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TREFFERT®
Color follows function

Laser welding of plastics

For joints under high mechanical stress

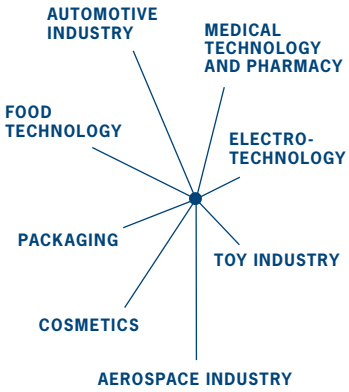
Laser welding in an innovative joining technique for plastics and offer advantages that cannot be achieved with any other process at this time. In plastics, laser welding generates a very clean weld seam that does not leave behind any residues and loose particles around the seam. This fact makes the procedure especially interesting for the manufacture of medical devices where the highest demands are placed on material and function.

In contrast to ultrasonic welding, laser welding procedures also permit the jointing of components with electronic parts, without compromising or destroying the properties of these parts.

Sample of a Blood sugar monitor with laser-welded housing

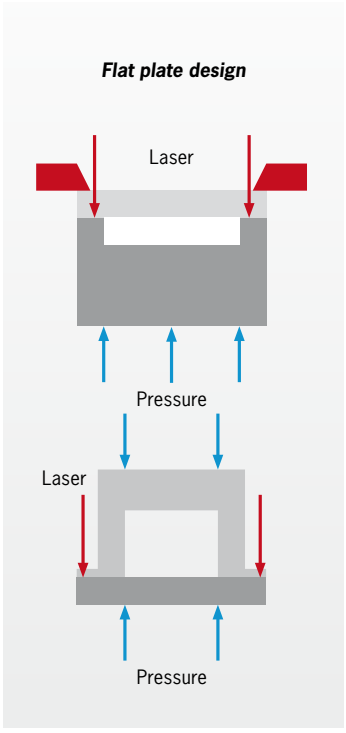
A joining process with versatile applications

REQUIREMENTS FOR LASER WELDING



As with any other process, laserwelding of polymers needs specific conditions to be a success. There are the following key factors:

- Choice of suitable polymers, additives and pigments.
- Use of the right laser source with suitable optics.
- Appropriate joint configuration and small gap width.
- Optimized clamping technology, allowing free access of the laser beam to the seam and applying sufficient pressure on the components.

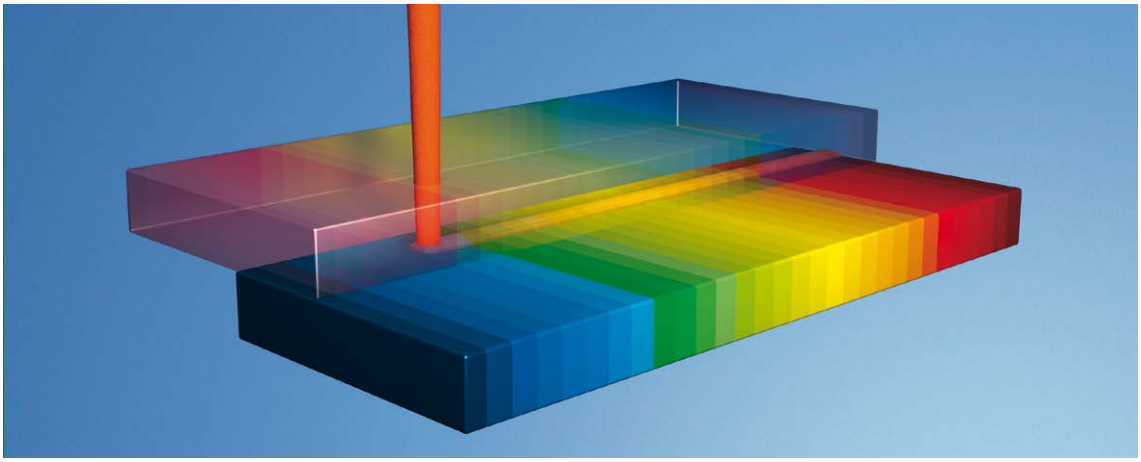


Graphic above:
Different process versions of laser welding for different plastic designs

THE BENEFITS ARE OBVIOUS

Every new technology must have strong arguments to replace established methods. The advantages of lasers as a tool for the joining of plastics are:

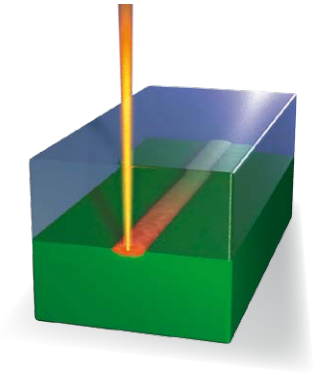
- Laserwelded joints resist high mechanical loads, they are gas tight and often achieve the same strength as the base material.
- Due to the high density of energy in a small spot, the welding is so precisely localized, that even sensitive components very close to the weld remain unaffected.
- The choice of laser wavelength allows selective reactions in the parts. In combination with special additives, the energy of the laser light is changed into heat energy.
- Minimal thermal and mechanical stress is applied. Due to the high density of energy in a small spot, the welding is so precisely localized, that even sensitive components very close to the weld remain unaffected.
- The results are surfaces with perfect quality, no micro particles, glue or roughness.
- Low reject rates and constantly high reproducibility.

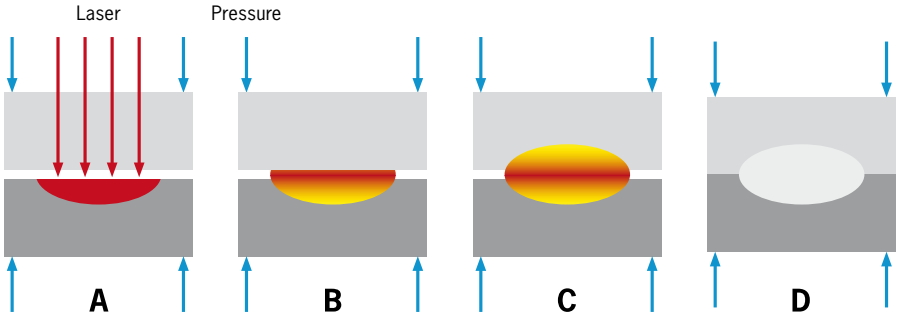


LASERWELDING PROCESS OVERVIEW

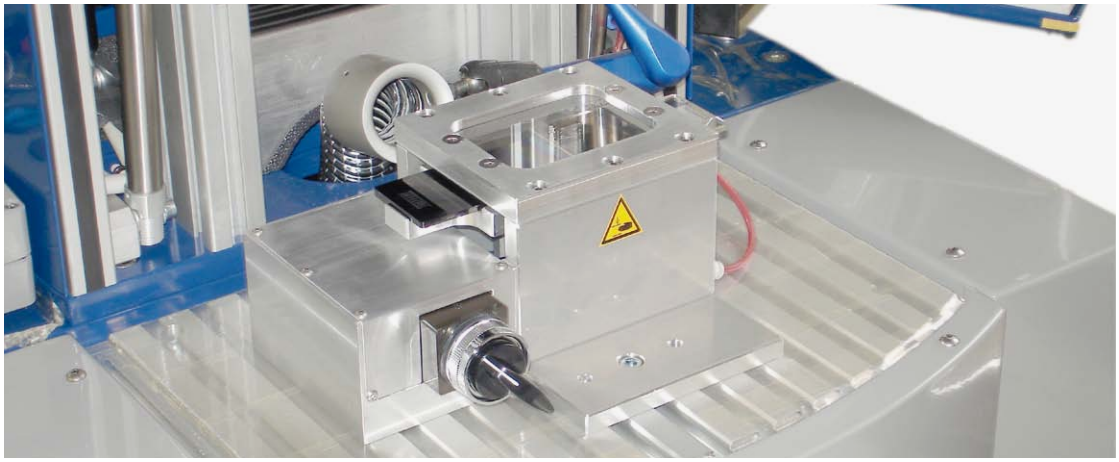
Low heat conductivity and viscosity of polymers means that the most practical welding geometry is overlap welding. Here, the laser beam penetrates the upper material and is absorbed by the lower material.

The heating of the latter leads to plastification which bridges the work-piece gap and melts the upper material by heat transfer. Therefore, having a small work piece gap is an important success factor.



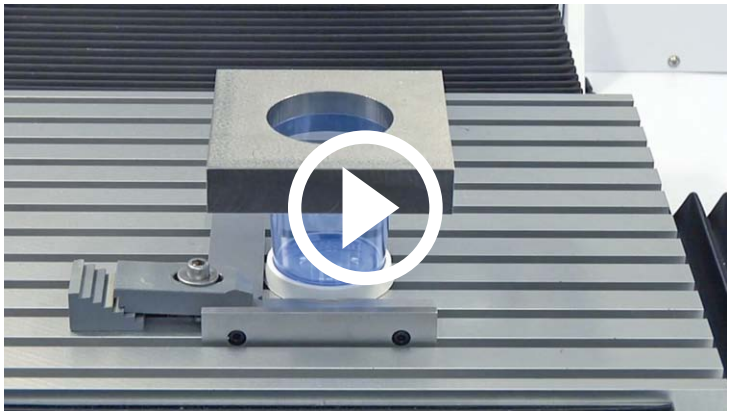


Laser light penetrates the upper layer and is absorbed by the lower material (A). The melting of the latter transfers (B) the heat to the upperlayer (C). The mutual melting pool solidifies under external pressure to a high-quality weld (D).

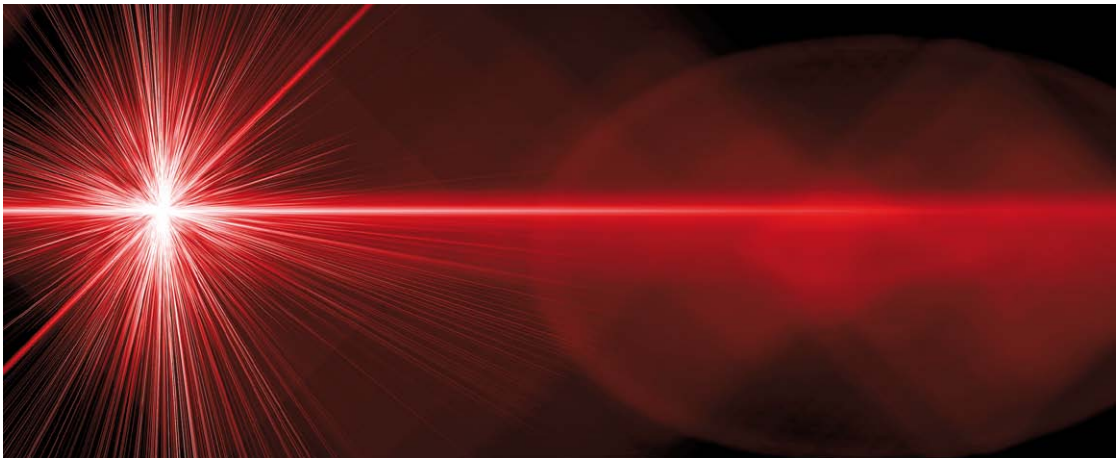


WHICH LASER SOURCE?

Due to their wave length, diode lasers, Nd:YAG lasers and fibre lasers are suitable for plastic welding. Over 90% of the applications can be implemented affordably with the diode lasers, it is particularly suitable for applications in which broader welding seams, rounding seams and simple spot welding can be implemented and offer high component stabilities. Other benefits lie in the comparably low procurement and service costs, long service life and capacity. Compared to diode lasers, Nd:YAG lasers and fibre lasers are less suitable for serial applications due to a lack of capacity and are therefore much more expensive in terms of procurement and service.



You can view a demonstration video on the laser welding process online under the following QR code or under www.treffert.eu/laserschweissen

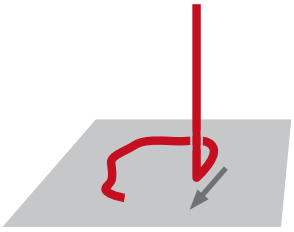


CONTOUR OR QUASI-SIMULTANEOUS WELDING?

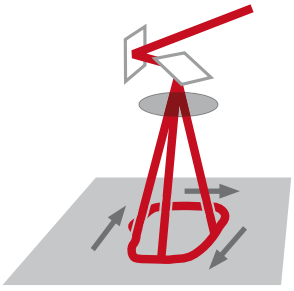
These two processes show presently the best market presence.
With contour welding, the laser beam follows the welding seam, similar to metal welding. Almost any work piece size can be welded.

The limits for this technique are set by the tolerable gaps.
With quasisimultaneous welding, the laser beam passes over the entire welding contour several times very rapidly. Beam deflection is done using galvo scanning heads and therefore higher beam quality is essential.
The entire welding path melts quasi-simultaneously due to heat buffering and allows the layers to move against each other easily.

The pressure on both layers and a suitably designed sacrificial region can bridge larger gaps. On the one hand, quasi-simultaneous welding requires higher laser power; on the other hand, it allows even distortion-free energy input.



Contour welding



Quasi-simultaneous welding

Sample of laser-welded lamp shades by the manufacturer Curio

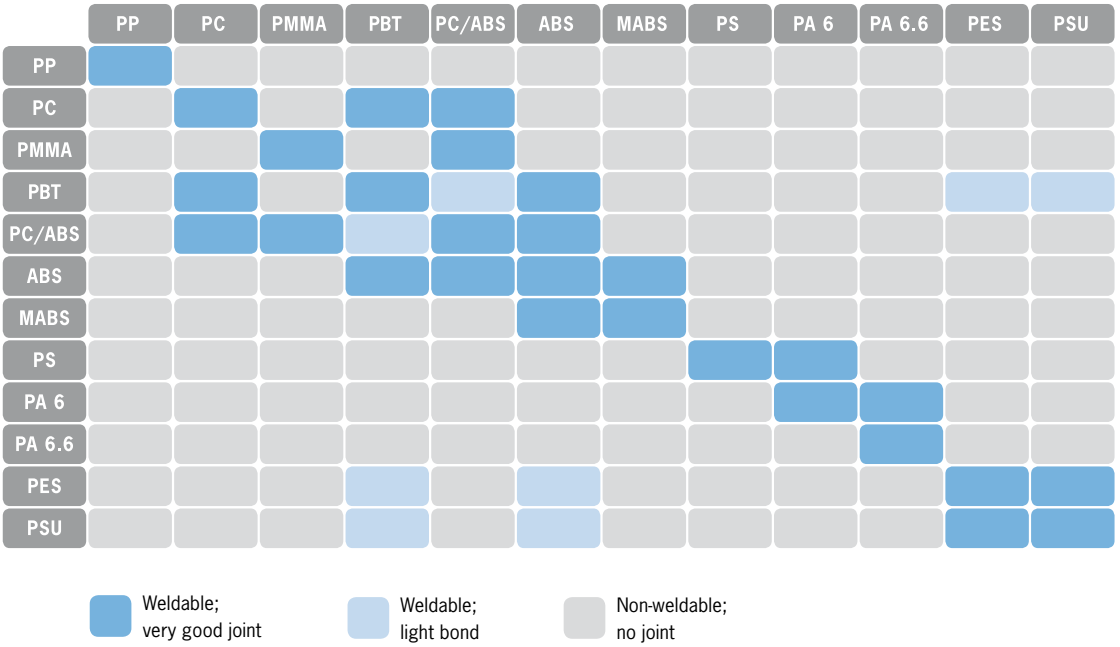
WHAT CAN BE WELDED?

In summary, all thermoplastics and almost any thermoplastic elastomer, unfilled or filled can be welded For example, in current applications, polymers with a glass fibre percentage of up to 30 % are laser welded. Some examples of materials, which can be welded: PE, PP, PS, ABS, SAN, PA6, PA6.6, PC, PMMA, PSU, PEEK, PET, PBT…

Also different kind of polymers can be joined without problems – provided they are chemically compatible and the two melting temperature ranges overlap sufficiently. There is also a rule of thumb for natural materials: What you can weld ultra-sonically can also be laser welded… and many more.

Laserwelding of polymers is already successfully used in numerous applications: in the automotive, electronic and telecommunication industries, medical device technology, human care and household devices.

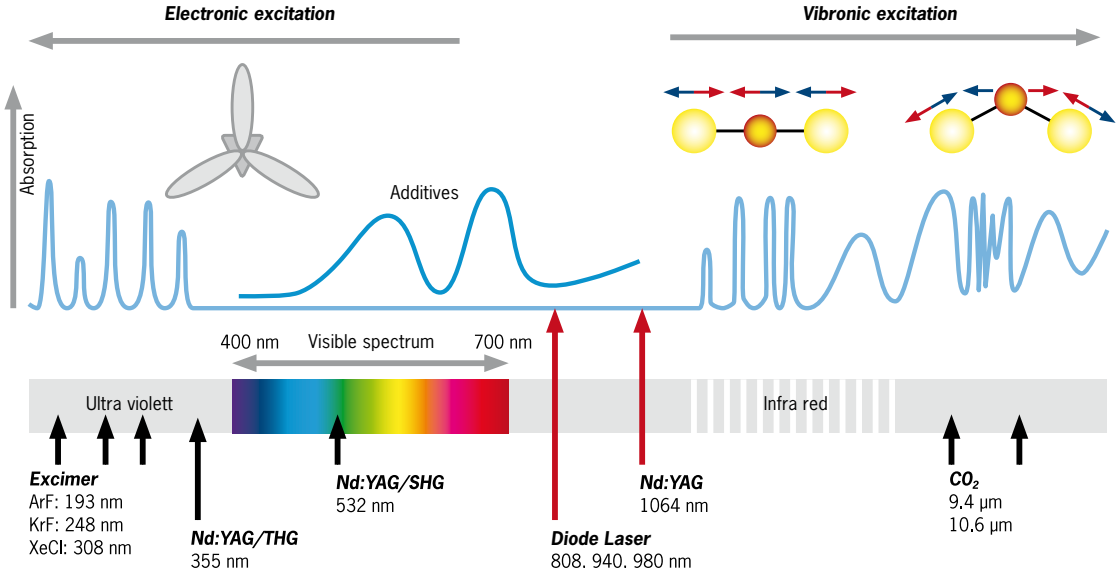
Laserwelding compatibility of selected polymers:



TRANSPARENCY AND ABSORPTION

All commonly used polymers are more or less transparent in undoped condition in the infrared wavelength range of the laser sources (except CO_2 lasers). Filler materials, like pigments, provide for the absorption of laser energy. Many colour pigments absorb within the infrared range and can be used for laserwelding.

Even simpler, and therefore most common, is the use of carbon black particles acting as absorbers, typically in a concentration of 0.05 – 0.5 %. However, this results in darker colours. There are already standard solutions for black-black and transparent-black welding availabe. For clear and bright colours, colorants, which are flexible in use, are also available. They absorb only within a certain wavelength range and have no significant influence on the colour. The slight colour changes due to the additives can be adjusted by colour matching.



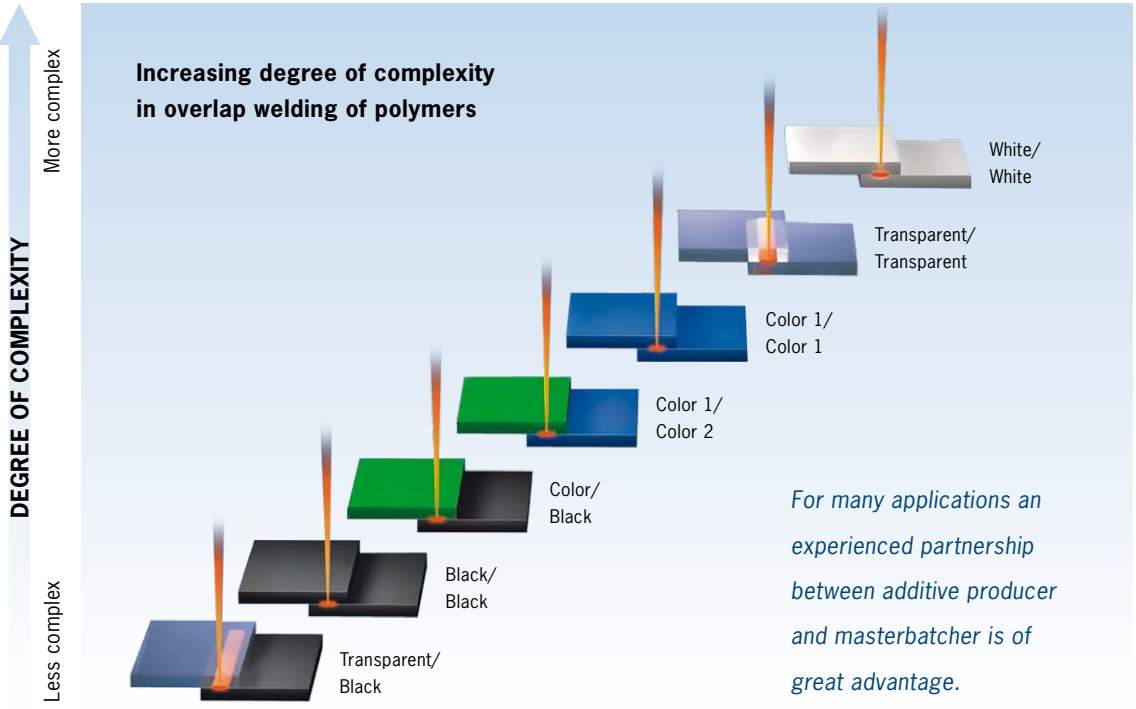
Most polymers (lighter blue curve) are usually transparent or translucent in the visible and near IR range. By adding pigments (darker blue curve), suitable absorption of the laser wavelength is achieved.

EVEN COLOURED AND ALSO TRANSPARENT

Black, coloured, transparent, white... In this order, the complexity of process requirements for laserwelding of polymers increases. Applications with black material, acting as absorber, are usually easy to realise or already available as a standard solution. For welding of coloured polymers, the necessary pigment combinations are customised in laser transparent and laser absorbing form a typical task for the experienced masterbatcher.

Welding of light-coloured or transparent polymers, which is particularly required in the medical device industry, is successfully achieved with CO_2 laser in the case of welding thin films or more general by using the above mentioned laser absorbing high performance additives. Those have to exhibit high absorption efficiency at the appropriate wavelength and low colour impression in the visible range as well as various additional characteristics: the know-how of an innovative worldwide operating masterbatcher ensures optimum results.

Titanium dioxide presents particular problems in relation to beam scattering and low transparency and requires customised solutions for white-white welding.



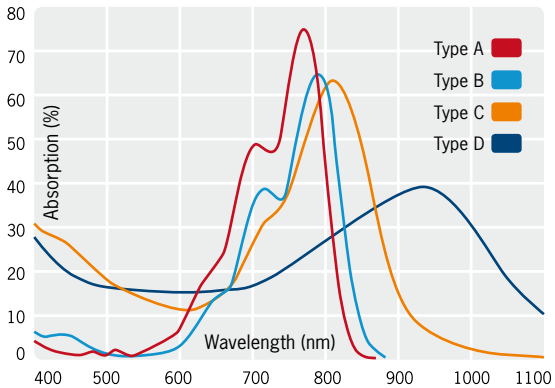
The conditioning of laser-weldable plastics at Treffert

NOVEL FAMILY OF LASER ADDITIVES FOR EVERY WAVELENGTH

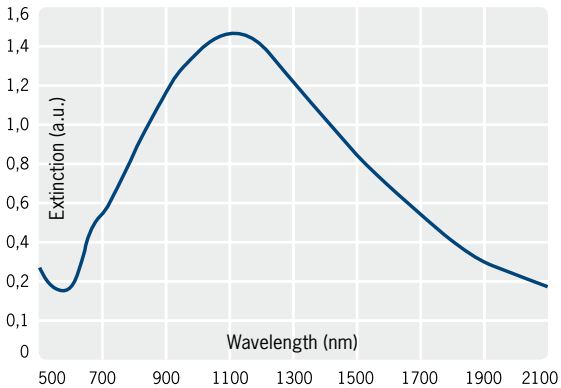
In addition to a series of additives which are tailored to the use of a diode laser with an emission wave length of 808 nm, for research purposes, Treffert has NIR absorbers in its portfolio which can be used in the very common laser wave ranges by the ranges 940, 980 and 1064 nm. These are absorbers which can have either an organic or an anorganic structure. Many of these additives offer high light and thermostabilities, associated with simple processability and good chemical resistence.

NIR absorbers in the Treffert portfolio for use in different wave length ranges:

NIR absorbers in polycarbonate (800 bis 1100 nm)



NIR absorbers in polycarbonate (900 bis 1500 nm)



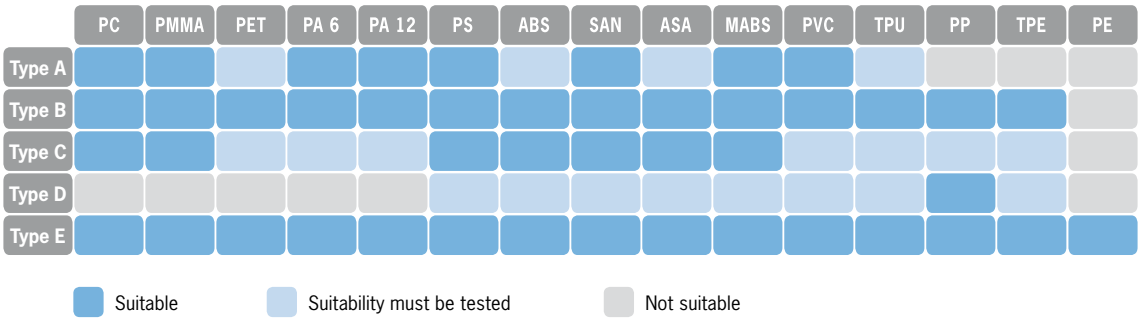
EASY TO COMPENSATE RESIDUAL COLOR WITH HIGH NIR ABSORPTION EFFICIENCIES

Organic NIR absorbers which have their own minimal, easy to compensate individual colour in combination with very high NIR absorption efficiency allow the application of visually transparent plastics which are absorbent in NIR. For visually opaque applications, we have primarily used anorganic NIR absorbers which are optimally tailored to the end application. Most absorbers are non-ionic, halogen and heavy metal-free and toxicologically safe- the best requirements for use in medical technology and other sensitive applications.

COLOURING: A FACTOR OF SUCCESS

To find the ideal colour formulation, the desired colour together with perfect laserwelding characteristics are the two key factors. For that, it takes a specialist with the knowledge and experience of hundreds of thousands of formulations and with a sophisticated laboratory equipped with modern extrusion lines. Colour samples submitted by the customer are the basis for the creation of masterbatches. The masterbatch is easy to process, optimally dispersed and identical in colour. If requested, the original material can be conditioned, which means it is used as the carrier material for the masterbatch. The characteristics and the authorization of the original material are thus retained to a large extent.

Compatibility of various NIR absorbers in selected polymers:



Company location Bingen

Company location
Ste-Marie-aux-Chênes

Color follows function

TREFFERT CORPORATE GROUP

At our two locations in France and Germany, we advise and guide our customers from the idea, through product development to technical production. We develop and supply charges for small to medium-sized supply requirements as well as for unusual uses – from the smallest sample quantities to capacities of several tons. The motor driving our performance is our passion for material and function – and for results that are made with the highest precisions.

Certified Quality, Environmental and Energy Efficiency Management

TÜVRheinland CERTIFIED

Management System
ISO 9001:2008
ISO 14001:2004
ISO 50001:2011

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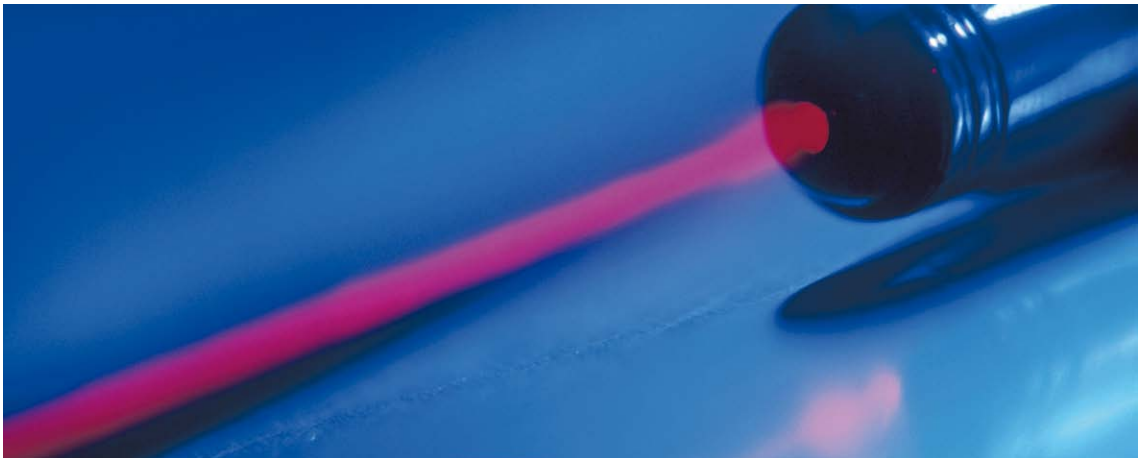
The results are high-grade products with an optimum of process security that meet all the criteria for tested quality management. Every step of development and manufacturing is subject to constant internal quality control. We thus provide for a constant improvement of our work processes and production quality.

Documented production processes and formulas as well as secure storage of reserve samples assure that we can still supply our customers with more than 50,000 dye formulas even years after they were made, and that with absolute fidelity to the original, and always just in time.



SUPPORT IN THE DEVELOPMENT OF LASER-WELDABLE PLASTICS

As a specialist in the conditioning of technical plastics, we are interesting innovative processing techniques for our products in order to always offer our customers the best application for the respective application. At our in-house innovation centres at our French facility at Ste-Marie-aux-Chênes, we test our products for suitability in the laser welding process. This makes it possible to study and modify customised products as part of feasibility directly in terms in of their suitability for these methods. In addition to equipment with diode, Nd:YAG- and fibre lasers, there is also a colourising and chemical/physical lab so that, within just a few days, you can receive the colour recipes suitable for your application which were already tested for their laser weldability.

At presentations and workshops we can test the laser welding process and the laser marking process currently on six independent laser sources, also directly with our customers. Here the basis is a 6-axle robot which can move the laser source freely within the room and thereby permit new opportunities when using the process. This means the development time can be considerably reduced for laser-marked plastics depending on the application.

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