Modular Solutions for Laser Plastic Welding

precise & concise
clean & green

Turnkey modular ready to use machines

Plastic parts for welding show a large variety of forms and geometries. To cope with this variety and to meet a wide diversity of customer preferences, our machines are designed in a strictly modular way. The Turnkey machines are configured in our modular design framework according to your requirements. Like this, they are precisely adapted to the processing of your plastic parts.

All lasers, optics, clamping units, and motion systems from our Modula product portfolio (see page 3-4) are available in the Turnkey systems.

A drawer or rotary table can be selected for the part handling in and out of the machine. With some customer-specific modifications also conveyor systems can be integrated to the Turnkey machines. Our Turnkey machines are delivered fully ready to use. They only need to be connected to an electric power source, and depending on configuration, to compressed air.

Turnkey S

The **Turnkey S** is the smallest version of the Turnkey machines. It can be set up on a normal work table. Despite its compact design, it is built up in a modular way and can be equipped for all different plastic welding processes with the Modula components. Control system, laser, and cooling are placed in the cabinet on the back side. No separate laser unit is needed.

The welding process can be set up and observed on the touchscreen user interface. Keyboard and mouse can optionally be connected to USB ports on the front of the machine. At the backside, an HDMI port allows for the connection of a larger monitor.

For the welding process a small lifting door is opened. For setting up the welding process and for maintenance the complete front cover can be raised providing good access to all components. The drawer for part handling as well as the lifting door can be actuated manually, pneumatically, or electrically. A rotary table is available in both manual or electric versions.

The **Turnkey S** can be connected to a local computer network by an Ethernet interface on the backside of the machine. Process data and welding recipes can be both uploaded and downloaded as needed by the user. For convenience, a secure internet connection can be established for remote services and maintenance.

Configuration shown
- drawer handling
- xy-axes
- pneumatic clamping

Configuration shown
- rotary table
- scanner
- pneumatic clamping

Technical data

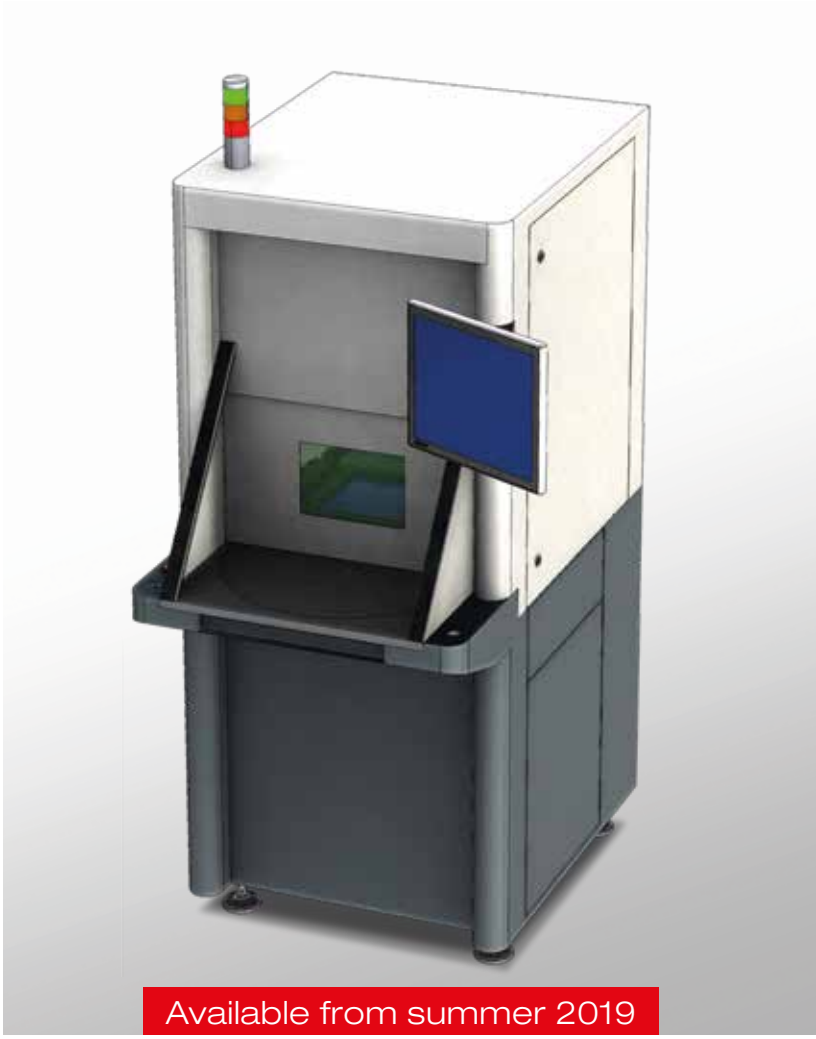
Welding area	Axes 150 x 100 mm, Scanner 100 x 100 mm
Laser power	40 - 200 W
Wavelength	about 980 nm
Laser class	1 (red pilot laser 2)
Clamping force	2300 N
Stroke distance	20 mm (extendable customer-specific)
Drawer	manual, pneumatic, or electrical
Rotary table	diameter 300 mm manual or electrical
Lifting door	300 x 140 mm – manual, pneumatic, or electrical
Cooling	air (IP20, filter mat)
Ambient temperature	35/40°C – depending on laser power
Electrical supply	100 - 240 V, 50/60 Hz, < 10 A
Dimensions	520 x 700 x 565 mm with lamp tower 780 mm

Turnkey M

The **Turnkey M** is in development as a ready to use machine for larger parts up to about 50 cm. It is designed as a workstation for standing or sitting operation.

Laser, system control, and cooling unit are located in the lower section. This allows unrestricted accessibility to the welding area with clamping unit, motion system, and optics in the upper section.

The touch-screen in front can be moved in various positions for an ergonomic operation.



Planned technical data

Welding area	Axes 500 x 350 mm, Scanner 350 x 350 mm
Laser power	40 - 200 W (wavelength 980 nm)
Laser class	1 (red pilot laser 2)
Clamping force	up to 7000 N
Drawer	manual, pneumatic, or electrical
Rotary table	diameter 660 mm
Lifting door	660 x 400 mm – pneumatic, electrical
Cooling	air (IP20, filter mat)
Ambient temperature	35/40°C – depending on laser power
Electrical supply	100 - 240 V, 50/60 Hz, < 10 A
Dimensions	about 880 x 1200 x 2000 mm

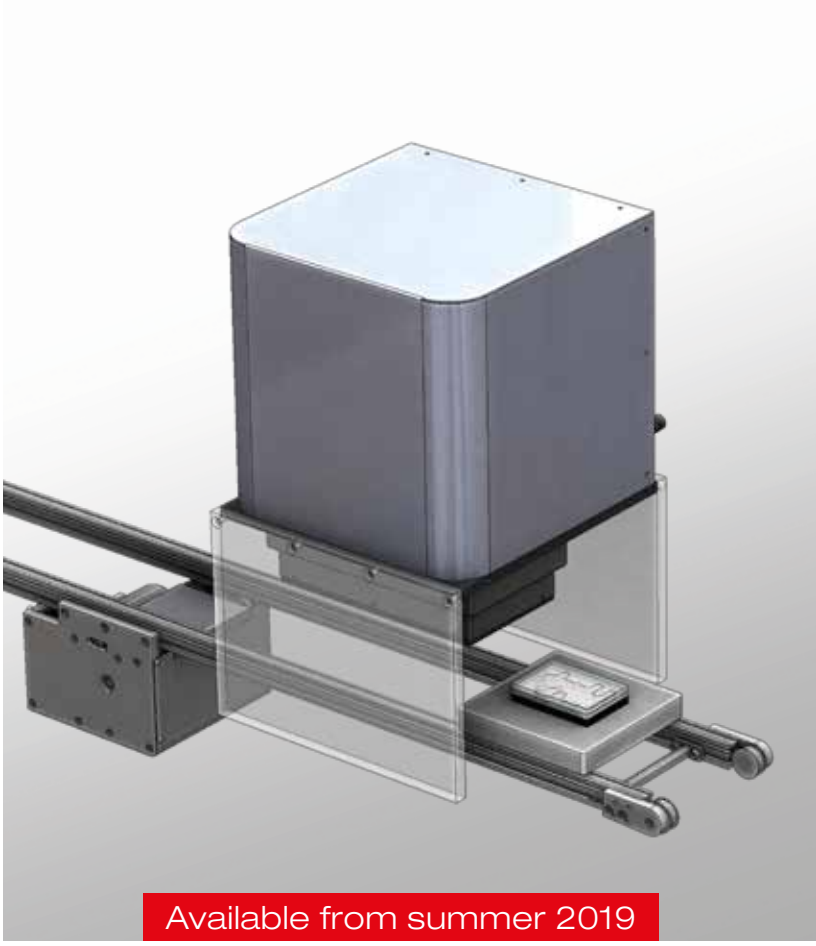
Modula Inline

The **Modula Inline** is a specific assembly of Modula components for an easy integration on a conveyor system or a larger rotary indexing table.

The modular design is comprised of a Modula laser and a processing unit equipped with scanner optics and clamping.

Requirements for integration:

- Substructure for the processing unit fitting the employed conveyor system or rotary table, mechanically rigid enough for clamping forces.
- Workpiece carrier with a laser safe tooling/clamping configuration.
- Interface cable for start trigger and emergency stop signals.



Planned technical data

Size welding contour	100 x 100 mm
Laser power	40 - 200 W (wavelength 980 nm)
Laser class	4 (red pilot laser 2)
Clamping force	up to 2300 N
Cooling	air (IP20, filter mat)
Ambient temperature	35/40°C – depending on laser power
Electrical supply	100 - 240 V, 50/60 Hz, < 10 A
Dimensions	Processing unit 330 x 330 x 410 mm Modula laser unit 520 x 430 x 215 mm

For integration in special-purpose machines we offer the same modules as you can find in our Turnkey machines. We also provide the necessary support for your internal machine building department or an external specialist. Laser units and optics are required for any integration. Additionally, we supply clamping units and motion systems so that all relevant modules for the welding process seamlessly work together and are supported by ProByLas. The machine building department or external special machine builder only needs to ensure sufficient enclosure including safety and part handling both in and out of the machine.

Laser

The laser unit is the central component of the Modula product family. Besides the laser itself, it also comprises of the system control, interfaces, and control elements.

On the touch-screen, the welding process is set up and observed during operation. Optionally a keyboard and mouse can be connected to the USB ports as well as a larger screen with the HDMI port on the backside.

The connections for other Modula components as well as the interface for automation carried out by digital and analog inputs and outputs are located on the backside of the laser unit.

The safety controls for emergency stop and two-channel interlock can be configured in different ways allowing integration up to the highest Performance Level e according to EN13849 standard.

Technical data	
Laser power	40 - 200 W
Wavelength laser	about 980 nm
Laser class	4 (red pilot laser 2)
Air cooling	Protection class IP20 or IP30, optionally with filter mat
Ambient temperature	35/40°C – depending on laser power and type of air cooling
Electrical supply	100 - 240 V, 50/60 Hz, < 10 A
Connectivity	Ethernet RJ45 on back side
Dimensions	520 x 430/530 x 215 mm depth depending on configuration

Front view with air vent slots IP20

Front view IP30 with pivoting legs

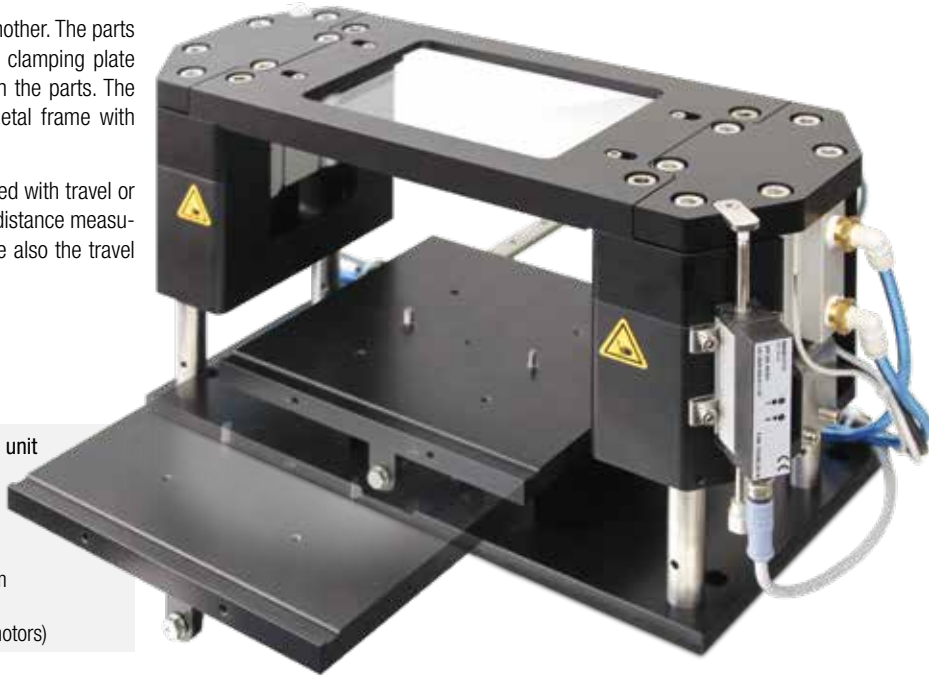
Connections on back side

Clamping unit

The clamping unit presses the parts to be welded against one another. The parts are inserted in part-specific cavities on the drawer. The upper clamping plate moves down by pneumatic or electric actuation and presses on the parts. The upper clamping tool can be a transparent glass plate or a metal frame with part-specific cutouts for the laser beam.

For process and quality control the clamping unit can be equipped with travel or force measurement. The clamping travel can be monitored with distance measurement. In the simultaneous or quasi-simultaneous process type also the travel during welding can be measured and analyzed.

Technical data	**small clamping unit**	**large clamping unit**
Size welding contour	150 x 100 mm	240 x 240 mm
Maximal width of part	210 mm	300 mm
Maximal clamping force	2300 N	7000 N
Maximal clamping stroke	20 mm (extendable customer-specific)	
Height part/tooling	65 mm – extendable in steps of 20 mm	
Motion drawer	manual, pneumatic, or electrical	
Actuation clamping	pneumatic (6 bar) or electrical (servo motors)	



Optics

The optics are designed modular as well. Besides the primary employed spot optics, other optics for specific process types can be utilized for special applications. The fiber connector module with collimation lens and the beam shaping elements are connected to the base body from the top and bottom.

Fiber connector & collimation
Depending on the type of laser different fiber connections are needed.
The collimation lens shapes a parallel beam. With different focal lengths of the lens, various diameters of the laser beam are possible.

Optics base body
For the base body of the optics, a simple version and an advanced version with monitoring of the laser power are available.
The advanced optics can also be equipped with a pyrometer for a temperature reading (100 - 400 °C).

Beam shaping

Spot diameter
0.5 - 3.0 mm

Line length
12 - 60 mm

Filled square
or rectangle

Ring
< 50 mm

DOE
for any contours

Ball
spot with clamping

Camera module side-mounted on optics for setup and monitoring of welding process

Motion

In order to track the weld contour with the laser beam different options are possible.
They are closely related to the type of welding process.

Scanner
The scanner is a combination of optics and motion system. Two pivoting mirrors deflect the laser beam in X- and Y-direction. With the small mass and inertia of the moving mirrors, high speeds of several meters per second are possible enabling the quasi-simultaneous process type.
The final focusing lens (f-theta) determines the size of the working area, which can measure 100 x 100 mm, 240 x 240 mm, or 350 x 350 mm.

XYZ-axes
The optics above can be mounted on an axes system driven by servo motors. Depending on the geometry of the parts and on the welding contour, a single axis may be sufficient or an X-, Y-, and Z-axis may be combined.
The motion control of the axes (numerical control NC) is integrated in the laser unit.

Rotation axis
For a weld on the circumference of a cylindrical part, a single servo motor is employed. It can also be combined with a translational axis e.g. along the length of the cylindrical part.

In the welding process the surfaces of two or more plastic parts are melted and pressed together so that the liquid plastic melts mix. When cooling down, the plastic melt solidifies to yield a strong bond. For welding, the plastics must melt when exposed to heat (thermo-plast). Plastics which do not melt when heated, but degrade or disintegrate, are not possible to weld (thermo-set plastics).

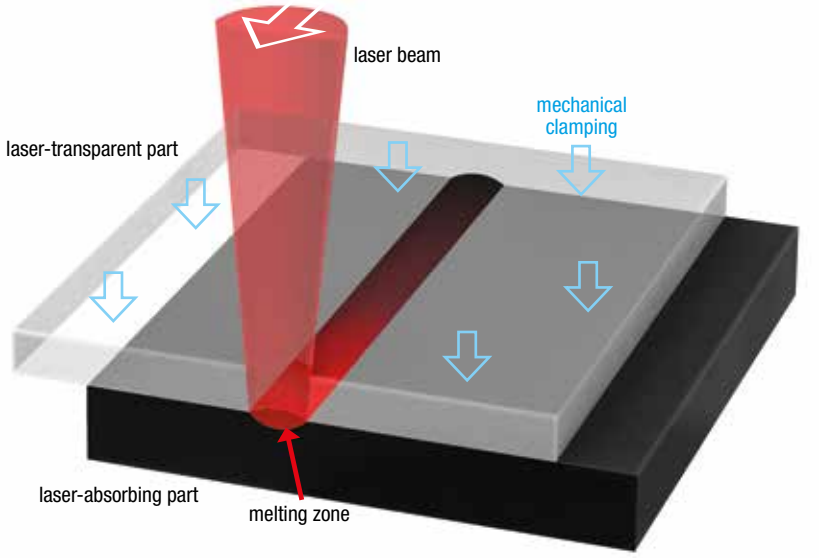
Process of laser welding

In laser plastic welding the heat to melt the plastic is introduced by a laser directly at the weld seam. The parts are already pre-mounted in the final position. The upper part is transparent for the laser, so that at least some part of the laser beam can propagate to the surface of the lower part.

This lower part absorbs the laser at the surface, heats up and melts. Due to mechanical clamping pressure, the parts are in contact. Both the upper surface of the lower part as well as the lower surface of the upper part plasticize and melt. The two melts mix to yield a strong and solid bond after cooling.

Advantages

- precisely localized
- shallow melting zone
- little energy needed
- low material strain
- no particles
- no vibrations
- no emissions
- no solvents



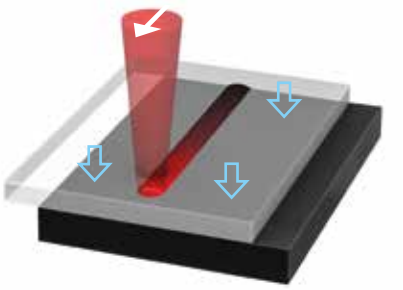
Industries

Based on its technical advantages, laser plastic welding is primarily applied in industries with high quality requirements such as

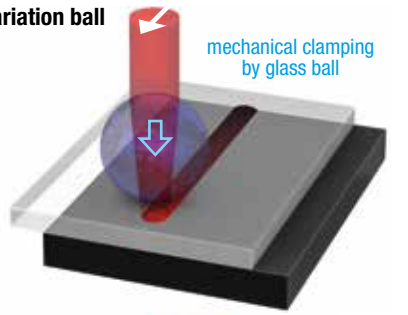
- Medical
- Automotive
- Electronics
- Consumer goods
- Technical textiles

Contour process

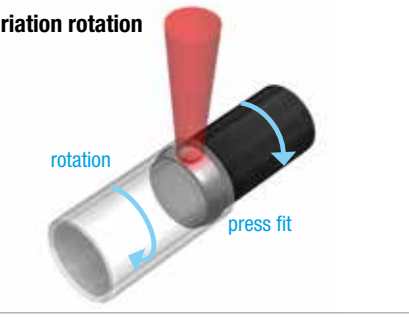
The laser tracks the weld contour once. The plastic melts only locally.



Variation ball

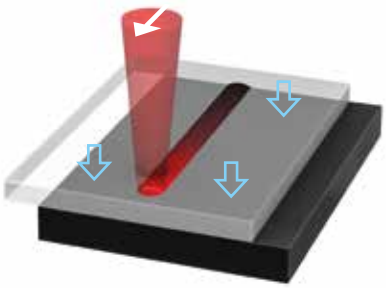


Variation rotation



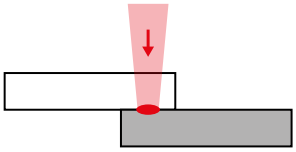
Quasi-simultaneous process

The laser tracks the weld contour several times per second and melts the plastic along the complete weld seam at the same time.

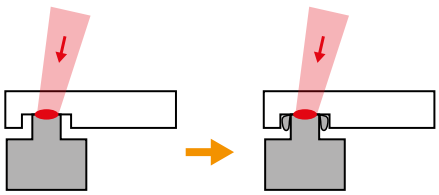


Design weld seam

In laser plastic welding the parts in the weld seam are flat on flat.

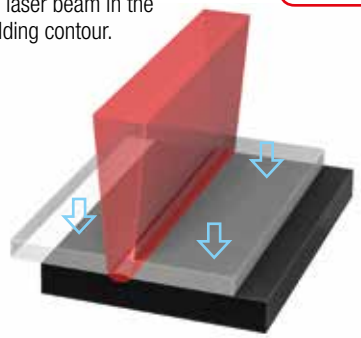


In simultaneous and quasi-simultaneous welding a rectangular rib for melting off and collapse can be added.

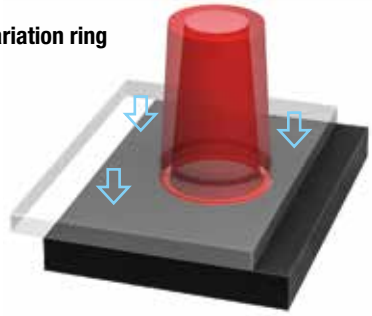


Simultaneous process

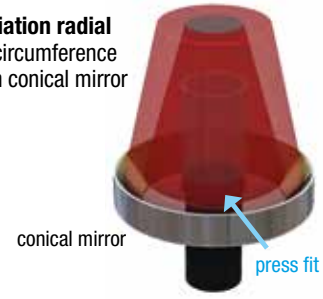
A special optics shapes the laser beam in the welding contour.



Variation ring

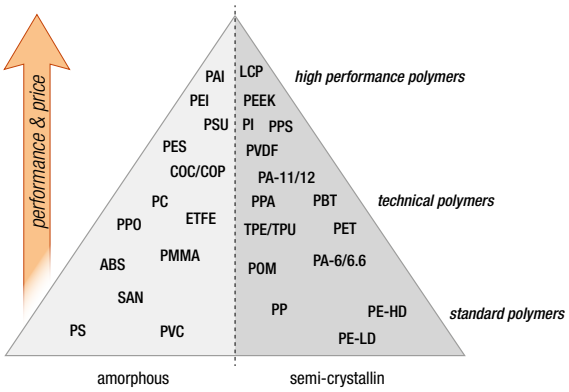


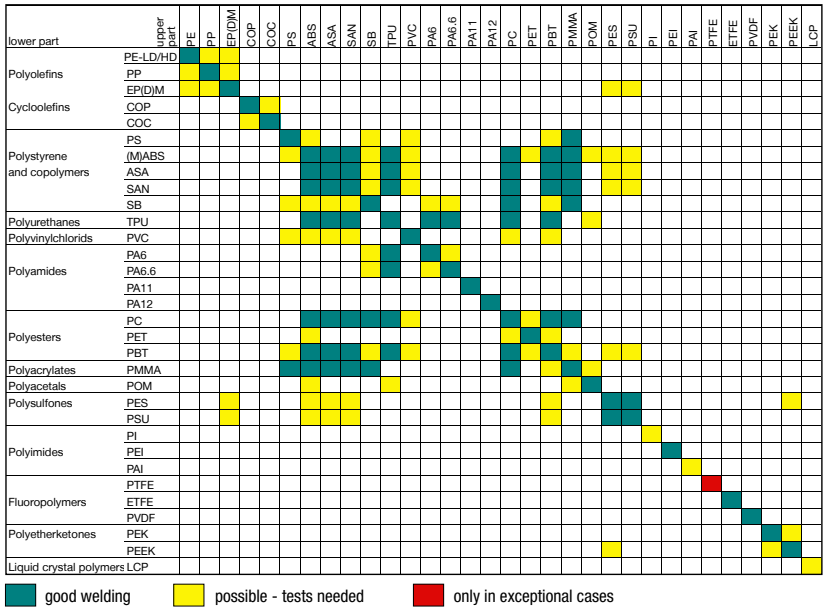
Variation radial on circumference with conical mirror



Plastics

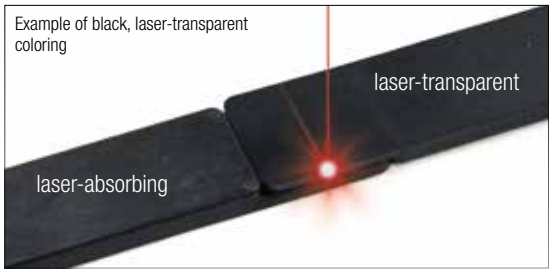
In general, all thermo-plastic polymers can be welded. Ideally both parts to be welded consist of the same type of polymer. Combinations of similar polymers are possible to weld if the melting temperatures are in the same range and if the polymer melts mix well.

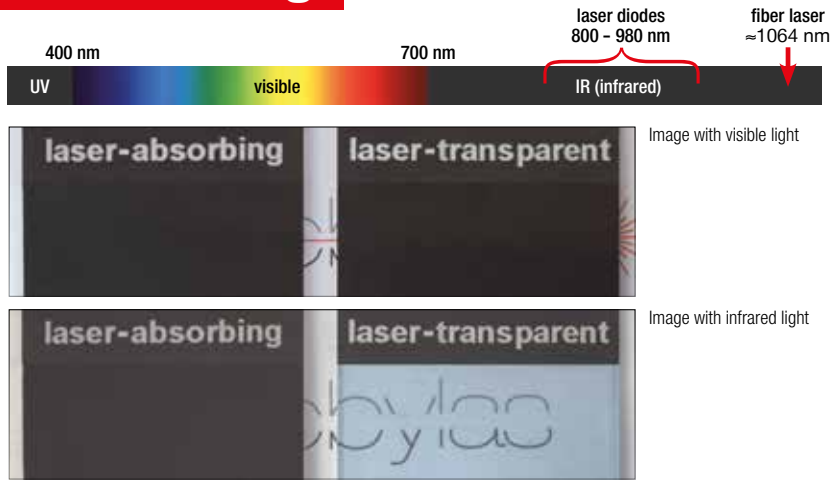




Laser-transparent and laser-absorbing

Laser plastic welding uses lasers with wavelengths in the near infrared range (800 - 1'100 nm). Therefore the transparency and the absorption of the plastics for the human eye and for the laser can be adjusted independently from one another by means of suitable colorants.



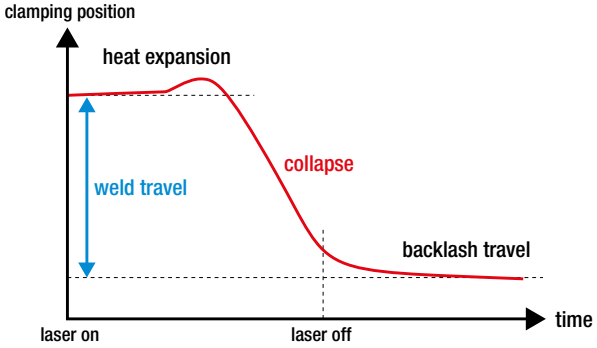


Process and quality control

Before, during, and after the welding process, various data can be measured and analyzed for a quality assessment. Besides the laser power measurement, pyrometry for the contour process and weld collapse for simultaneous and quasi-simultaneous processes are frequently applied during welding.

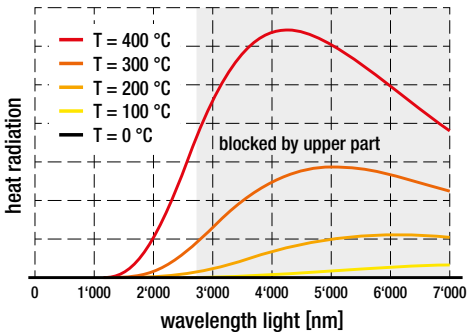
Weld collapse

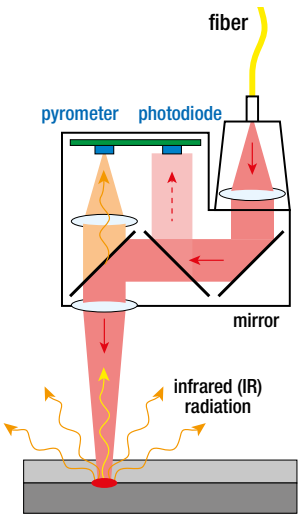
Depending on the plastic used, a small expansion can be observed before the plastic melts and the collapse of a melt rib starts. After switching off the laser, the travel does not stop immediately as the melt has to cool down and solidify first before the collapse ends.



Pyrometry

A pyrometer detects the heat radiation from the weld seam. As the upper part blocks some part of the heat radiation only a relative temperature signal can be retrieved and not an absolute temperature value.





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Modular Solutions for Laser Plastic Welding

We also support you with the following services before, during, and after the purchase of a machine:

- Design consulting for your parts
- Welding tests in our laboratory
- Sample parts up to small series
- Installation and training
- Maintenance and troubleshooting
- Upgrade of machines