Ultradur® LUX

PBT for laser welding

Ultradur® in the web:
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Ultradur® LUX

High, consistent laser transparency

The new Ultradur® LUX is a polybutylene terephthalate (PBT). Researchers at BASF have successfully refined its morphology so that its laser transparency has been improved from 30 to around 60 percent – a high, consistent laser transparency that has not previously been achieved with PBT. Its mechanical properties are comparable to those of standard Ultradur®.

With the improved laser transparency it is now possible to achieve much higher welding speeds. At the same time, the process window is considerably wider. In Figure 1 this is shown as an example for a laser process with the so-called contour method. Given the same laser power (50 W) and the same thickness of the transparent joining partner (2 mm), standard PBT can only achieve welding speeds of 5 to 12 millimeters per second using a 1064 nanometer laser. With Ultradur® LUX, speeds of 10 to 70 millimeters per second are now possible. Comparable effects can be seen with other laser welding methods (e.g. quasi simultaneous welding) and other processing parameters (e.g. higher laser power).

The higher laser transparency also offers other advantages: For example, thicker joining partners than before can be welded. This means that applications that previously required other joining methods can now be laser welded. Alternatively, lower laser power can now be used, extending the life of the laser. The laser-transparent Ultradur® LUX therefore not only opens up completely new possibilities, it also contributes significantly to the efficiency of the process.

**Quick and reliable –
advantages for the processor at a glance:**

- greater freedom of design
- wide process window
- shorter cycle times
- high process consistency
- high quality consistency
- greater flexibility

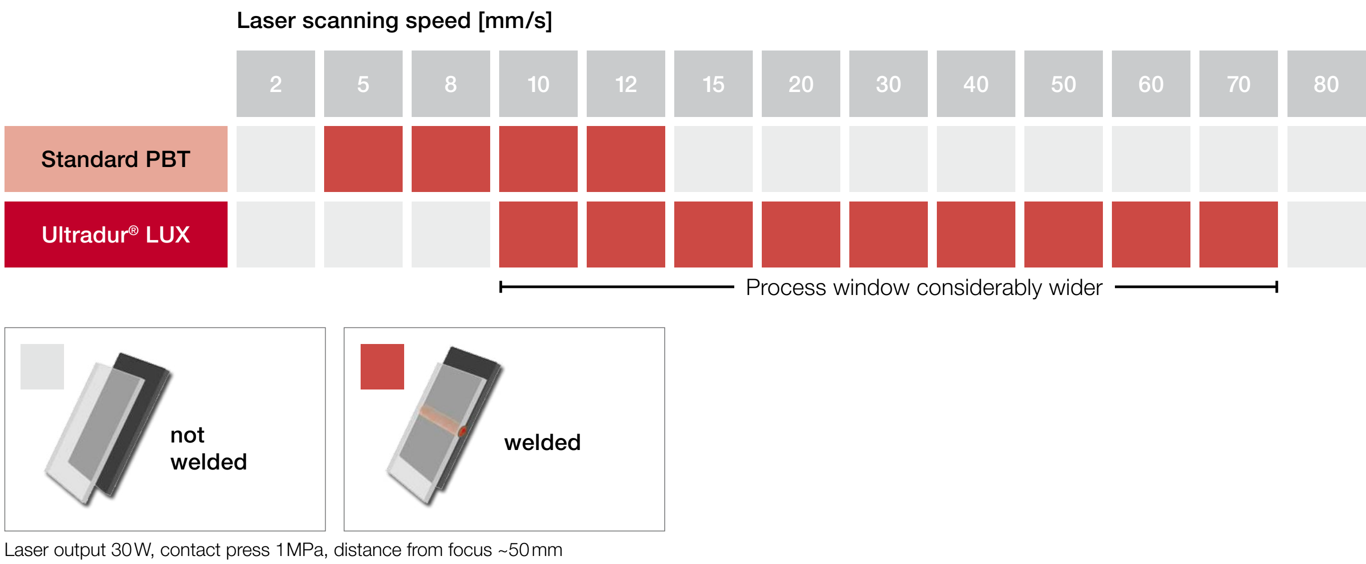


Fig. 1: With Ultradur® LUX, the process window for laser welding PBT is considerably increased.

Small scattering centers are the solution

Laser welding of partially crystalline thermoplastics is in principle more difficult than that of amorphous plastics because the laser beam is scattered on the spherulites. This problem, which is common to all partially crystalline plastics, was particularly apparent with PBT. With Ultradur® LUX, a partially crystalline PBT with optical properties that have never been achieved before is now available. In comparison to conventional PBT, Ultradur® LUX lets through much more laser light, the laser beam is considerably less widened (Figs. 2 and 3).

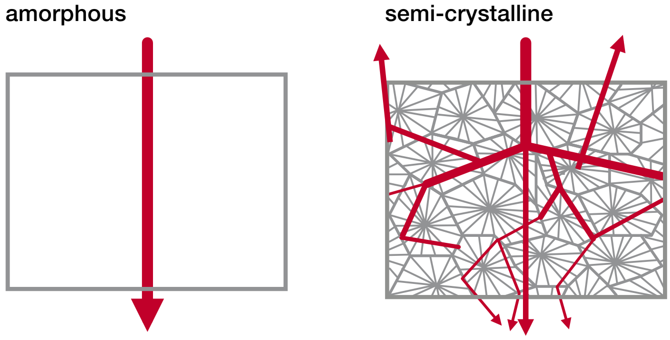


Fig. 2: Unlike amorphous thermoplastics, partially crystalline thermoplastics have a spherulitic microstructure containing phases with a different refractive power. This means that the laser beam is widened more and the backward scattering is greater.

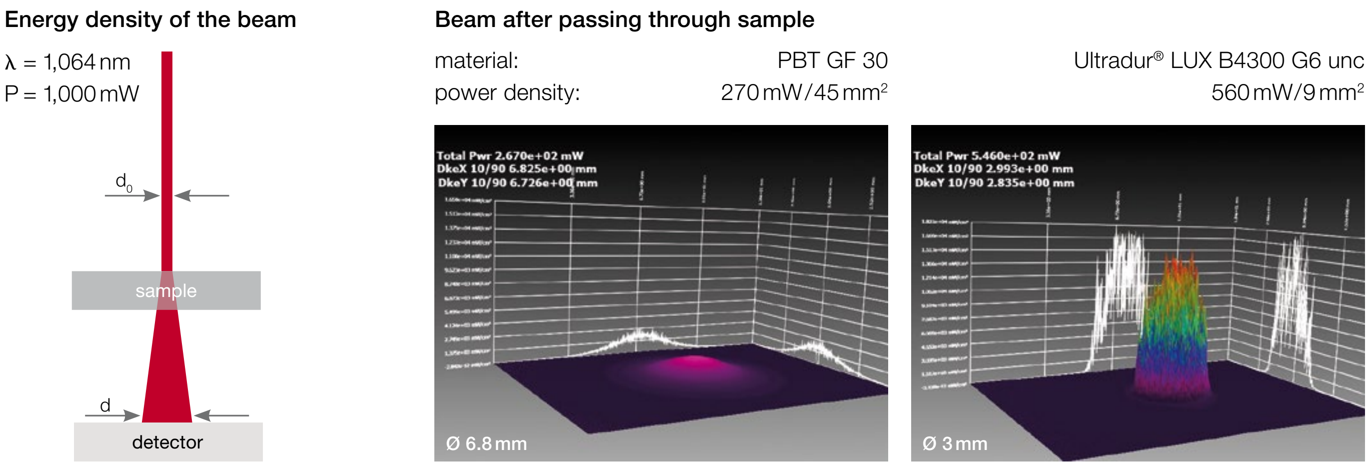


Fig. 3: Widening of the laser beam (1,064 nm) after passing through a plate of 2 mm thickness: conventional PBT GF 30 (left) and Ultradur® LUX GF 30 (right) in comparison.

From physics, we know that the deflection of light beams is particularly low if the scattering centers are smaller than the wavelength of the light. With the Nd:YAG or the diode laser, the most common laser types, these are approximately 1,000 nanometers (i. e. one micrometer). Therefore, the solution to this problem is to limit the spatial growth of the spherulites to a maximum size of one micrometer (Fig. 4).

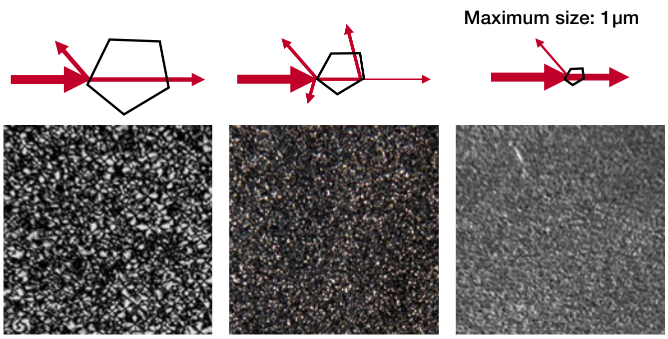
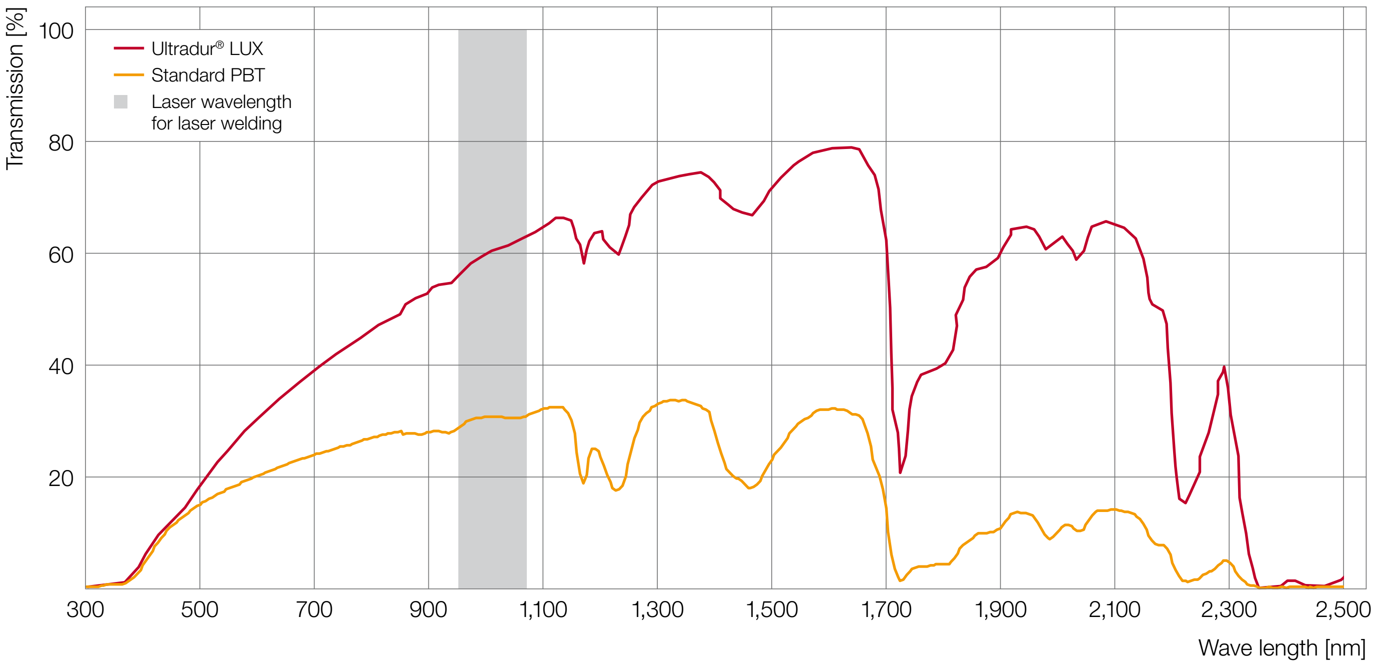


Fig. 4: Small scattering centers cause low deflection of the light beams.

Optical properties never achieved before

The improved optical properties of PBT are clear from the transmission curves. At the wavelengths of welding lasers, Ultradur® LUX lets through about twice the amount of light as standard PBT (Fig. 5).

But not only is the laser transparency itself better – the quality of the transmitted laser beam has also been considerably increased. Scattering experiments using what is known as an Ulbricht sphere showed that conventional unreinforced PBT in the wavelength range relevant for laser welding allows virtually no light through directly – all the beams passing through are scattered to a greater or lesser extent. For Ultradur® LUX, however, a direct transmission of about 50 percent at the relevant laser wavelengths is possible and consequently a considerably lower widening of the laser beam (Fig. 5 bottom).



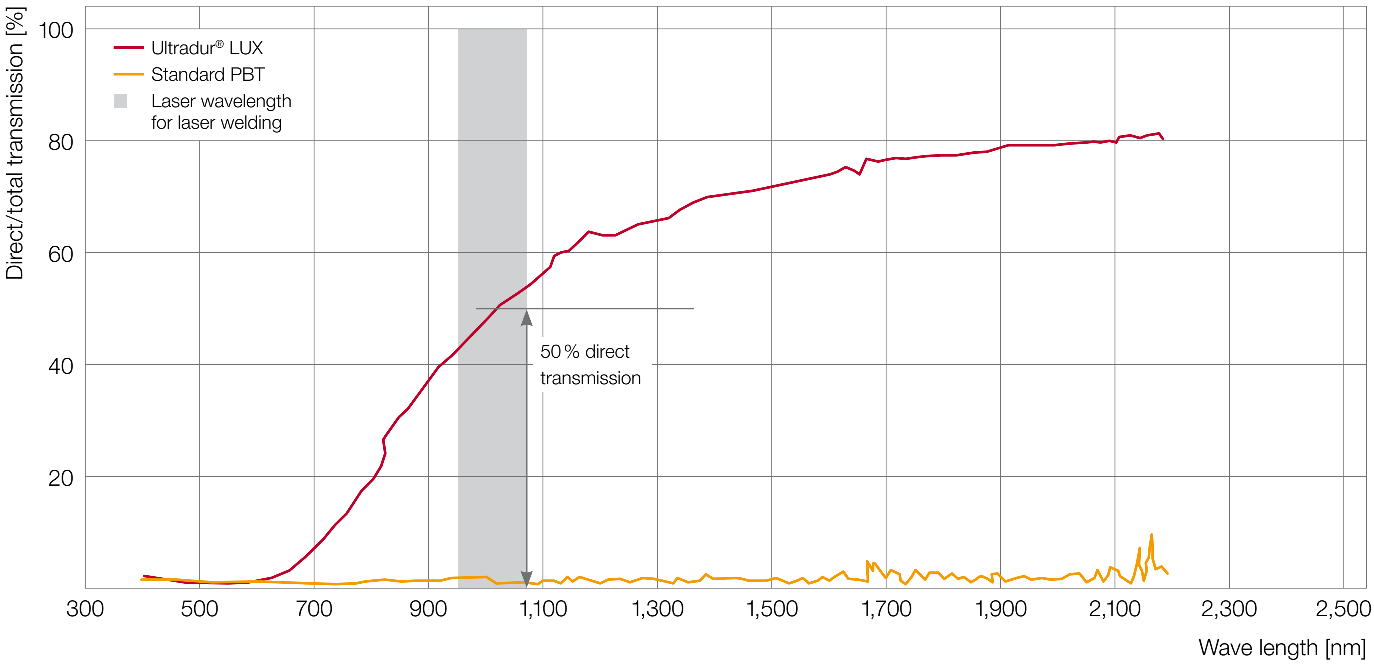
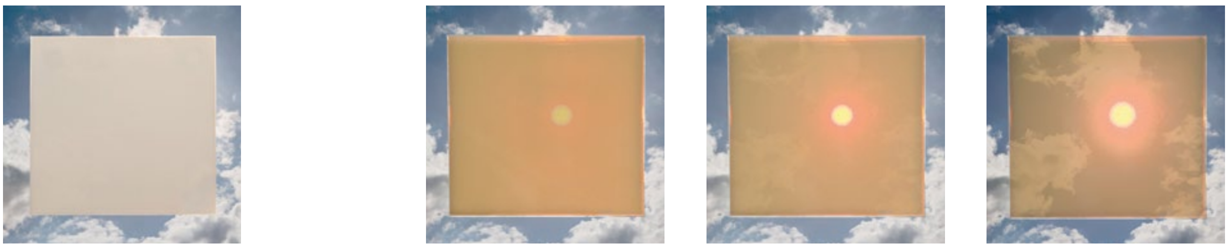


Fig. 5 top: Spectrally resolved transmission (total transmission) of Ultradur® LUX
Fig. 5 bottom: Portion of direct (not scattered) transmission of total transmission

The practical significance of these theoretical values is clear when looking at sample plaques held up to the sun: This shows the high light transmission of Ultradur® LUX. If we consider that the transparency of the new material for laser light is much higher than for daylight (380 to 780 nanometers), the major advance in quality of the new plastic is evident (Fig. 6).

Standard PBT	Ultradur® LUX		



Plaque thickness 0.5 mm	Plaque thickness 3.0 mm	Plaque thickness 2.0 mm	Plaque thickness 1.0 mm

Fig. 6: Transmission of sunlight: comparison of sample plaques of varying thickness made of standard PBT and Ultradur® LUX.

Air flap control unit

Laser welding – a clean joining method

Laser transmission welding, or laser welding, is a joining method with several advantages and offers an economic alternative to conventional connecting methods such as screwing or adhesion. The principle of laser welding: laser beams pass through a laser-transparent part to be joined and melt the underlying half of the component that absorbs laser beams. The melted plastic transfers the heat to the laser-transparent material, thus ultimately creating a weldline. Therefore, the basic premise for laser welding is the pairing of a laser-transparent and a laser-absorbing material (Fig. 7).

Vibration-free joining is particularly important, if sensitive components are integrated into one of the two joining partners. Therefore, the advantages of laser welding are important primarily for small parts in which flexible geometric design and clean operations are needed. This is particularly necessary for electronic and medical applications such as housings for automotive control units or assemblies with sensors.

Laser welding has the following advantages over other joining methods:

- no storage of other materials, e. g. adhesive and primer
- no particle abrasion (such as with friction and ultrasound welding)
- no mechanical loading of the molded parts
- lower, locally restricted input of heat
- virtually wear-free behavior
- materials with different viscosities can be welded
- repair welding possible
- no vibration due to the welding process

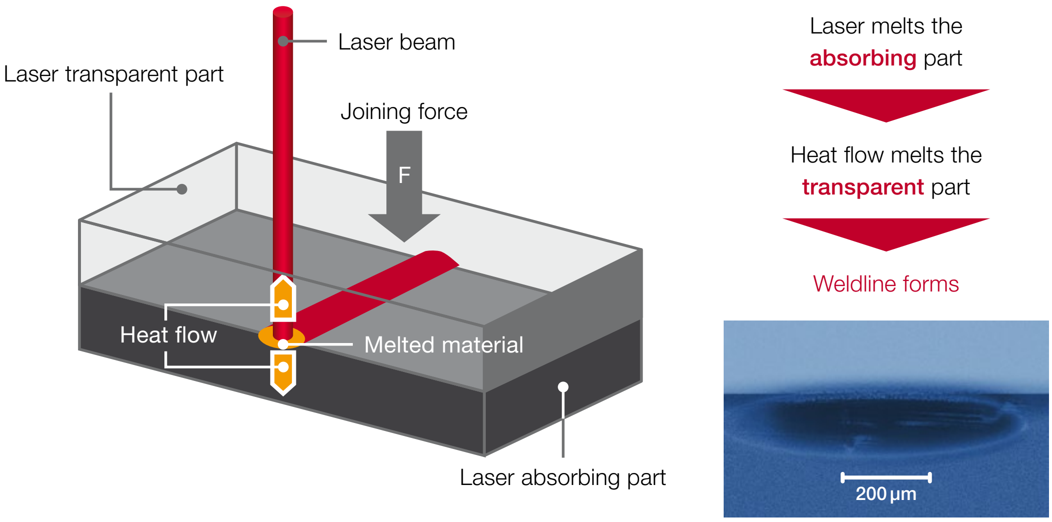


Fig. 7: The principle of laser welding

Selected Product Literature for Ultradur®:

- Ultradur® – Product Brochure
- Ultradur® – Product Range
- Ultradur® HR – An Extremely Resistant PBT for Hot-damp Environments
- Ultramid®, Ultradur® and Ultraform® – Resistance to Chemicals
- Engineering Plastics for the E/E Industry – Products, Applications, Typical Values
- Engineering Plastics for the E/E Industry – Standards and Ratings
- Engineering Plastics for Automotive Electrics – Products, Applications, Typical Values

Note

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Fax: +49 621 60-49497

If you have technical questions on the products, please contact the Ultra-Infopoint:

Ultra Infopoint
+49 621 60-78780
ultraplaste.infopoint@basf.com

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