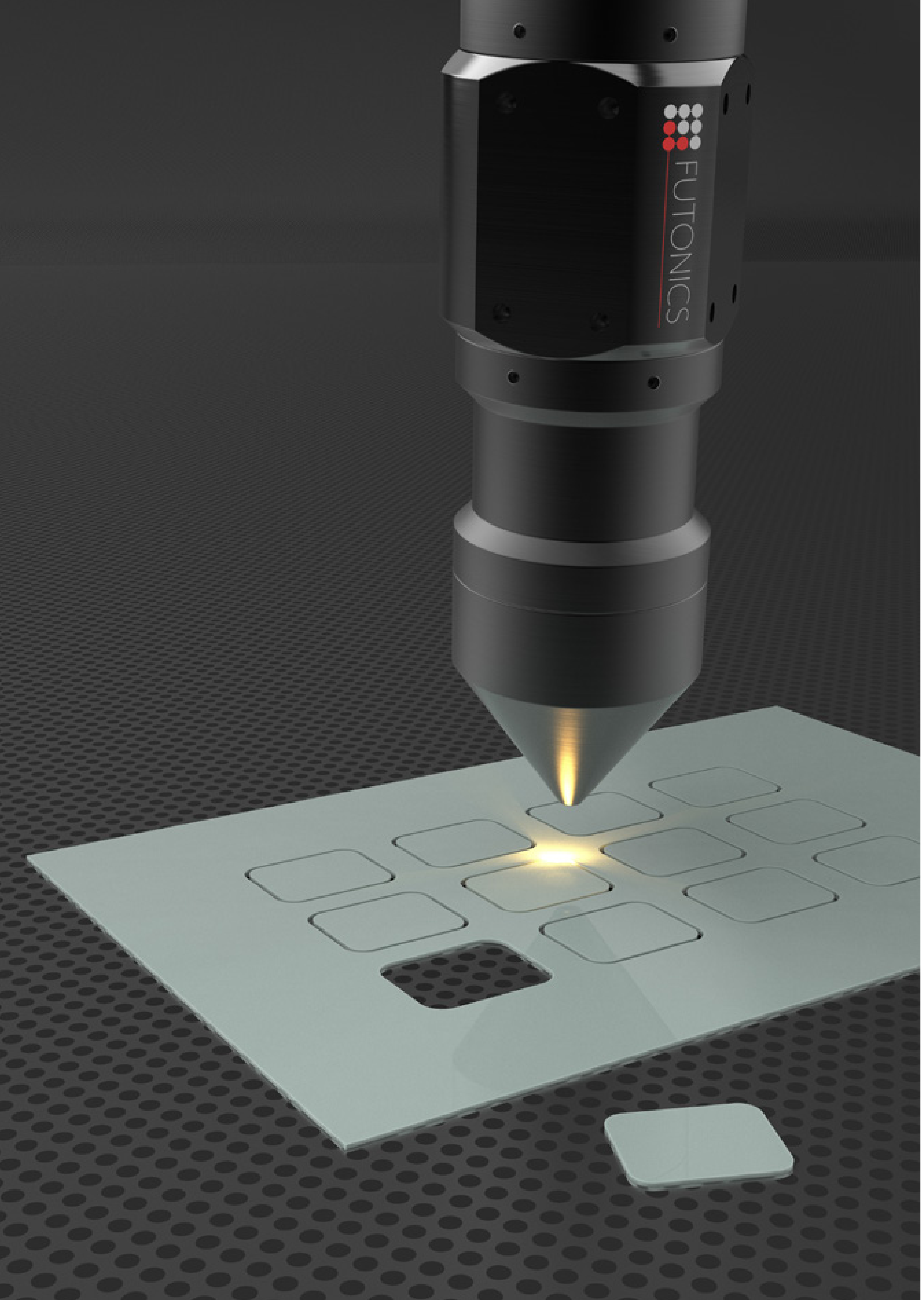


Figure 7: Wobble modes

TWIST WELDING PROCESS

TWIST (Transmission Welding by an Incremental Scanning Technique) is a low-cost and easy-to-integrate technology based on a beam-wobbling process. This technique helps to overcome porosity and hot cracking problems in laser welding of some materials and to suppress sputtering during the welding process. With the ability to independently control penetration depth, wobble frequency, feed rate and seam width, the process is used for welding small, temperature-sensitive assemblies and poorly fitted parts that would be difficult to weld without post-processing. Figure 7 demonstrates the concept of dynamic 2D beam movement, showing the four basic programmable shapes of an industry standard welding head. Independent control of the amplitude and frequency of the oscillation is achieved by a galvo mirror controller, allowing greater flexibility in stabilizing the keyhole melt during the welding process.

Overall, the wobble process allows better temperature management of the component, since the laser beam passes any point on the weld seam several times. The temperature increase and cooling speeds are slower than with conventional laser welding, which is helpful in eliminating defects and treating spatter. In addition to stabilizing the keyhole melt and reducing porosity in the subsequent weld seam, beam deflection technology has proven valuable in reducing the requirements for the high precision fit of parts during laser welding. The additional degrees of freedom provided by the independent amplitude and frequency of the wobble head oscillation, combined with the high available power of the fiber laser, provide the level of control required for high quality laser welding of difficult materials. In addition, studies comparing the wobble head with traditional laser welding processes have shown that the technology offers significant advantages in part fit due to relaxed tolerance in seam gap and misalignment.



LASER CUTTING APPLICATIONS

The laser systems developed by Futonics can be used for cutting several different materials. With the 2.0 µm technology it is possible to process complex shapes precisely and quickly. Most materials can be cut without burrs, resulting in less or no reworking of the workpieces. Futonics offers processing heads specially developed for cutting materials, which are customized to the users' requirements.

LASER FUSION CUTTING

Laser fusion cutting is a non-contact process in which the workpiece is melted locally by a laser beam.

The material is cut by constant melting of the cutting gap with a low-reaction gas, which removes the molten material and thus prevents oxidation of the cutting surface. Nitrogen or argon is often used as process gas during cutting applications, which prevents a chemical reaction of the material. A post-processing of the cutting edges is not necessary with laser fusion cutting since no burr formation at the kerf is produced on the cutting surface during the process.

Important parameters in laser cutting are focus position and diameter (influence power density, gap width as well as the shape of the kerf), output power, operating mode, cutting speed, degree of polarization, process gas and pressure as well as the diameter of the nozzle on the processing head (influences the shape and gas quantity of the gas jet), through which the process gas is directed onto the workpiece. These changeable parameters allow the machining process to be optimized. All materials that sufficiently absorb the laser radiation can be cut.

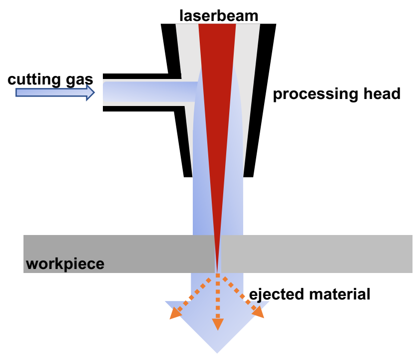


Figure 8: Principle of laser fusion cutting

Cutting laminated safety glass

Futonics lasers can cut the plastic film between layers of glass. In combination with glass cutting tools, laminated glass can be cut precisely and automatically in both straight and contoured lines, offering a wide range of possibilities for cutting laminated glass.

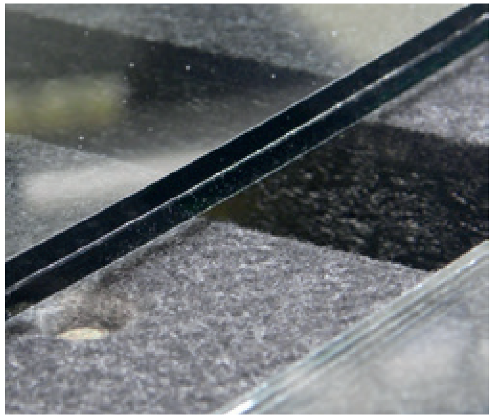


Figure 9: Cutting of laminated safety glass

Cutting of fiber reinforced plastics

Fiber-reinforced plastics are composite materials in which a polymer matrix is reinforced with fibers to improve the strength and elasticity of the plastic. Futonics fiber lasers can produce a highly focused high-power beam that precisely cuts fiber-reinforced plastics in a variety of complex shapes.

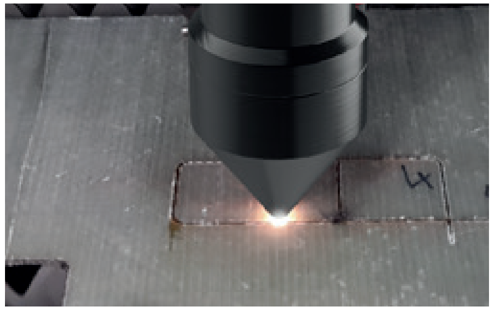
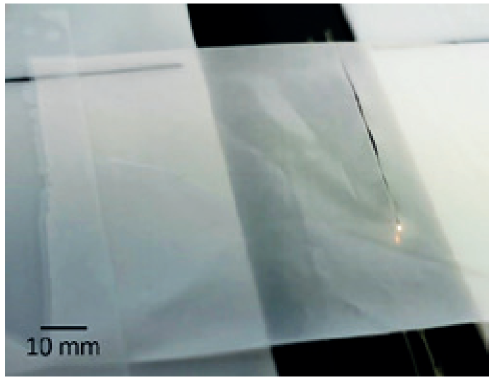


Figure 10: Cutting of fiber reinforced plastics

Cutting of plastics

The laser is a very flexible tool that can be used to cut different polymers with different thicknesses. In laser cutting, the cutting gap is very narrow, and the quality of the cut is very good compared to other cutting methods. Depending on the laser cutting system, all materials can be cut. Furthermore, depending on the material and the laser cutting process, a clean, narrow, and often rework-free cutting edge can be achieved. In addition, laser cutting offers a high material utilization and is therefore very economical.



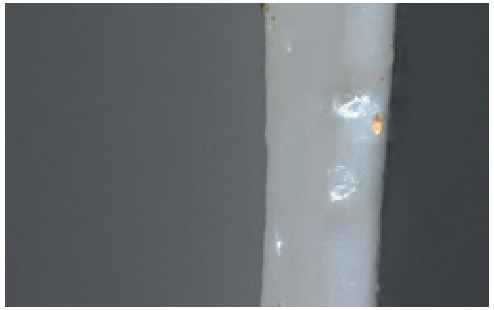


Figure 11: Cut edge of an 80 µm thick PP-PET film Zoom X/500.0

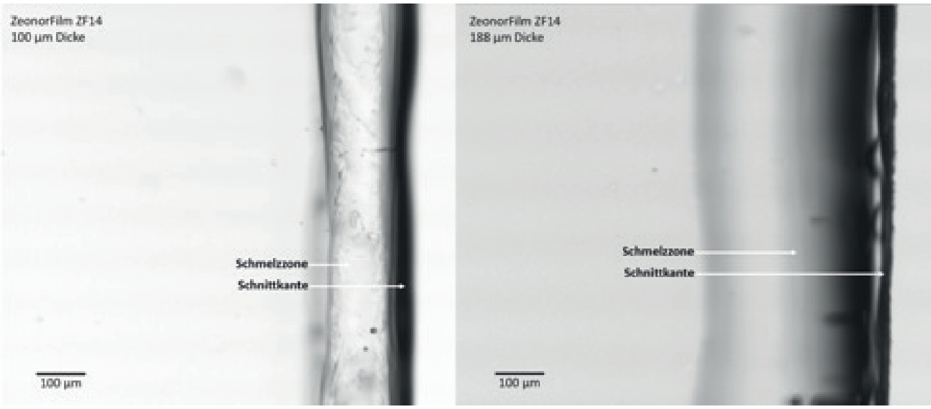


Figure 12: Cut edges of ZeonorFilm ZF14

Cutting of botanical materials

Futonics lasers can be used in botany to cut various cellulose-containing samples.

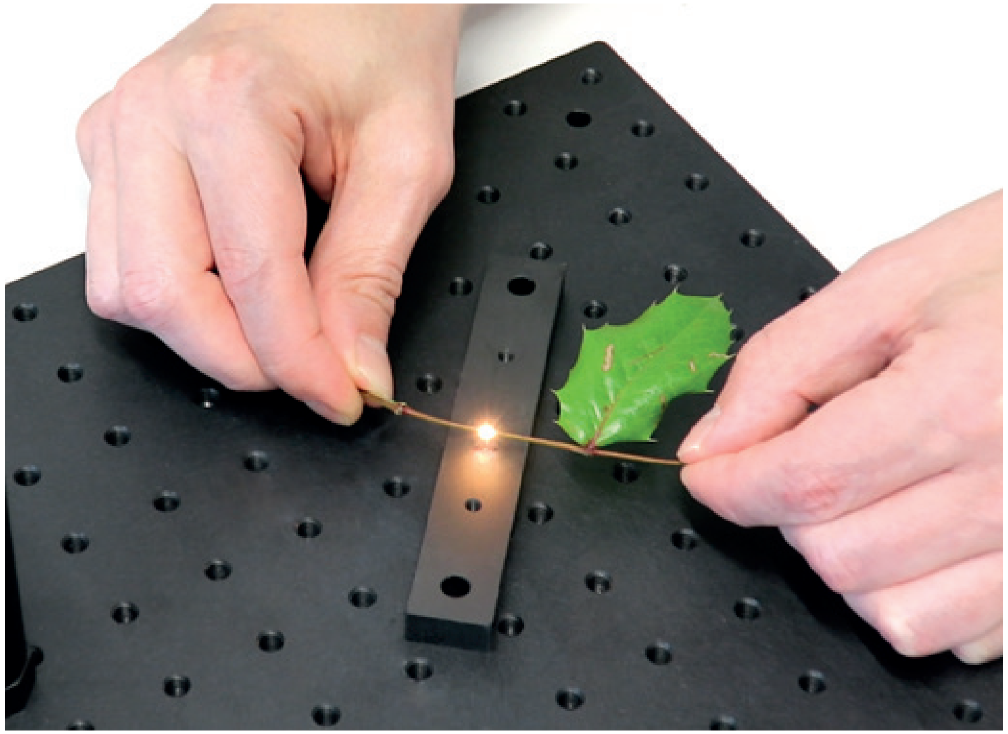


Figure 13: Cutting of botanical materials

FUTONICS

MARKING, ENGRAVING, LABELLING

MARKING AND ENGRAVING OF METALS AND POLYMERS

Laser marking and engraving offers the possibility to apply an uncomplicated, precise and above all permanent marking.

Advantages of marking and engraving of metals and plastics using a Futonics 2.0 µm fiber laser:

Benefits

- Non-contact marking and engraving
- In combination with scanner optics: direct engraving without stencil
- No tool change and wear
- High repetition accuracy with constant engraving quality
- Smallest details possible due to very small spot sizes of the fiber laser

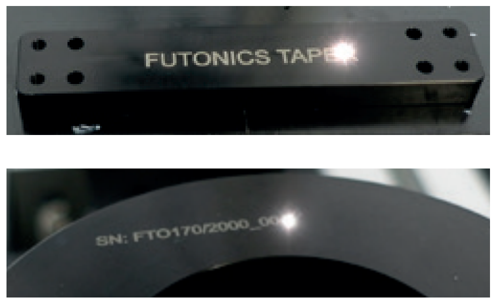


Figure 15: Engraving of black anodized aluminum

ORGANIC LABELLING

With Futonics 2.0 µm lasers, fruit, vegetables, and other food products are marked safely. The contactless process has no influence on the quality or shelf life of the food. Especially in retail, food labeling can help to avoid unnecessary packaging or labeling materials. For example, food can be labeled efficiently and quickly with an organic seal or indication of the country of origin. With marking, the label is burned into the peel without damaging the fruit pulp.

Benefits

- Use in retail
- Labelling of food
- Fruit stays fresh
- Labeling in fruit peel, but not in the pulp

Figure 16: Organic labelling on various food items

LASER SYSTEMS

Futonics offers high-power polarized and unpolarized 2.0 µm thulium-doped fiber lasers with a beam quality of $M^2 < 1.1$, allowing continuous and modulated operation up to 10 kHz. For a robust and compact setup, they are designed in an „all-fiber“ configuration with single-mode fibers and Fiber Bragg gratings (FBG) and allow the user to order a fixed wavelength between 1930 nm and 2050 nm, depending on the absorption of the materials.
Tm-doped fiber lasers are well suited to generate high signal powers in the 2.0 µm wavelength range. By using 792 nm laser diodes for pumping, the upper laser level is not directly excited, but is populated by a cross relaxation process (CR) (see Figure 17).

During the CR process an ion from the ground state is excited to the upper laser level when an ion from the upper pump level relaxes down to the upper laser level. Two excited ions were generated by an absorbed pump photon. This allows high efficiencies for the system, which can be higher than the limit given by the quantum defect. The 2.0 µm Tm-laser transition ends in the ground state, which means that the lower laser level is thermally populated. To couple the power of fiber-coupled laser diodes into the active fiber, specially designed tapers or combiners are often used. These components enable the realization of fiber laser systems with a fiber-only configuration.

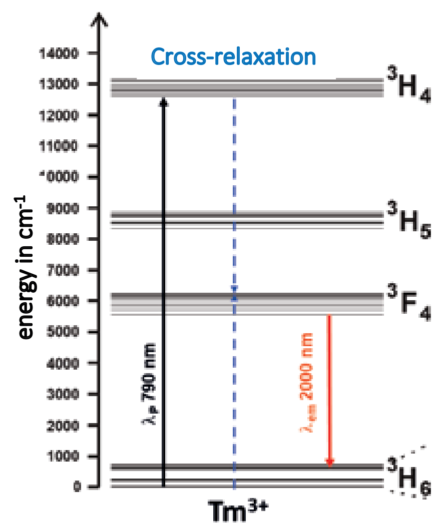
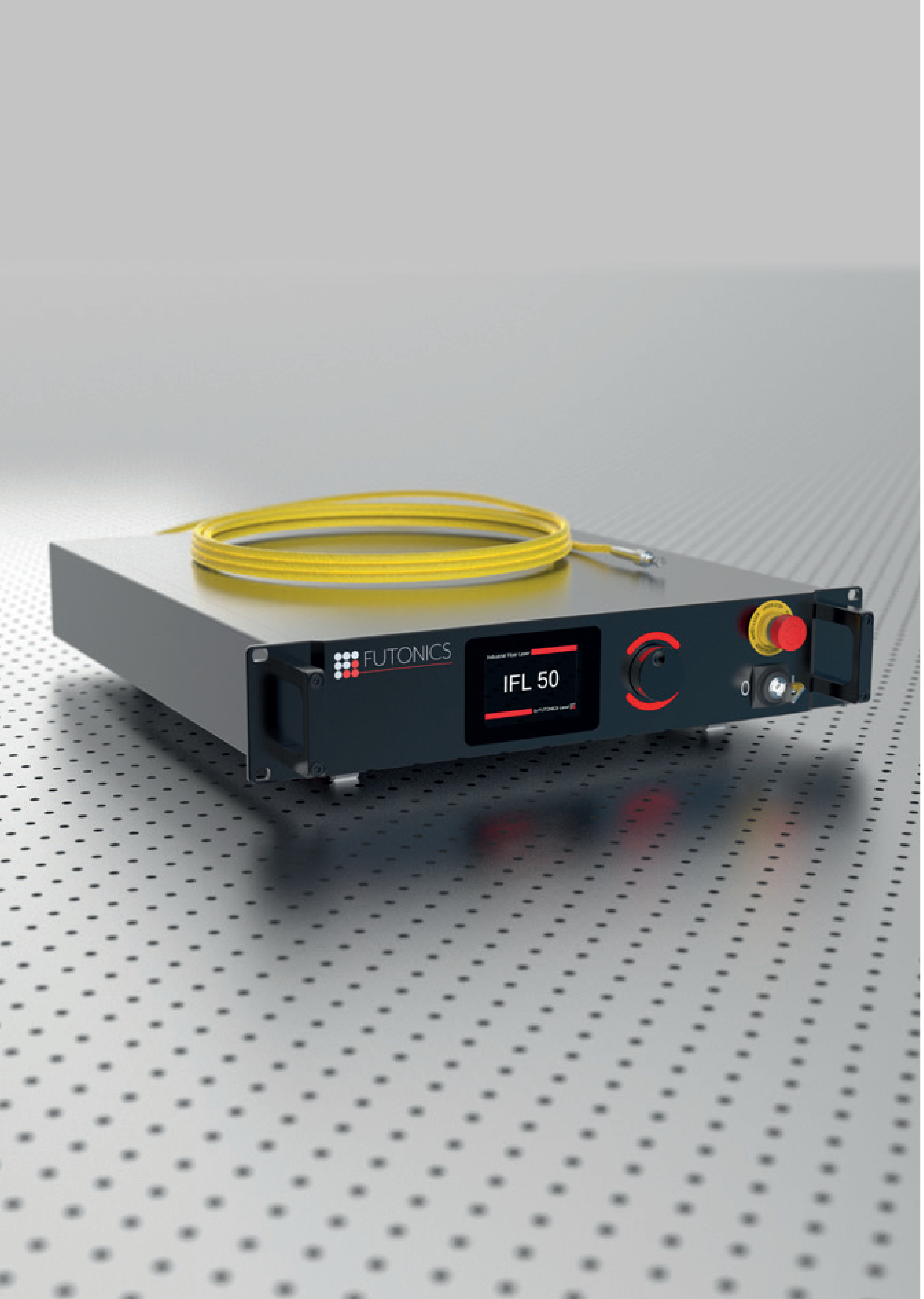


Figure 17: Cross-relaxation process



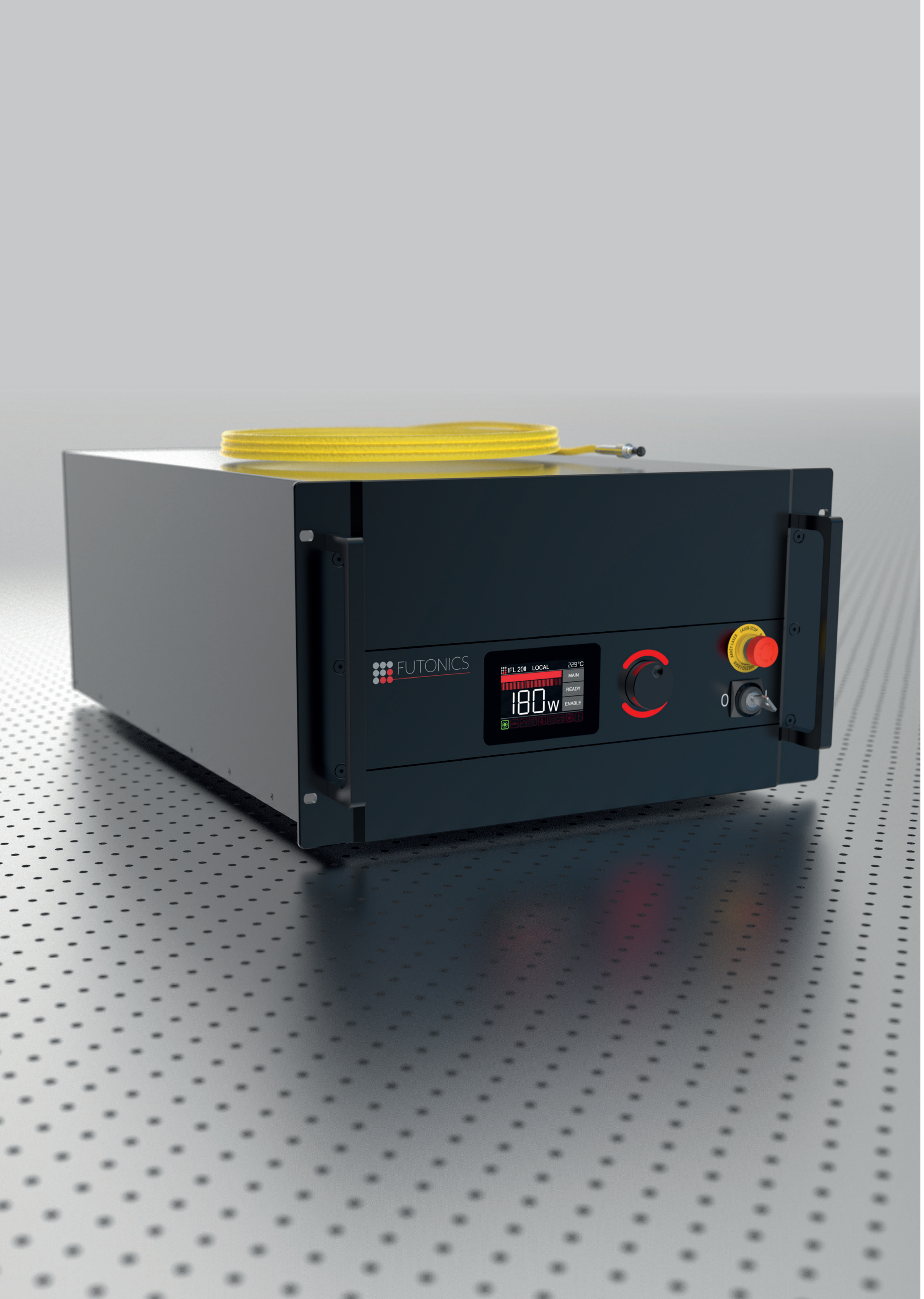
FUTONICS

IFL10 - IFL50

The new industrial fiber laser product line IFL from Futonics is based on thulium-doped single-mode fiber laser oscillators with wavelength stabilization by Fiber Bragg gratings (FBG). Due to the high beam quality and the compact design, these new products are ideally suited for a wide range of applications.

IFL10 - IFL50

Output power:	10 W (IFL10), 20 W (IFL20), 30 W (IFL30), 40 W (IFL40), 50 W (IFL50)
Standard wavelengths:	2000 nm or 2050 nm
FWHM:	< 1 nm
Beam quality:	M2 < 1.1, single-mode
Operating mode:	Continuous wave, modulated up to 10 kHz
Laser class:	4
Fiber connector:	FC / PC or SMA
NA:	0.15
Length:	5 meters
Collimator:	optional
Dimensions (width x height x depth):	483 mm x 88 mm x 505 mm (19″, 2 RU)
Power Supply voltage:	100 – 240 VAC, 50 – 60 Hz
Energy consumption:	≤ 500 W
Control interfaces:	Analog, Digital, Serial, Touchscreen
Display:	Capacitive 3.5“ touch screen, adjustment wheel
Cooling:	Water
Additional fiber length:	1 meter steps up to 20 meter total
Fiber applicator I:	Basic collimator
Fiber applicator II:	Improved collimator with power detection for regulation
Performance stabilization:	Regulation up to 10 kHz
Fixed user-defined wavelength:	Selection between 1930 nm und 2050 nm
External power supply:	optional
Enhanced interface:	Industrial Ethernet on demand



FUTONICS

IFL200 - IFL250

The new industrial fiber laser product line IFL from Futonics is based on thulium-doped single-mode fiber laser oscillators with wavelength stabilization by Fiber Bragg gratings (FBG). Due to the high beam quality and the compact design, these new products are ideally suited for a wide range of applications.

IFL200 - IFL250

	IFL200	IFL250
Output power:	200 W	250 W
Standard wavelengths:	2000 nm or 2050 nm	
FWHM:	< 1 nm	
Beam quality:	M^2 < 1.1, single-mode	
Operating mode:	Continuous wave, modulated up to 10 kHz	
Laser class:	4	
Fiber connector:	Futonics Special, QBH compatible, 5 meters	
NA:	0.1	
Length:	5m	
Collimator:	optional	
Dimensions (width x height x depth):	483 mm x 266 mm x 703 mm (19″, 6 RU)	
Power supply 1:	24 V, 3 Ampere	
Power supply 2:	40 V, DC, 33 Ampere	78 Volt DC, 33 Ampere
Energy consumption:	≤ 1,5 kW	≤ 2,8 kW
Control interfaces:	Analog, Digital, Serial, Touchscreen	
Display:	capacitive 3.5“ touch screen, adjustment wheel	
Cooling:	Water	
Additional fiber length:	1-meter steps, up to 10 m in total	
Fiber Applicator I:	Basic collimator	
Fiber applicator II:	Improved collimator with power detection for regulation	
Performance stabilization:	Regulation up to 10 kHz	
Fixed user-defined wavelength:	Selection between 1930 nm and 2050 nm	
External power supply:	optional	
Enhanced interface:	Industrial Ethernet on demand	

FUTONICS

IFL10P - IFL30P

The new industrial fiber laser product line IFL from Futonics is based on thulium-doped single-mode fiber laser oscillators with wavelength stabilization by Fiber Bragg gratings (FBG). Due to the high beam quality and the compact design, these new products are ideally suited for a wide range of applications.

Polarized fiber lasers offer a very good protection against back reflections, which is especially interesting for processing highly reflective surfaces. In scientific applications the polarized lasers can be used as pump source for polarization dependent laser crystals, e.g. holmium.

IFL10P - IFL30P

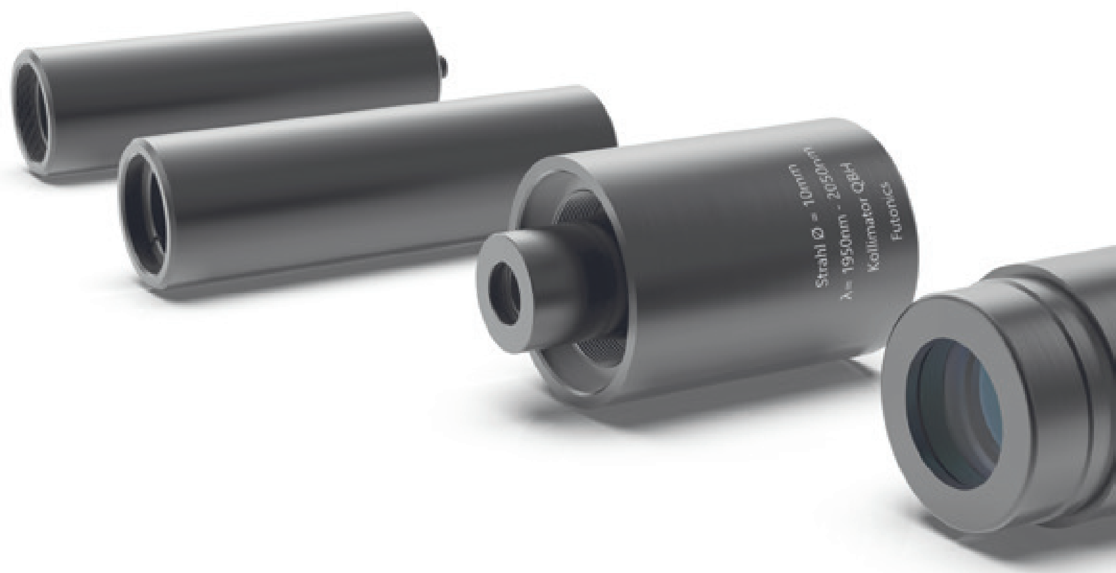
Output power:	10 W (IFL10), 20 W (IFL20), 30 W (IFL30)
Standard wavelengths:	2000 nm or 2050 nm
FWHM:	< 1 nm
Beam quality:	$M^2 < 1.1$, single-mode
Operation mode:	Continuous wave, modulated up to 10 kHz
Laser class:	4
Fiber connector:	FC / PC oder SMA
NA:	0.15
Length:	5 meters
Collimator:	optional
Dimensions (width x height x depth):	483 mm x 102 mm x 505 mm (19“, 2 RU + feet)
Power supply voltage:	100 – 240 VAC, 50 – 60 Hz
Energy consumption:	≤ 500 W
Control interfaces:	Analog, Digital, Serial, Touchscreen
Display:	Capacitive 3.5“ touch screen, adjustment wheel
Cooling:	Water
Additional fiber length:	1-meter steps, up to 20 m in total
Fiber applicator I:	basic collimator
Fiber applicator II:	Improved collimator with power detection for regulation
Power stabilization:	Regulation up to 10 kHz
Fixed user-defined wavelength:	Selection between 1930 nm and 2050 nm
External power supply:	optional
Enhanced interface:	Industrial Ethernet on demand

FUTONICS

OPTICAL SYSTEMS

For welding, cutting, marking, and engraving applications, Futonics offers customized optical systems designed to meet the requirements of the user. These include scanner systems (consisting of two mirrors to guide the laser beam) with F-Theta optics and processing heads (with or without integrated cooling system) for welding and cutting applications. For customized applications, optics optimized for medium IR wavelengths including collimators, focusing lenses and complete setups can be supplied.

Scanner systems can be upgraded with pilot lasers, pyrometers, or camera systems. The camera system identifies the structure of the workpiece to automatically detect the position of the weld seam. Laser connectors like Futonics Special, FC/PC, SMA or QBH compatible are available.



FUTONICS

COLLIMATORS

Laser collimators are an indispensable accessory for the integration of lasers into higher-level machine units. It is essential to have a collimated laser output both for the coupling in and out of light from or into an optical fiber. With the help of an optical collimator, the divergence of the light output can be significantly reduced. Based on this requirement, Futonics has developed its own collimator systems. By using optical infrared materials, beam quality and efficiency are maximized. The product design is compact, easy to use and suitable for various optical applications.

Collimators

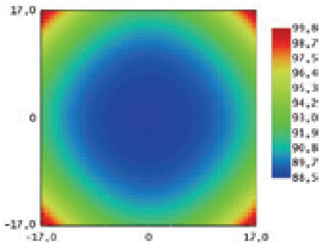
Specifications	Futonics 12.0	Futonics 16.4	Futonics 18.0	QBH 10.0	SMA 2.0	SMA 8.8	SMA 10.0	SMA 12.7
Wavelength [nm]	1940 – 2050	1940 – 2050	1940 – 2050	1940 - 2050	1940 – 2050	1940 – 2050	1940 – 2050	1940 - 2050
Effective focal length [mm]	44.5	83.3	64.4	49.7	6.9	44.5	35.7	64.4
Beam diameter (1/e²) [mm]	12.0	16.4	18.0	10.0	2.0	8.8	10.0	12.7
NA	0.14	0.10	0.14	0.10	0.14	0.10	0.14	0.10
Fiber Connector	Futonics	Futonics	Futonics	QBH	SMA	SMA	SMA	SMA
Housing size [mm x mm]	117 x 30	117 x 30	117 x 30	68 x 43	48 x 39,6	117 x 30	60 x 39	117 x 30
Weight [g]	112	114	114	90	110	112	172	114
Suitable for laser output [W]	200	200	200	200	50	50	200	50

* Theoretical beam properties at the collimator output

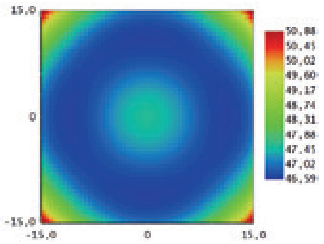
FUTONICS

Design wavelengths
1940 nm – 2050 nm

F-TO 345/2000



F-TO 170/2000



Spot diameter [µm] as a function of optical scan angle [°]. Diameter of the entrance beam ($1/e^2$): 10 mm (F-TO 345/2000) or 7.5 mm (F-TO 170/2000)

F-TO 345/2000

Design wavelength [nm]	1940 – 2050
Effective focal length [mm]	344.8
Entrance beam diameter ($1/e^2$) [mm]	10
Scan area [mm²]*	205 x 205
Working distance [mm]	319.5
Flange - focus distance [mm]	468.4
Optical scan angle [°]	±24
Mirror - flange distance [mm]	48.4
Spot diameter focus ($1/e^2$) [µm]	87.8
Max. telecentricity error [°]	14.6
Lens material	ZnSe, CaF_2
Cover glass	CaF_2
AR-Coating VIS (600 - 700 nm)	T>80%,
AR-Coating Laser (1940 - 2050 nm)	T>99%,
AR-Coating Pyrometer (3,5 - 5 µm)	T>60%
Weight [kg]	4.5
Mounting thread [mm]	M85 x 1

* For a system with two mirrors with mirror distances from the lens housing: 19.7 mm / 35.7 mm

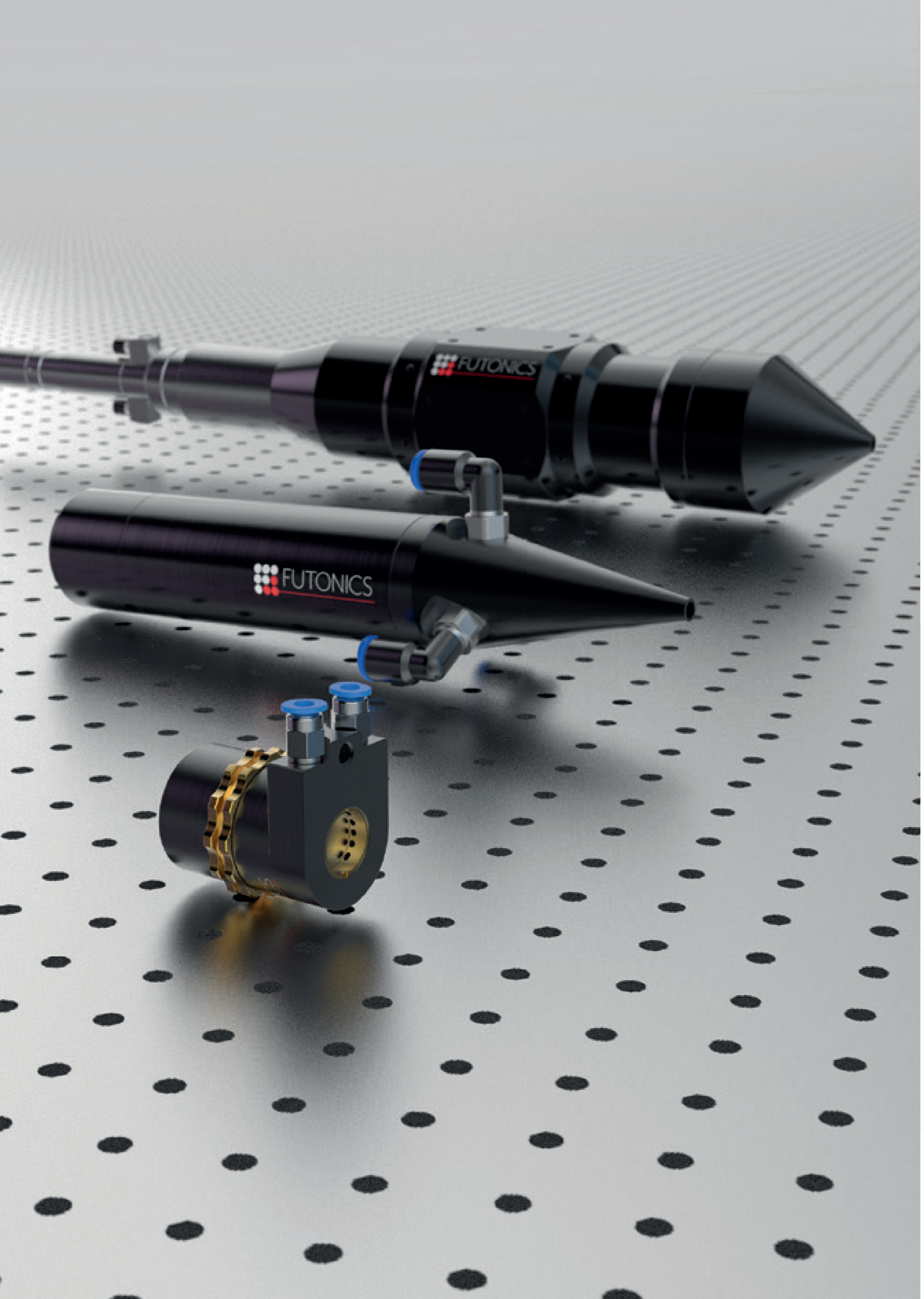
F-THETA LENSES

In most cases, an f-theta lens is installed behind a moving galvanometer mirror system to realize various applications such as marking, drilling, welding, scribing, and cutting. The f-theta lens, in combination with the XY-galvo scanner unit, creates a two-dimensional work area in which any contour can be mapped. The lenses are diffraction limited and are characterized by high imaging quality. In addition, they offer a high damage threshold, high spot constancy over the entire scan area and guarantee a minimal focal point shift for high-power lasers.
Futonics offers different f-theta lenses for the near infrared wavelength range. The new product line is based on crystal lenses made of zinc selenide (ZnSe) and calcium fluoride (CaF_2). Available are focal lengths of 170 mm (scanning field 90 mm x 90 mm) and 345 mm (scanning field 205 mm x 205 mm). The extremely versatile possibilities of the fiber laser can only be fully exploited by providing focusing systems suitable for manufacturing. The Futonics f-theta lenses for laser material processing guarantee best processing results over the entire working area. Especially in demanding applications, these lenses can help to meet your manufacturing requirements. The wide range of applications includes: Laser material processing, Automotive Industry, Medical Technology, Solar cell production, Semiconductor Manufacturing

F-TO 170/2000

Design wavelength [nm]	1940 – 2050
Effective focal length [mm]	170.2
Entrance beam diameter ($1/e^2$) [mm]	7.5
Scan area [mm²]*	90 x 90
Working distance [mm]	198,8
Flange - focus distance [mm]	242.8
Optical scan angle [°]	±22
Mirror - flange distance [mm]	30.5
Spot diameter focus ($1/e^2$) [µm]	57,8
Max. telecentricity error [°]	11.5
Lens material	ZnSe, CaF_2
Cover glass	CaF_2
AR-Coating VIS (600 - 700 nm)	T>80%,
AR-Coating Laser (1940 - 2050 nm)	T>99%,
AR-Coating Pyrometer (3,5 - 5 µm)	T>60%
Weight [kg]	0.8
Mounting thread [mm]	M85 x 1

* For a system with two mirrors with mirror distances from the lens housing: 19.7 mm / 35.7 mm



PROCESSING HEADS

Futonics offers a comprehensive range of optical processing heads to efficiently optimize fiber laser applications in precision cutting and welding. The Futonics laser processing heads can work with a 5-axis system or a robotic arm to follow irregular geometries. Our fiber lasers offer high quality beams to meet your different needs for different processing scenarios. The futonics laser head with precision optical design improves product quality, increases performance, and makes it easier to manufacture precision products.

FUTONICS

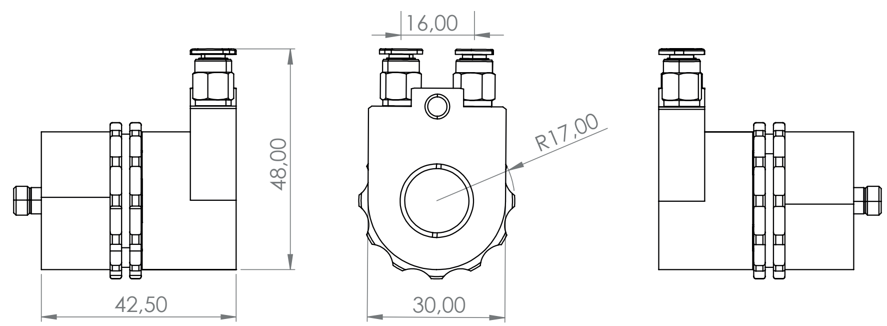
FMH980/1000

The processing head FMH980/1000 was developed by Futonics for welding applications. The welding head has a variable working distance up to collimation, which can be adjusted for the respective application via the setting wheel. At the minimum focal length of 25 mm the spot diameter is 50 µm, at collimation 1.93 mm. The processing head is designed with an SMA fiber connector to couple the laser.

FMH980/1000

Wavelength [nm]	1940-2050
Working distance [mm]	980
Beam diameter focus (1/e²)* [µm]	1000
NA Input	0.14
NA Output	0.0006
Fiber Connector	SMA
Housing size [mm x mm]	48.5 x 39.6
Weight [g]	110
Suitable for laser power [W]	50
Application	Welding

* with single-mode fiber with NA Input = 0,14



FMH46/45

The processing head FMH46/45 can be used to cut various materials. It has a working distance of 46 mm and a beam diameter of 45 µm in focus. The process gas can be fed into the cutting head through cooling connections. The user can choose between one to three cooling connections for the cutting application. Lasers can be coupled into the processing head through either an SMA, Futonics Special or QBH compatible fiber connector.

FMH46/45

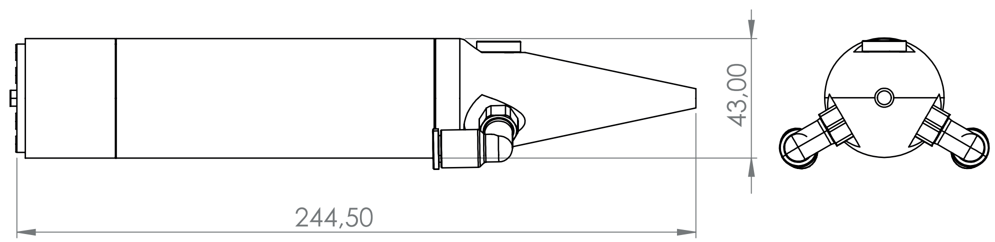
Wavelength [nm]	1940-2050
Working distance [mm]	46
Beam diameter focus (1/e²)* [µm]	45
NA Input	0.14
NA Output	0.03
Fiber Connector	SMA/Futonics/QBH
Housing size [mm x mm]	250 x 43.1
Weight [g]	560
Suitable for laser power [W]	200
Application	Welding

* with single-mode fiber with NA Input = 0,14

3 Cooling instruction

2 Cooling instructions

1 Cooling instructions



FUTONICS

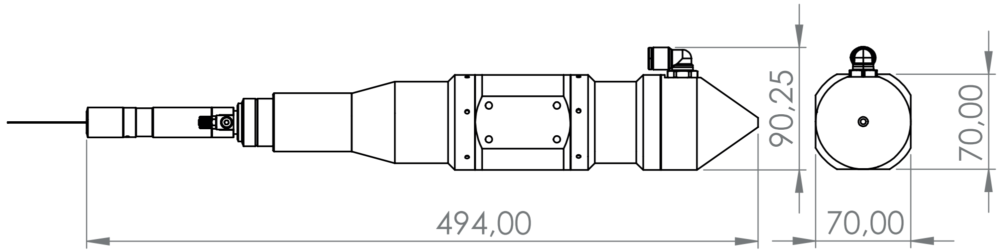
FMH9/14

The processing head FMH9/14 can be used to cut various materials. It has a working distance of 9 mm and a beam diameter of 14 µm in focus. The process gas can be fed into the cutting head through a cooling connection. Lasers can be coupled into the processing head through either an SMA, Futonics Special or QBH compatible fiber connector.

FMH9/14

Wavelength [nm]	1940-2050
Working distance [mm]	9
Beam diameter focus (1/e²)* [µm]	14
NA Input	0.14
NA Output	0.09
Fiber Connector	SMA/Futonics/QBH
Housing size [mm x mm]	448 x 99.96
Weight [g]	1600
Suitable for laser power [W]	50/200
Application	Cutting

* with single-mode fiber with NA Input = 0,14

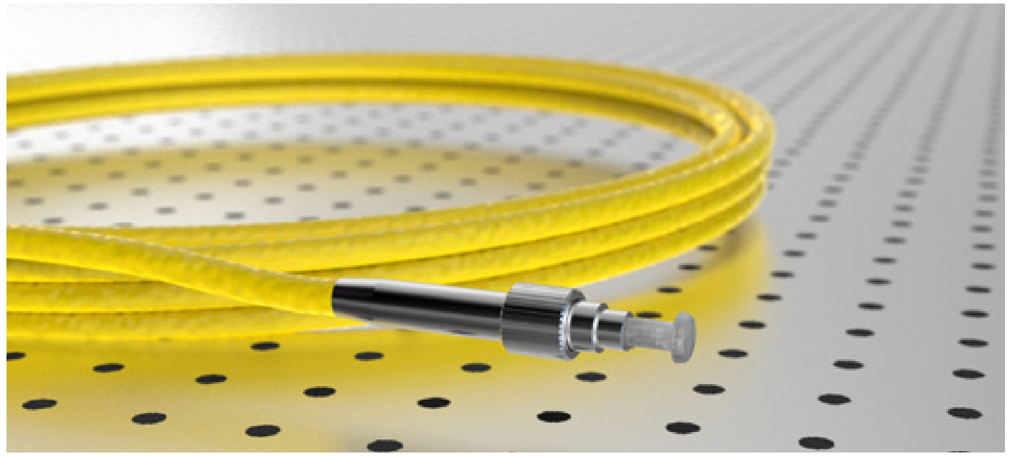


FUTONICS

INSTALLATIONS

Futonics also offers customized material processing assemblies for the respective application area.

ACCESSORIES



Working fibers

Fiber NA	0.22/0.45	0.22 ± 0.02
Fiber Core [µm] (± 3 - 5 µm)	100/200/400/600/800/1000	1000
Fiber Cladding [µm] (± 3 - 5 µm)	105/220/440/660/880/1100	1100
Fiber Coating [µm] (± 3 - 5 µm)	125/320/700/960/1100/1600	1600
Fiber material	Low OH Quartz (SiO2)	Low OH Quartz (SiO2)
Cladding material	Fluoride doped Quartz	Fluoride Doped Quartz
Coating material	Acrylate	Acrylate
Protection cable material	Interlock stainless steel	Interlock stainless steel
Protection cable outer diameter [mm]	6.2	6.2
Protection cable color	Yellow	Yellow
Connector both sides	Standard SMA	Standard SMA
Length [m]	10	10
Operating temperature [°C]	-40 - 85	-40 - 85
Bending radius [mm]	≥ 200 times cladding diameter	Short-term: ≥ 220 Long-term: ≥ 110

Futonics Laser GmbH
Albert-Einstein-Str. 3
37191 Katlenburg-Lindau
Deutschland

Tel: +49 551 504207-0
Fax: +49 551 504207-20

info@futonics.de
www.futonics.de