Laser Plastic Welding
The Latest Evolution in Joining Technology
from the Leading System Supplier
LPKF Laser & Electronics stands for innovation strength and international presence. Over 30 years of experience in drive and control technologies married to in-depth competence in the industrial application of laser technology. LPKF WeldingQuipment GmbH, a subsidiary of the publicly listed company, specializes in the use of lasers for welding plastic components.

The use of laser plastic welding in industrial applications began with a spin-off from the University of Erlangen-Nuremberg. The company still maintains close contacts with the university’s research environment, which is highlighted by its over-proportional involvement in research and development. This creates a positive impact on technique optimization, as well as the discovery of completely new applications.
Binding Solutions

Lasers are becoming increasingly popular for joining two components because the technique is fast, reliable and inexpensive. As the leading supplier of serial production solutions LPKF has much to offer.

**Transparent and Absorbent Thermoplastics**

Laser welding relies on two types of polymers, transparent or absorbent. Most thermoplastics in their natural state are transparent at typical laser wavelengths. Additives, such as carbon, in the plastic change the properties so that they become absorbent. The absorbing surface converts the laser energy into heat.

In the transmission laser welding technique, a material transparent to the laser wavelength lies on top of an absorbent material. A clamping tool presses together the parts to be joined. The laser beam penetrates through the transparent component with minor energy loss and melts the surface of the absorbing material. Heat transfers through conduction to plasticize the adjacent surface of the transparent material.

This process is precisely controlled and continuously monitored during laser welding to ensure a repeatable quality weld. After resolidification, the two parts at the joint have been reliably and cohesively bonded.

**Reliable Clamping Technology**

During laser plastic welding, a defined pressure guarantees the necessary thermal transfer between the two parts being joined. It is therefore essential that the technology works with complete reliability. Uniform clamping is vital for high process quality.

Contents

- 2 Binding Solutions
- 4 From Ideas to Products
- 6 Optimal Technique – Optimal Result
- 8 Benchmark for Laser Welding
- 10 Assured Quality
- 12 Automotive Technology in Top Gear
- 14 Medical Technology – Putting People First
- 16 Laser Systems for the World Market
New Applications and Material Combinations

High joint quality criteria bring the economic advantages of laser plastic welding into the spotlight. No other method simultaneously combines such a high degree of safety, cleanliness and speed – opening up completely new opportunities!

Laser plastic welding can easily handle complex three-dimensional designs. The beam head itself never touches the material. Even poorly accessible zones or thick layers can be safely joined. Other convincing features are the continuous development of new materials and a wide range of combination options. The process is so gentle, the LPKF WeldingEquipment systems are ideal for components with sensitive surfaces.

Automotive, medical and consumer products all profit from the transmission laser welding technique.
Application Center for Process Development and Quality Assurance
The results of in-house research, and in-depth practical experience, are made available to a broad circle of users in the LPKF Application Center.

A successful laser welding process begins with the design. Highly qualified engineers help with the process planning; they provide advice on the selection of materials, and determine the best laser parameters. Finally, they jointly work with the clients to develop prototypes and create optimal clamping tools. The Application Center then elaborates quality assurance processes, and trains the operatives. This ensures the economical and uncomplicated operation of this innovative laser joining technology.

Economic Advantages:
• Fast product development
• Low total cost of ownership (TCO)
• High flexibility
• Short cycle times
• Simple product solutions

Comparison with Alternative Methods

Laser compared to ultrasonic and vibration welding
• Minor mechanical impact on the components
• No surface damage
• Completely particle-free
• Highest visual quality joint line
• No tool wear and tear, minor tool costs

Laser compared to mirror and hot-gas welding
• Minor thermal stressing of components
• Lower melt overflow
• Much shorter cycle times
• Lower machine and tool costs

Laser compared to hot-melt technology and gluing
• No additives required
• Better options for online process monitoring
• Highest visual quality joint line
• Higher quality and long-term stability
• Shorter cycle times

LPKF operates a Class ISO 5 clean room for medical technology laser applications. This clean room is used for the production of samples, and for making process optimizations, under the same production conditions used in the medical technology sector.
Simultaneous Welding
Simultaneous welding is where the entire welding seam is heated at the same time. This method requires power density distribution over the radii and changes in height. It is especially recommended for extremely high production runs which justify the large investment required for the special laser equipment.

Quasi-Simultaneous Welding
Quasi-simultaneous welding is a combination of contour and simultaneous welding. A mirror guides a focused laser beam several times along the welding contour at a very high speed so that the entire joint line is effectively heated up and melted simultaneously. Quasisimultaneous welding enables the melt travel to be monitored and compensates for tolerances in the molded parts.

Contour Welding
Contour welding is where the laser moves relative to the component. The width of the joint line can vary from a few tenths of a millimeter to several millimeters. Contour welding is particularly good when rotation-symmetrical or very large components need to be welded without any melt overflow.

Optimal Technique – Optimal Result
The key feature of transmission laser welding is transmitting energy through a material. Different approaches can be used. Each method has its own specific strengths; in addition to many shared advantages. LPKF’s laser specialists help identify the best method for each application. Their involvement in the production of millions of components gives them the quality experience required for professional consulting.
Advantages of Laser Plastic Welding:

- Optional online process monitoring
- Visually high quality weld seam
- Particle-free welding
- Minor stress on the components
- No surface damage

More information on these methods is available at [www.lpkf.com](http://www.lpkf.com)

**Patented Hybrid Welding**

Hybrid welding combines laser energy with infrared thermal radiation from conventional halogen lamps. An air-cushioned roller positioned directly on the joint line applies the required clamping pressure, so that no additional upper clamping tool is needed.

This increases the welding speed whether the components are in two or three-dimensions. The main application for this technology is structural components in the automotive sector, such as: automotive lighting and motor assemblies.

**Clear-Clear Joints**

ClearJoining technology is the name of a new process developed by LPKF for welding together transparent components without any additives. A laser is focused very precisely onto the joining zone in the transparent material, where it causes localized melting to create a highly reliable weld. A special laser system, a vision system, and the further advanced clamping technology, ensure that this method is always dependable and economic.

More information on these methods is available at [www.lpkf.com](http://www.lpkf.com)
Benchmark for Laser Welding

Economically efficient laser systems are the product of in-depth experience. LPKF combines applications know-how and consulting competence with successfully tried-and-tested laser welding machines. This brings the users of LPKF laser technology safely to their goal of efficient production.

Objective Advice
Objective advice can only be dispensed by experts having solutions in their product line covering a broad spectrum of applications. LPKF standard systems range from laboratory systems all the way to fully automatic welding cells. LPKF engineers work together with clients to develop customized system concepts for special applications.

All LPKF welding systems are compact and equipped with standard interfaces. They are easy to integrate into existing production environments.

From Laboratory Systems through to Fully Automatic Welding Cells
- LPKF InlineWeld: for integration in client-specific production solutions**
- LPKF PowerWeld: for laboratory applications, small and medium series, as well as large batches*/**
- LPKF TwinWeld3D: for welding large, complex 3D components in a thermal field*
- LPKF PrecisionWeld: for clear-clear joints and microfluidic structures

* range of handling versions available
** different laser configurations available
Quality You Can Rely On
The quality of the final product is determined by the whole process chain. Confirming the process reliability – for each separate component – is becoming an increasingly crucial factor. Production data from LPKF systems can be clearly assigned to individual components. This sets up the seamless background for the specified “tracking & tracing”. LPKF welding systems have also been successfully integrated by clients within Manufacturing Execution Systems (MES).

Easy-to-Use Machine Controls
Two of the key advantages of LPKF welding systems are comprehensive machine capability combined with simple operation. They are equipped with a fail-safe SPC. The remote servicing capability reduces maintenance costs and increases production availability. ProSeT, the standard set-up software, simplifies the programming of welding contours and laser parameters, for a rapid product change.

Holding, Clamping, Feeding
High productivity depends on optimal workpiece loading and feeding. LPKF supplies solutions for every application. The spectrum ranges from manual placement in 2-way rotary tables, to conveyor systems and robot-based feeding systems.

Dual-clamping tools ensure reliable thermal conduction contact within the welding zone. Clamping on both sides of the joint line ensures particularly uniform pressure distribution. The tools can be optionally equipped with air cooling.
Assured Quality

LPKF laser plastic welding is designed to satisfy the highest quality standards in production. It begins with a reliable welding process and continues into the testing phase. LPKF welding systems have integrated process monitoring, including regulation mechanisms which correct even the smallest deviations.

Seamless Control
High quality standards demand seamless control. LPKF welding systems record important process parameters during production, and react to deviations to set values by making automatic corrections or warning the operator. All the data can be easily archived making it ideal for integration within a manufacturing data logging system.

Recording Process Parameters
The successfully tried-and-true melt travel monitoring system gauges the melt travel during laser plastic welding, providing further quality control. Almost all scanner-based LPKF welding systems are equipped with this monitoring method as a standard.

Other methods round off the process monitoring package: a pyrometer measures the temperature in the joining zone to provide information on localized interferences. The burn detection system identifies even the smallest burns on the surface of the components, whilst the vision systems are an option when strongly contrasting materials are used. This range of monitoring systems provides the optimal basis for ISO quality monitoring and documentation.
**Stringent Testing to Check Welds**

The LPKF testing laboratory has a wide range of methods at its disposal to analyse plastic welds, such as:

- Programmable burst pressure testing up to 7 bar air pressure
- Water bath leak testing up to 7 bar air pressure
- Burst pressure testing up to 40 bar water pressure
- Destructive inspection
- Light microscope evaluation with digital archiving
- Transmission test

The LPKF Application Center offers feasibility studies during product development, and the opportunity to produce prototypes. The laboratory is also available to its clients for testing batch production.

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**Material Qualification with LPKF TMG 3**

The transmission tester LPKF TMG 3 enables the transparency properties of plastics to be quickly and easily checked and proved. The inline-capable device does the component testing automatically within the welding system. This involves shining light on a component with the same laser wavelength used in the welding process. The transmission parameters are determined within a few seconds and are ready for instant comparison with the original values. Testing reveals any deviations in the materials before an unsuitable component enters the production process.
Automotive Technology in Top Gear

The product quality and production reliability criteria specified by car makers and the automotive subcontracting sector are very high. Laser welding is one of the disciplines which meet the demand of low-cost/high quality requests. Many car makers and models use components economically joined using LPKF laser technology.

Sensor-Electronics for Cars
Modern cars are equipped with numerous sensors to boost passenger comfort and safety. The advantages of laser processing stand out when sensitive electronic assemblies are used in these sensors. Instead of screwing, gluing or pouring sensor housings, they are joined by lasers gently, reliably and economically. Additionally, the entire welding process can be documented for later inspection.
Laser Plastic Welding in the Automotive Sector:
- Traceability / MES integration
- Shortest cycle times
- Low life-cycle costs
- Particle-free processing
- Quality assurance during welding process
- High flexibility

Control Devices for Electronic Steering Systems
Internal electronic components are first fixed in place using laser staking, and the cover is then welded tight to the housing – this can only be done using transmission laser welding.

Control Calve for Lumbar Support System
The tight weld required here can only be performed using the LPKF Dual-Clamping Device (DCD) which simultaneously clamps the outer contours and inner surface of the component.
Putting people first – this equates to especially high specifications for products and processes. Laser plastic welding scores on both counts. Particle-free processing, different validation methods even during the welding, and clean-room compatibility, are just some of the features highlighting lasers as the tool of choice in the manufacturing of medical products.

An area of application which combines all of these demands is microfluidics. It needs extremely precise joint lines up to several meters long. There must be no contamination by foreign bodies or additives; Creating compelling arguments for laser plastic welding.

Mini laboratory for complex analysis: thanks to modern microfluidics
LPKF Plastic Welding in the Medical Technology Sector:

- Hygienic energy input
- Particle-free processing
- No adhesives
- Traceability / process monitoring
- Shortest cycle times
- New design possibilities

A Classic Product of Laser Plastic Welding

Ostomy bags of this kind have been mass produced using laser welding for a long time. The joint line is hidden in the interior and satisfies the highest hygiene and quality specifications. Another plus point for laser technology in this application is the minor, easily controllable energy input. Welding machines from the LPKF InlineWeld series are equipped with a pyrometer for online process monitoring.

99 RNA Sensors in an Extremely Compact Unit

This laser-welded microfluidic cartridge is part of a complete, highly specialized mini-laboratory. This opens up a whole new range of opportunities for surgeries and clinics lacking sophisticated laboratory facilities. LPKF was selected to make this product because of the specified two-meter-long joint line, particle-free and additive-free contact surfaces, complete tightness, and guaranteed channel cross-sections.
Laser Systems for the World Market
LPKF has been active in laser material processing for many years – with high performance systems for industrial production. LPKF WeldingQuipment combines its own development potential with global mass production experience.

Full Round-the-Clock Service
The clients of LPKF enjoy full round-the-clock service to guarantee optimum availability of their equipment. Service technicians or engineers are available for commissioning the LPKF welding systems and to ensure that production starts smoothly. When the welding systems are running, highly qualified service staff provide professional support via hotlines, remote diagnosis or on-site trouble shooting.

The global LPKF network for service and distribution:
- Headquarters
- LPKF Group
- LPKF Distributors