Ultramid® Structure LFX

LGF plastics for metal fans

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Ultramid® Structure LFX

High-performance polyamides with long-glass fiber reinforcement

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BASF offers long-glass fiber reinforced polyamides under the trade name Ultramid® Structure. As part of the Ultramid® range, this product group with its specific range of properties opens up new possibilities when it comes to metal replacement.

The Ultramid® Structure grades form a 3D fiber network in the part, which is a substantial feature making it different from the short-glass fiber reinforced polyamides.
This makes it possible to produce plastic parts which, as well as displaying very high stiffness, also have an extremely high level of toughness (Fig. 1) and which previously had to be produced from metal.

All in all, the Ultramid® Structure grades are noted for having a particular range of properties compared to short-glass fiber reinforced plastics:

- Very good mechanical properties particularly at higher temperatures
- Significantly improved notched impact strength at room temperature and -30 °C
- Very low creep tendency
- Reduced shrinkage and warpage
- Enhanced fatigue strength
- Improved surface quality
- High energy absorption under rapid application of force (crash performance)
- Lower level of wear during processing and in the part (e.g. gear wheels)
- More isotropic material behavior

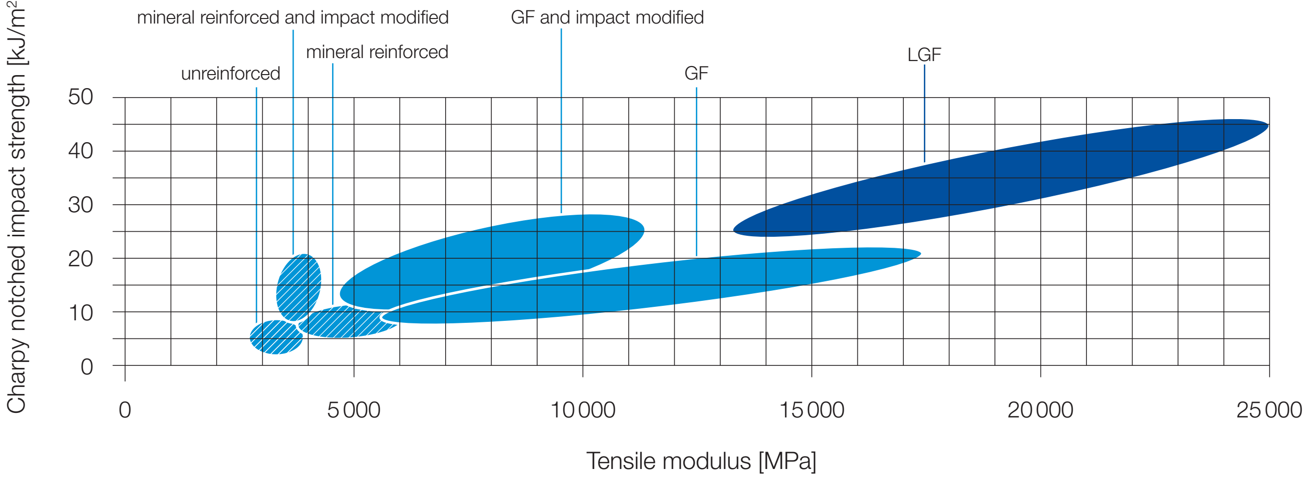


Fig. 1: Long-glass fiber reinforced polyamides offer a benefit in the stiffness/toughness ratio

Other typical properties of Ultramid® such as good chemical resistance, weathering resistance and UV resistance as well as simple processing are retained along with physiological safety.

Thanks to their range of properties (Fig. 2), Ultramid® Structure grades allow the manufacture of innovative parts to replace metal in demanding applications and more modern lightweight construction thanks to optimized part design with thinner walls.

This makes them particularly suitable for applications in mechanical and automotive engineering, in construction, in power tools and household appliances, as well as in the leisure and sports sector, for example in:

- structural components demanding especially high levels of stiffness and toughness, in particular at elevated or low temperatures
- components that need to be durable
- fixing parts used outdoors
- energy absorption structures

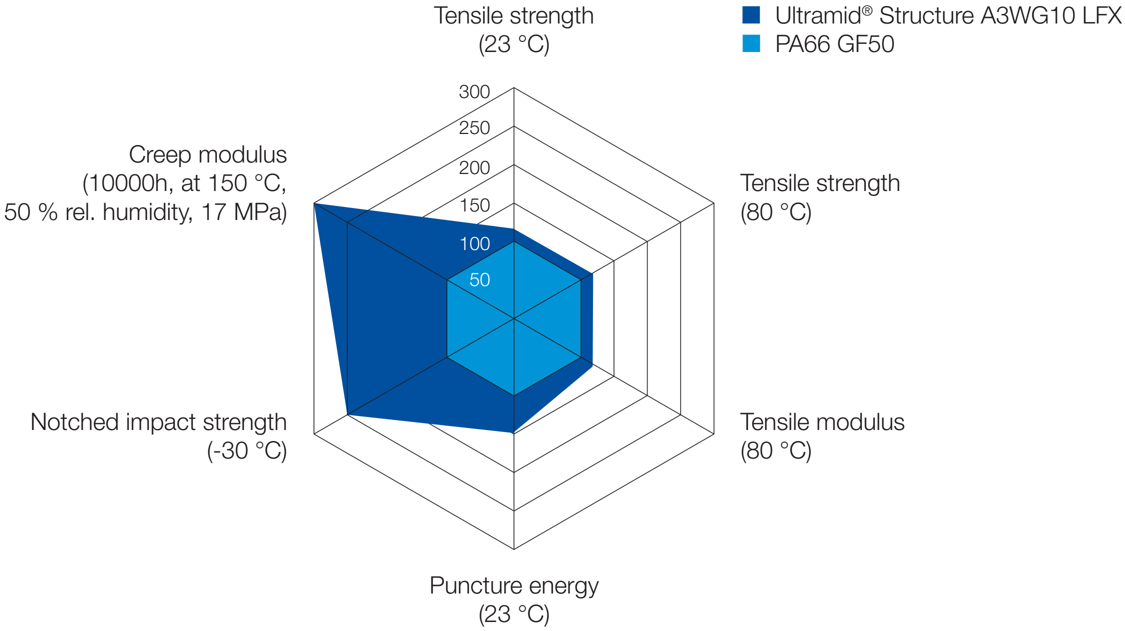


Fig. 2: The property range of Ultramid® Structure compared to a standard short-glass fiber reinforced polyamide (glass fiber content of 50 %).

Range

The Ultramid® Structure grades are based on various polyamide matrix materials which are supplied with different additives and degrees of fiber reinforcement. The Ultramid® Structure A (PA 66) and Ultramid® Structure B (PA 6) grades are noted for having particularly high mechanical strength, stiffness, resistance to heat distortion and resistance to hot lubricants and hot water.

Parts which are manufactured from them are dimensionally stable and have high creep rupture strength.
The Ultramid® Structure D compounds are special polyamides which display high levels of mechanical strength and stiffness both in the dry and in the conditioned state.

Ultramid® Structure is offered with the designation LFX (long-glass fiber reinforced).

For even more demanding application conditons BASF is in the unique position to offer the Ultramid® Advanced portfolio based on polyphthalamide (PPA) polymers with long fiber reinforcement to enable customers to develop new parts for future applications:

Ultramid® Advanced T1000:
compounds with the highest strength and stiffness of all Ultramid(R) grades and stable mechanical properties up to ~120 °C (dry) and 80 °C (cond.) as well as high chemical resistance.

Ultramid® Advanced T2000:
excellent flow, high heat distortion temperature and good E&E performance.

Ultramid® Advanced N:
lowest water uptake, highest glass transition temperature (cond.) and excellent chemical and hydrolysis resistance.

Ultramid® Structure A	**Ultramid® Advanced T1000 LFX**
▪ PA66 with 40-60% LGF ▪ Particularly high stiffness and energy absorption	▪ PA6T/6I with 50% LGF ▪ High stiffness and strength up to 120°C ▪ High chemical resistance and low water uptake
Ultramid® Structure B	**Ultramid® Advanced T2000 LFX**
▪ PA6 with 40-60% LGF ▪ High stiffness, high impact strength and good surface quality	▪ PA6T/66 with 50% LGF ▪ High HDT and good E&E performance ▪ High flowability and dimensional stability
Ultramid® Structure D	**Ultramid® Advanced N LFX**
▪ Special polymers with 40-60% LGF ▪ Very high stiffness, dimensional stability and particular good surface quality	▪ PA9T with 50% LGF ▪ High glass transition temperature, high toughness and low water uptake ▪ High chemical and hydrolysis resistance ▪ No blistering in reflow soldering

Table 1: Brief description of the Ultramid® Structure LFX and Ultramid® Advanced LFX product range

Manufacture

Ultramid® Structure grades are manufactured in a special pultrusion process. This involves continuous glass fiber rovings being fanned out and then in the impregnation unit, the heart of the process, wetted with a polyamide melt that has already been provided with all additives. The special design of the impregnation unit makes it possible for the glass strands to be encapsulated not as a compact bundle, but rather each filament individually (Fig. 3).

As the process continues, the wetted glass fiber rovings are shaped into circular polyamide strands and ultimately granulated in a final step. The pultrusion process results in pellets whose glass fibers have exactly the same length as the granules.

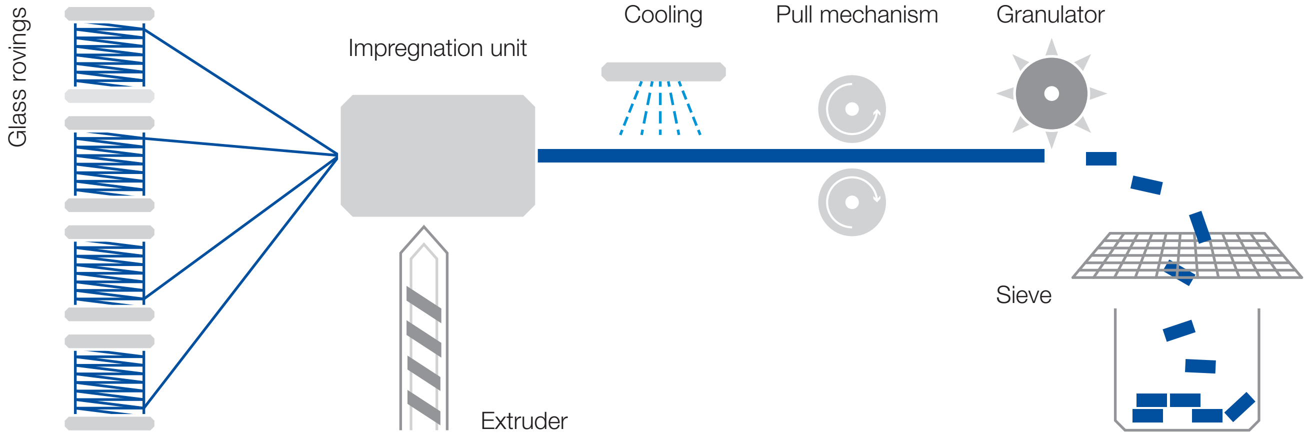


Fig. 3: Schematic illustration of the pultrusion process for manufacturing Ultramid® Structure.

Fiber network of long fibers

As with comparable short-glass fiber reinforced polyamides, the injection-molding of Ultramid® Structure produces a three-layer structure of the individual fiber levels in the mold cavity. A border layer with higher orientation and a core layer oriented vertically with respect to it forms in the flow direction. But in contrast to short-glass fiber reinforced polyamides, with the Ultramid® Structure grades a much more isotropic component is formed as a result of the long fibers and the resulting change in fiber orientation in the solid material.

Another important difference compared to short-glass fiber reinforced polyamides is that during the injection-molding process the long-glass fibers in Ultramid® Structure form a three-dimensional fiber network in the part. This forms the fiber skeleton and is retained even after ashing of the plastic (Fig. 4). This basic framework allows induced stresses to be transmitted directly from fiber to fiber. This significantly reduces changes to properties depending on the temperature and level of moisture. Furthermore, the creep behavior and energy absorption of Ultramid® Structure closely match those of metals without losing the traditional advantages of a plastic.

Compared to corresponding short fiber granules, the three-dimensional long-glass fiber structure of Ultramid® Structure provides a part with better properties at the same temperature or identical properties at a temperature which is roughly 20 °C higher.

Fig. 4: Gear wheel made of Ultramid® Structure D3EG10 LFX before and after ashing.

Mechanical properties

Thanks to their length and the spatial overlap in the three-dimensional fiber skeleton, the long-glass fibers create a reinforcing structure which is capable of carrying more load via the fibers. This manifests itself in the form of the material advantages described below.

Stiffness

Compared to corresponding short-glass fiber reinforced polyamides, the Ultramid® Structure grades display more linear behavior in a tensile test and greater elastic deformability. Both materials have approximately the same values up to the glass transition temperature. However, above this temperature the Ultramid® Structure grades have tensile moduli that are 20 % - 30 % higher. This means that parts based on Ultramid® Structure are less flexible and allow higher reversible changes of shape (Fig. 5).

The Ultramid® Structure product range also comprises grades with a particularly high level of glass fiber reinforcement. For example, the Ultramid® Structure with 60 % by weight long-glass fibers shows further enhanced mechanics compared to the corresponding grade with 50 % by weight long-glass fibers (Fig. 6).

The D grades are another special feature of the Ultramid® Structure range. These grades are long-glass fiber reinforced special polyamides which have markedly higher glass transition temperatures compared to pure PA66 compounds such as Ultramid® Structure A3WG10 LFX. For example, Ultramid® Structure D3EG10 LFX has the special feature that it has almost identical mechanical properties in the dry and conditioned state at room temperature. The D grades are outstandingly suitable in particular as a replacement for metal in demanding applications where they are subject to constant use at temperatures up to 60 °C (Fig. 6).

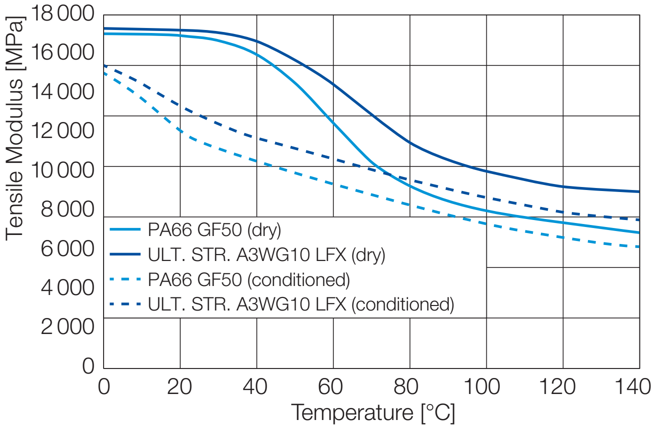


Fig. 5: Temperature-dependent profile of the tensile modulus in the dry and conditioned state of Ultramid® Structure A3WG10 LFX compared to a standard polyamide with short-glass fiber reinforcement (glass fiber content of 50 %).

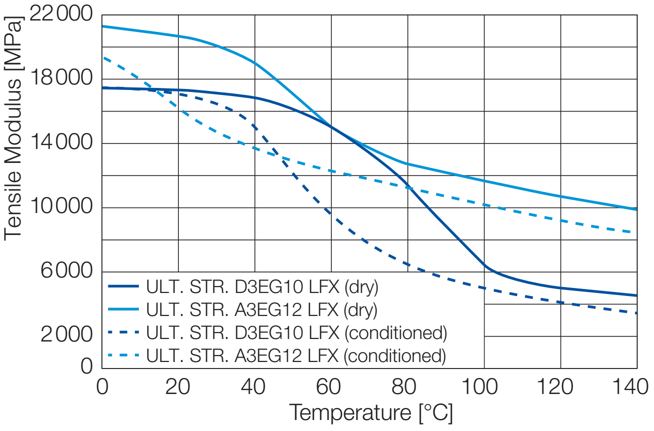


Fig. 6: Temperature-dependent profile of the tensile moduli of Ultramid® Structure A3EG12 LFX uncolored and Ultramid® Structure D3EG10 LFX in the dry and conditioned state.

Strength

In contrast to stiffness, a different behavior can be observed with the temperature-dependent decline in strength. In the case of the Ultramid® Structure grades, this displays the same curve shape as it does for the corresponding short-glass fiber reinforced materials both in the dry and conditioned state. Nevertheless, here too the influence of the long-glass fibers is clearly apparent with the Ultramid® Structure grades: all of the values on the curve have shifted upwards by roughly 20 % (Fig. 7).

The mechanical properties of Ultramid® Structure therefore allow new degrees of freedom when it comes to the design of parts. The higher levels of stiffness and strength mean that it is possible to manufacture new parts for replacing metals that are capable of absorbing higher loads.

Furthermore, parts for lightweight construction can be optimized because they can have thinner walls while being able to absorb the same loads.

Parts are frequently subjected to multiaxial stresses. As a result of the high anisotropy of short-glass fiber reinforced polyamides, it can occasionally be difficult to produce a balanced part design. By contrast, the Ultramid® Structure grades display more isotropic behavior (Fig. 8).

Another advantage of Ultramid® Structure is the higher secant modulus at increased strains or stresses. This means that the material displays almost linear-elastic behavior.

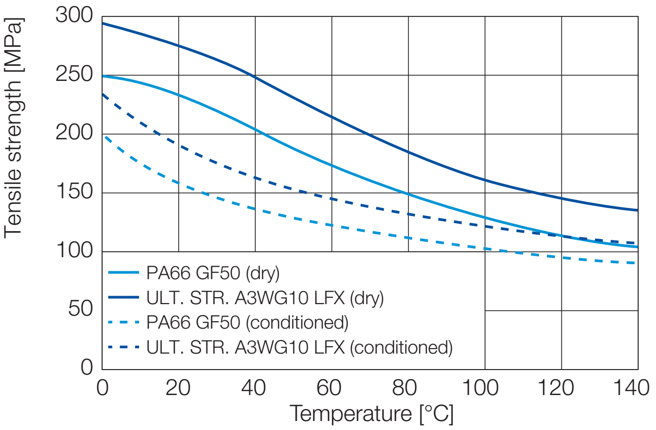


Fig. 7: Temperature-dependent profile of the tensile strengths in the dry and conditioned state of Ultramid® Structure compared to a standard polyamide with short-glass fiber reinforcement (glass fiber content of 50%).

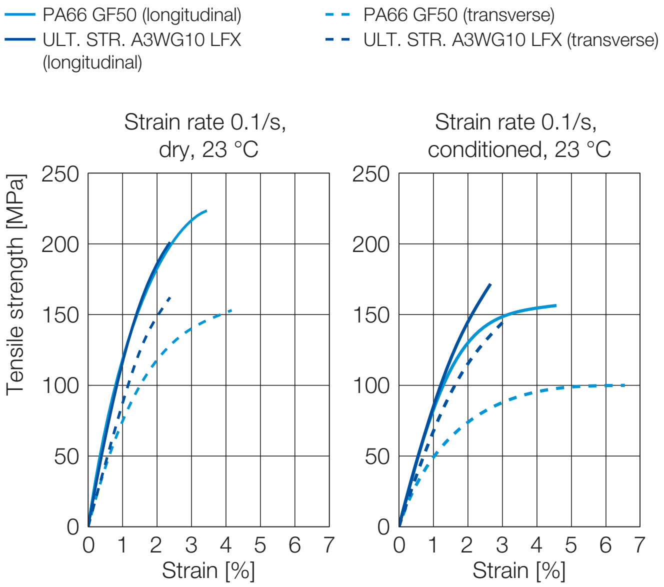


Fig. 8: Tensile strain curves longitudinally and transversely to the preferential direction of the fibers of Ultramid® Structure compared to a standard polyamide with short-glass fiber reinforcement (dry and conditioned).

Impact strength and energy absorption

With Ultramid® Structure the formation of the three-dimensional glass fiber network means that the onward transmission of an induced crack is made so difficult that a part is able to absorb more energy before it fails (Fig. 9).
The long-glass fiber reinforced polyamides therefore have excellent toughness values without the reductions in stiffness which are otherwise observed in impact-modified short fiber reinforced polyamides. Furthermore, the Ultramid® Structure grades display excellent notched impact strength across a very wide temperature range. At room temperature and at -30 °C almost identical values are measured (Fig. 10), and they are therefore more than twice as high compared to short-glass fiber reinforced polyamides. Even impact-modified grades (such as PA6-I GF50) perform less well than the comparable long-glass grades. Accordingly, Ultramid® Structure shows no evidence of brittleness even at very low temperatures.

The puncture test is used to measure the energy absorption of Ultramid® Structure. In this test method, the long-glass fiber reinforced polyamides not only display significantly higher energy absorption but also more ductile fracture behavior of the test specimens compared to standard polyamides (Fig. 11). The fracture patterns reveal that the punctured fragments do not splinter but rather are just bent. This has an impact in the event of a crash as the component is still held together as one part (Fig. 12).

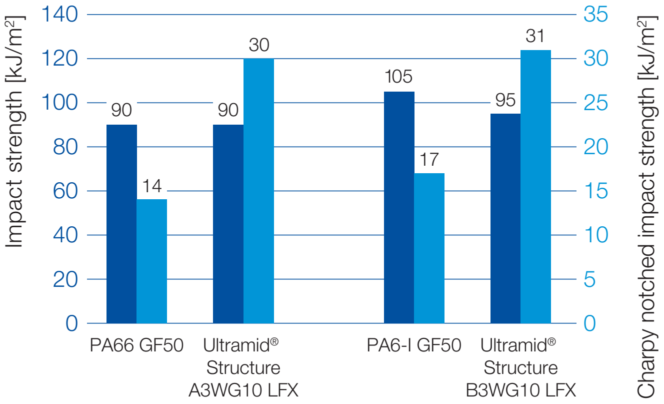


Fig. 9: Impact strength at room temperature of Ultramid® Structure compared to short-glass fiber reinforced polyamides.

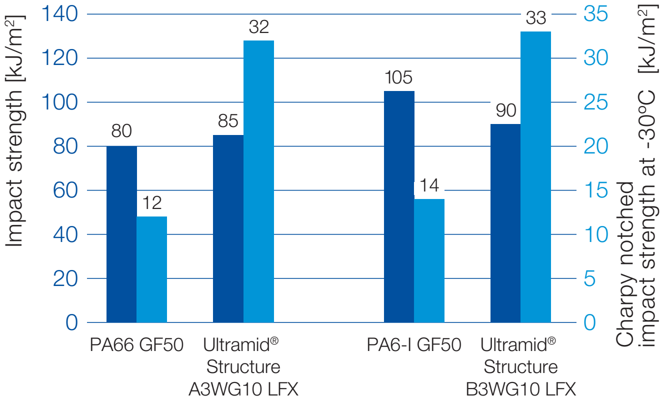


Fig. 10: Impact strength at minus 30 °C of Ultramid® Structure compared to short-glass fiber reinforced polyamides.

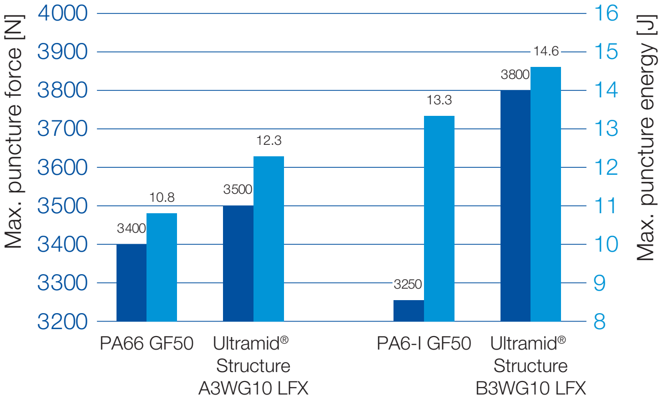


Fig. 11: Puncture force and energy at room temperature of Ultramid® Structure compared to short-glass fiber reinforced polyamides.

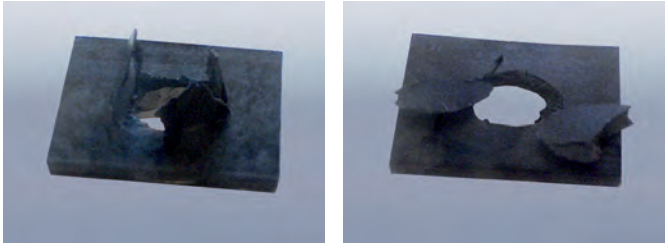


Fig. 12: More ductile fracture pattern after performing a puncture test on a panel made of Ultramid® Structure A3WG10 LFX (left, hinge break) and PA66 GF50 (right, splinter break).

Creep and fatigue behavior

The high performance of Ultramid® Structure can be seen under permanent static and dynamic loading. Parts made of Ultramid® Structure show lower creep and much slower fatigue behavior than parts made of short-glass fiber reinforced polyamide. This advantage is obvious in particular at elevated temperatures and in moist conditions.

Compared to corresponding short-glass fiber grades, the Ultramid® Structure materials display a much lower tendency to deformation caused by creep. This is down to the three-dimensional fiber network in which the individual fibers support one another. This means that much more force needs to be applied to achieve the same deformation, or a lower level of deformation results if the same level of force is applied (Fig. 13).

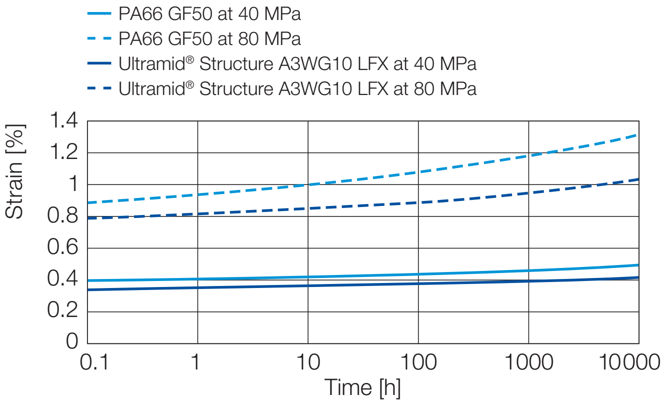


Fig. 13: Creep behavior with different levels of stress acting in the conditioned state (23 °C, 50 % RH) of Ultramid® Structure compared to short-glass fiber reinforced polyamide.

The dynamic fatigue test (Fig.14) shows that Ultramid® Structure reaches a number of load cycles that is up to 100 times higher compared to a polyamide with short-glass fiber reinforcement (changing load, R=-1, f=5 Hz, standard climate [23 °C, 50 % RH]).

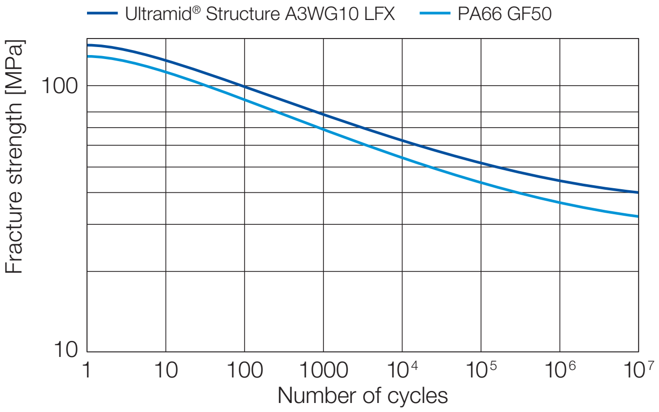


Fig. 14: Fatigue behavior in the conditioned state (23 °C, 50 % RH) of Ultramid® Structure compared to short-glass fiber reinforced polyamide.

DIMENSIONALLY STABLE UNDER HEATSTRENGTH

METAL SUBSTITUTI

HIGH NOTCHED IMPACT ST

DIRECT SCREWING LONG-GLASS FIBER REINFORCE

NEW DEGREES OF FREEDOM IN THE DESIGN OF PARTS

GOOD MECHANICAL PROPERTIE

MECHANICAL AND AUTOMOTIVE ENGINEERING

EASY PROCESSING

POWER T

REDUCED WARPAGE

HIGH ENERGY ABSORP

APPLICATION IN HIGHLY STRESSED PARTS

GOOD WELDING PROPERTIES

GARDEN TOOL HANDLE

GOOD CHEMICAL RESISTANCE

GOOD CREEP STRENGTH

ON

HUBS IN FAN PROPELLERS

HIGH STIFFNESS AND STRENGTH

TRENGTH

LEISURE AND SPORTS SECTOR

ED

LIGHTWEIGHT CONSTRUCTION

CONSTRUCTION

DESIGN OF PARTS USING ULTRASIM®

ES AT HIGH TEMPERATURE

INCREASED FATIGUE STRENGTH

TOOLS AND HOUSEHOLD APPLIANCES

SKI BINDINGS

PTION

REDUCED SHRINKAGE

COFFEE MACHINE HANDLE

PROCESSING WITH LOW WEAR

IMPROVED SURFACE QUALITY

HYDROLYSIS-RESISTANT

Shrinkage and warpage

Besides improving the mechanical properties, the three-dimensional fiber skeleton also results in reduced mold shrinkage and therefore lower warpage. As long-glass fibers are less heavily oriented in injection-molded parts than corresponding short-glass fibers, the overall result is that the parts have less pronounced direction-dependent properties. For the molding shrinkage, this means a great reduction transverse to the direction of flow whereas a slight rise can be observed along the direction of flow (Fig. 15).

In general, the shrinkage and warpage during processing are dependent on the holding pressure and the mold temperature. If the processing conditions are the same, the overall shrinkage and warpage of the Ultramid® Structure grades are always reduced considerably compared to corresponding short-glass fiber products (Fig. 16).

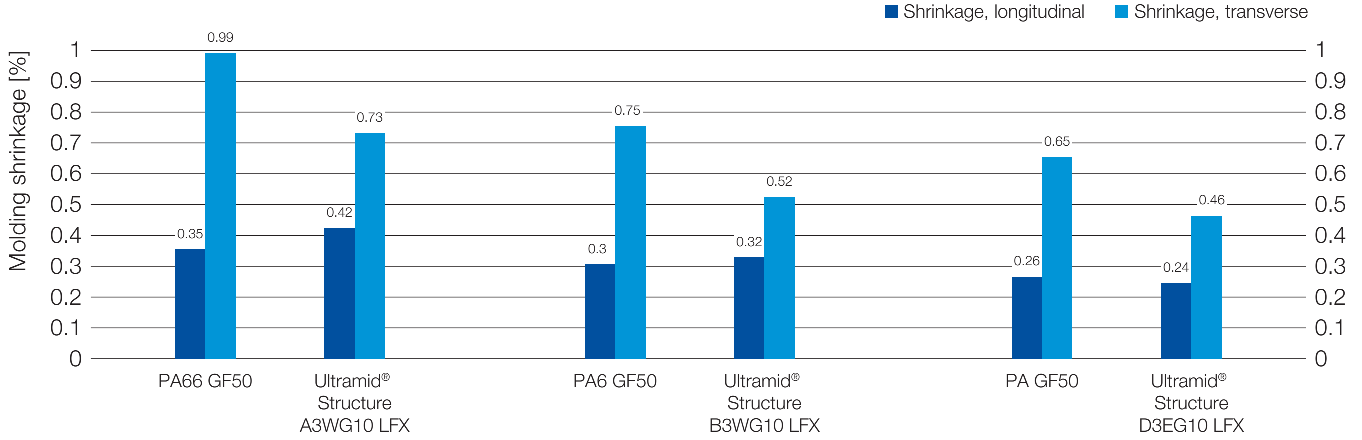


Fig. 15: Comparison of the molding shrinkage according to DIN EN ISO 294 of Ultramid® Structure grades and corresponding polyamides with 50% by weight short-glass fiber reinforcement.

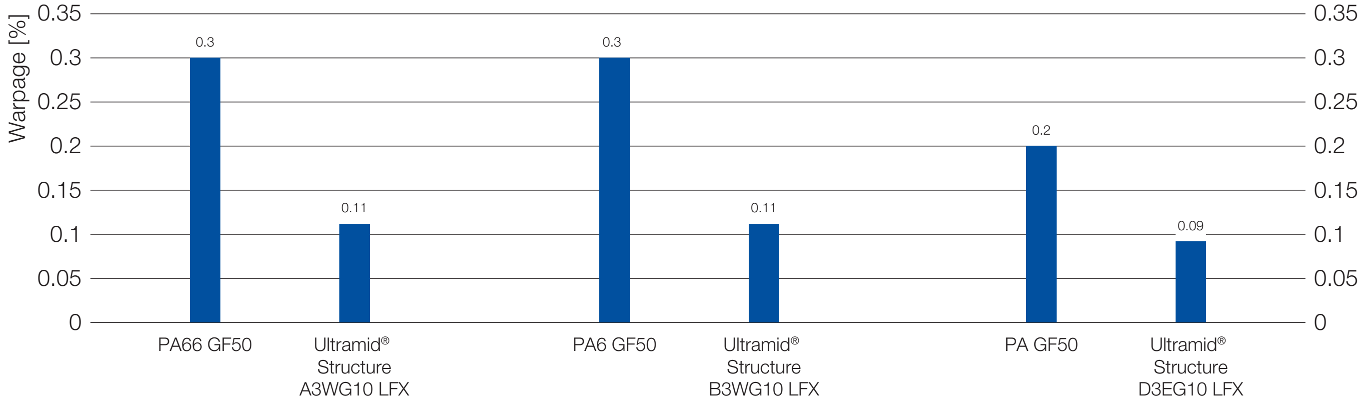


Fig. 16: Comparison of the warpage of Ultramid® Structure grades and corresponding polyamides with 50% by weight short-glass fiber reinforcement.

Long-term hydrolysis resistance

Ultramid® Structure displays good resistance to ethylene glycol, which is used primarily as an antifreeze agent. In cars, it is normally added for this purpose to the engine coolant in a mixture ratio of 50:50. On the one hand this provides protection from frost down to around -40 °C, and on the other hand the vapor pressure of the mixture is lower than that of water. The consequence of this is that, if there is a lower excess pressure, coolant temperatures of more than 100 °C are possible.

Typical test specifications in the automotive industry are simulated in laboratory tests: in these scenarios there is a flow of coolant with an excess pressure of 2 bar and temperatures of 130 °C over a period of 2,000 hours.

Polyamide swells on contact with ethylene glycol/water mixtures and after just a short period of contact (roughly 48 hours) it is softened as a result of this swelling. After this, depending very much on the temperature, the polymer chains begin to degrade.

This behavior occurs when it comes into contact with all commercially available coolants. For this purpose, BASF has already developed hydrolysis-stabilized short-glass fiber products with the designation HR (hydrolysis resistant) and HRX which have considerably increased hydrolytic stability compared to standard products under the conditions of use which are set out above.

Compared to the special HR short-glass fiber products, Ultramid® Structure A3WG10 LFX displays slightly increased hydrolytic degradation in coolant when it is stored in a Glysantin®/water mixture (50:50) at 130 °C. Starting from an initial mechanical strength which is higher compared to Ultramid® A3WG7 HRX, the LFX material is only slightly below the HRX final strength after being stored for 2,000 hours. In contrast to Ultramid® A3WG7 HRX, the LFX grades display almost the same elongations at break in the swollen state as they do in the dry state (Fig. 17).

The Ultramid® Structure A grades are therefore suitable for use in contact with coolants.

For even higher demands on hydrolysis resistance both Ultramid® Advanced N and T1000 compounds are suitable.

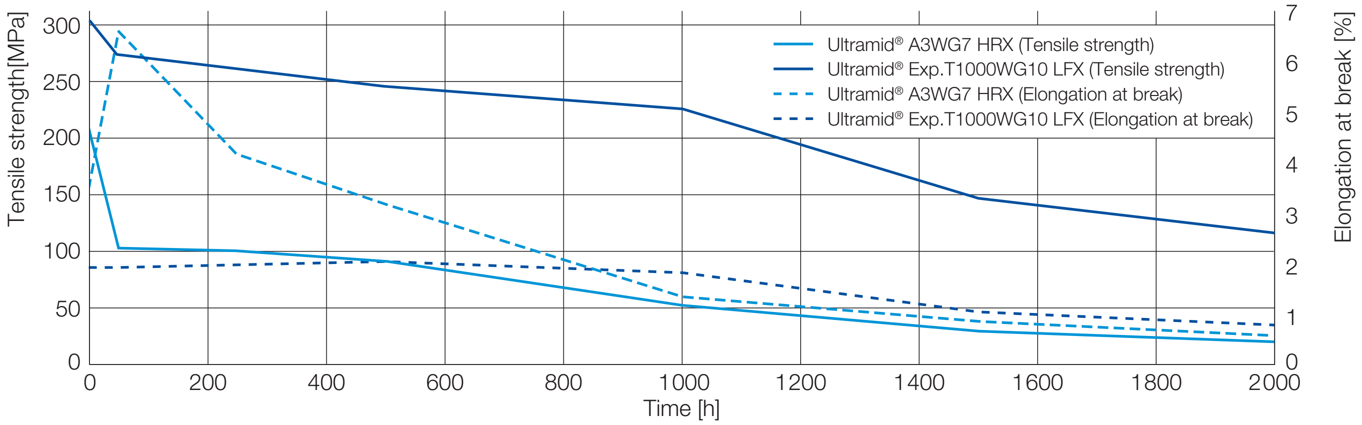


Fig. 17: Comparison of the hydrolysis resistance of Ultramid® Structure Exp. T1000WG10 LFX with the hydrolysis-stabilized short-glass fiber grade Ultramid® A3WG7 HRX against coolant when stored in a Glysantin®/water mixture (50:50) at 135 °C.

Surface quality

Thanks to their special glass fiber reinforcement, the Ultramid® Structure grades have much better surfaces compared to corresponding short-glass fiber reinforced polyamides. The longer glass fibers mean that in these polyamides, in a direct comparison, there are fewer fiber ends on an area of the same size. This means that much more homogeneous surfaces can be achieved during the injection-molding. Measurement of the surface roughness proves this. For example, in the case of Ultramid® Structure A3WG10 LFX the roughness depth R_Z is around 10 % lower than it is with a comparable PA66 GF50. Likewise with the Ultramid® Structure grades the average surface roughness R_a is lower compared to corresponding short-glass fiber reinforced polyamides (Fig. 18).

The smoother surface means that the Ultramid® Structure grades display higher measured values in the gloss measurement according to DIN 67530. The improved gloss compared to corresponding short-glass fiber reinforced polyamides is evident both at an angle of 20° and at an angle of 60° (Fig. 19).

For parts that need to have a particularly high surface quality, the use of the Ultramid® Structure B grades such as Ultramid® Structure B3WG10 LFX is recommended (see Fig. 19 and 20).

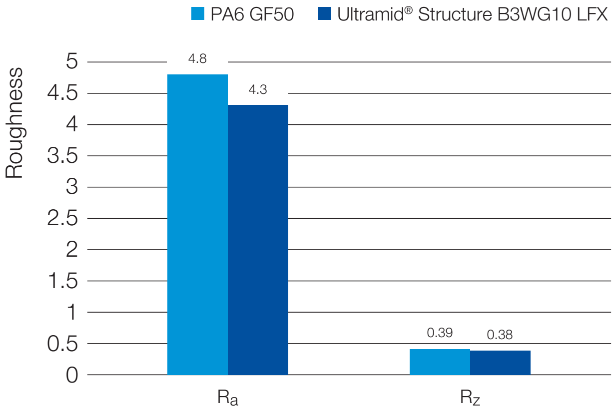


Fig. 18: Comparison of the surface roughness of Ultramid® Structure grades and corresponding polyamides with 50% by weight short-glass fiber reinforcement.

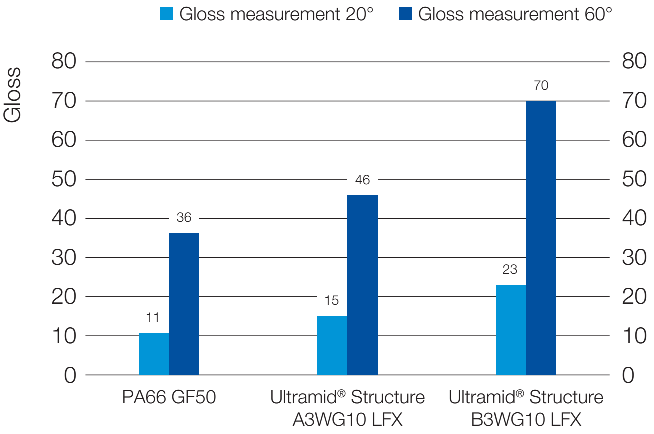


Fig. 19: Gloss values of Ultramid® Structure grades compared to short-glass fiber reinforced PA 66 GF50.

Fig. 20: A vacuum cleaner lid made from Ultramid® Structure B3WG10 LFX has a particularly high surface quality.

Burning behavior

Ultramid® Structure A, B and D begins to slowly degrade above a temperature of 310 °C. In the temperature range of from 450 °C to 500 °C, flammable gases are formed and they continue to burn after they have been ignited. These processes are influenced by many factors so that, as is the case for all flammable solid materials, it is not possible to specify a defined flash point. The use of flame retardants is intended to prevent fires from starting (ignition) or, in the event of a fire, minimize its spread (self-extinguishing). The decomposition products produced during carbonization and combustion are essentially carbon dioxide and water, depending on the amount of oxygen available small amounts of carbon
monoxide and, in addition to nitrogen, nitrogens compounds to a low degree. According to toxicological investigations, the decomposition products produced in the temperature range up to 400 °C are less toxic than those of wood; at higher temperatures the toxicity is comparable.

Ultramid® Structure grades are generally classified as HB for their fire behavior according to UL94. If this fire behavior also needs to be guaranteed at higher temperatures over a long period of time, Ultramid® Structure A3WG10 LFX and Ultramid® Structure B3WG10 LFX are recommended. Both products have a relative temperature index electrical (RTI Elec.) of 125 °C, documented on the respective UL Yellow Card.

Ultramid® Structure grades with special features are available for applications that are subject to special fire safety requirements.

Ultramid® Structure	**Fire behavior according to UL94**	**RTI Elec.**
A3WG10 LFX SW23215	HB	125 °C
B3WG10 LFX SW23215	HB	125 °C

Table 2: Fire behavior of the Ultramid® Structure grades

Welding

Ultramid® Structure is easy to process using injection-molding. In the subsequent welding step, an established process for fabricating complex parts, the process adopted dictates the performance capacity of the serial parts and is therefore to be regarded as a key technology.

Ultramid® Structure offers a persuasive choice thanks to its very high level of weld line strengths. The results achieved in vibration welding are shown here by way of example.

In a direct comparison with a polyamide having the same short-glass fiber content, with Ultramid® Structure it is possible to achieve an increase in the weld line strength of more than 10 %. By selecting the appropriate welding parameters, long-glass fibers can transfer their reinforcing effect to the weld line and thus significantly enhance the strength of the part.

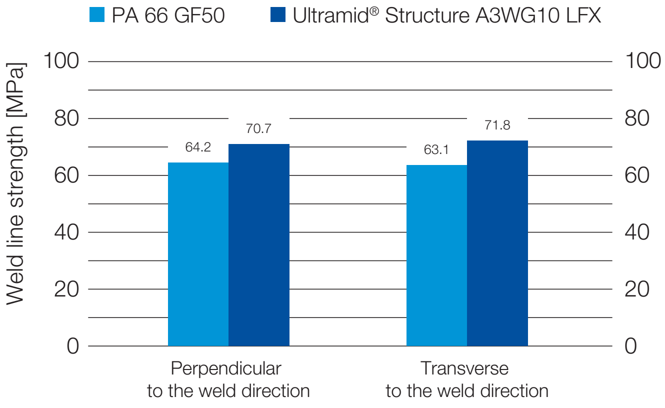


Fig. 22: Weld line strength of Ultramid® Structure compared to a standard polyamide with 50 % short-glass fiber reinforcement

Application of force and direct screwing

The force application defines how the performance capacity of a part is exploited. Properties of fiber-reinforced injection-molded parts are determined essentially by the orientation of the fibers in the part. This can be configured through clever design and skilful positioning of the runner system to cater for the loads.

When it comes to applying forces into the part, it is vital that the properties of the plastic part are utilized in an optimum way. In order to ensure that corresponding tightening torques are transmitted constantly over the lifespan of the part, metal inserts should generally be integrated at the positioning points.

However, one disadvantage of the metal inserts is the associated increased level of design outlay for the corresponding part. In addition, the integration of metal inserts represents an additional operation that takes up more time and results in higher costs. One alternative is direct screwing with thread-forming metal screws, but this places high demands on the materials which are to be used.

Ultramid® Structure is outstandingly suited to direct screwing due to its excellent mechanical properties, in particular the very low tendency to creep. The material therefore enables manufacturing costs to be reduced in comparison to a suitable part made from short-glass fiber reinforced polyamide.

A CT scanning of screw threads shows that the long fiber reinforcement forms a very compact surface on the thread, which results in this benefit:

When it comes to direct screwing, the time curve of the pretensioning force is an essential criterion. In this respect, Ultramid® Structure displays markedly better performance compared to corresponding short-glass fiber reinforced polyamides (Fig. 23).

Starting from the same pretensioning force, with Ultramid® Structure it falls to a much lesser extent. After the pretensioning force relaxes briefly at the start of the screw connection, the level of force then remains at a constantly high level. This behavior is evident even at room temperature; the difference in relation to the comparative grade at 80 °C is still marked.

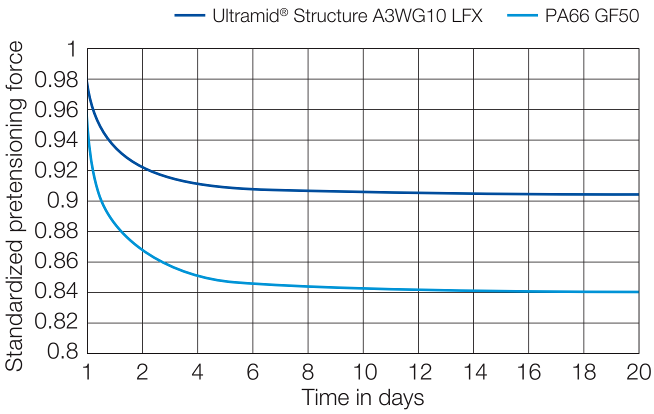


Fig. 23: Drop in the pretensioning force with direct screwing of Ultramid® Structure compared to a standard polyamide with 50% short-glass fiber reinforcement (at 80 °C and 50 % RH)

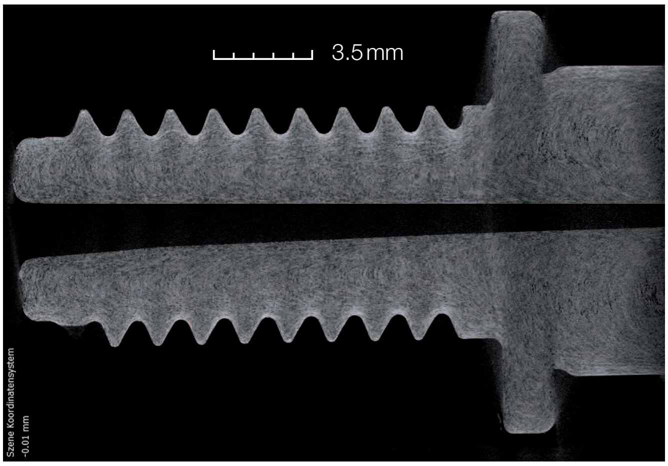
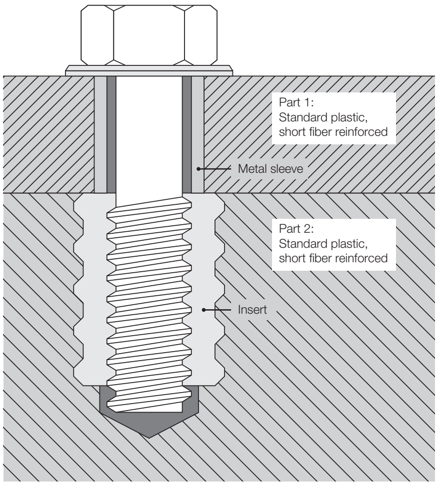
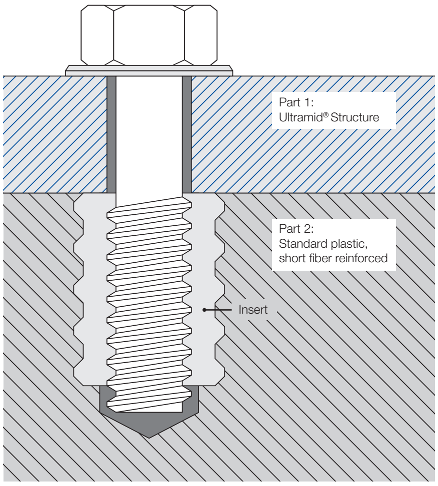
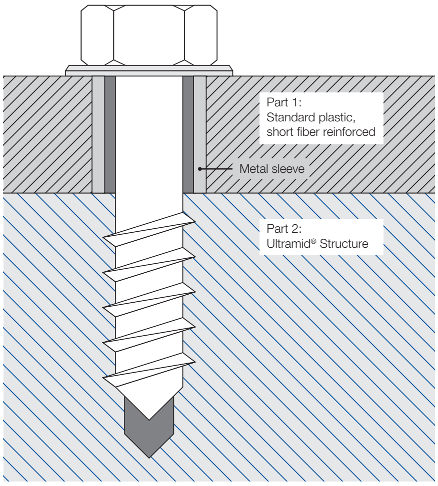


Fig. 24: CT scan of screw threads: The long glass fibers fill up the fine structure of the thread completely. They are also pressed on the surface of the thread and build up a compact layer. This leads to an extremely hard surface of the thread.







When metal inserts are used to create a screw connection, the plastic in the area of the screw head is only subject to a low level of tension as the screw rests substantially on the sleeve. Ultramid® Structure offers the possibility of dispensing with inserts entirely. The force can be introduced through the plastic directly and transmitted at a constantly high level.

To design a connection such as this, it is recommended that the present material parameters of the creep curves are taken into account and the maximum permitted tension is followed.

Processing

The processing of Ultramid® Structure is comparable to that of corresponding short-glass fiber reinforced polyamides. Conventional injection-molding machines can be used and only a few additional stipulations also need to be followed when it comes to the design of the mold. The processing also involves a low level of wear.

Plasticizing unit

Ultramid® Structure can be processed on conventional thermoplastic injection-molding machines which are fitted with a standard three-section screw and are suitable for processing glass-fiber reinforced polyamides.

Practical experience shows that, due to the optimized formulation and shape of the pellets, it is possible to work with very small screw diameters of down to 20 mm without seriously shortening the fiber length as a result of the plasticizing process. The material feeding properties and the feed behavior of Ultramid® Structure are comparable to standard compounds.

An open machine nozzle is always recommended, but processing is also easily possible with appropriate needle shut-off nozzles.

Shearing and mixing elements are not generally advisable because a strong shear may cause unwanted shortening of the glass fibers.

Parameters such as the screw speed, back pressure or injection speed should be chosen to be as gentle as possible to ensure that the shear load on the fibers is reduced to the largest possible extent. In general, the Structure grades only display a very low tendency for fibers to break.

The temperature profile of the plasticizing unit can be adjusted similarly to the processing of comparable short-glass fiber reinforced polyamide 6 and 6.6 grades. However, it is recommended that the temperature level should be increased by 10 °C to 20 °C. The resulting lower melt viscosity ensures more gentle melting of the Ultramid® Structure and reduces the shear load on the long-glass fibers.

Mold design

General recommendation: when it comes to processing long-glass fiber reinforced plastics, the mold design should include the largest possible cross sections and radii. This guideline also applies to the processing of Ultramid® Structure. Practical experience has shown that the optimized formulation enables production of parts which are smaller and have more critical geometric shapes. In a series of small to minute parts, a high concentration of long-glass fibers can be found in the final product following fabrication.

The runner system and the gate are crucial for the manufacture of parts with high mechanical properties. Ultramid® Structure enables processing to take place with gate diameters of down to 1 mm. Molds which are equipped with a tunnel gate therefore do not present any problem. However, the general rule is that a large cross section is preferable.

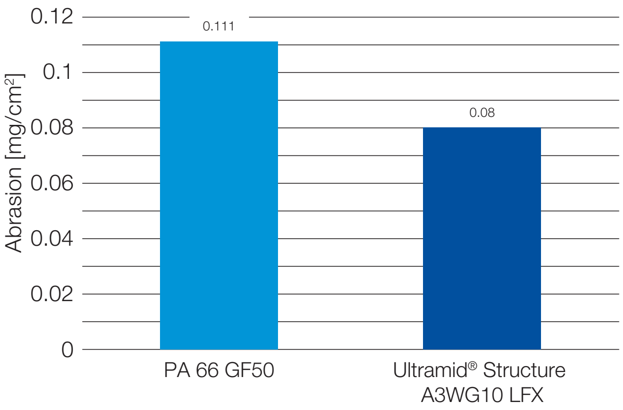


Fig. 25: Mold wear of Ultramid® Structure compared to a standard polyamide with 50% short-glass fiber reinforcement.

In the case of molds with hot-runner systems, we recommend that the guidelines and specifications of the manufacturers should be followed. Ultramid® Structure has already been processed with a range of open hot runners and systems with a needle shut-off without any notable reductions in fiber length being ascertained.

Ultramid® Structure offers the advantage of low-wear processing. With the same fiber weight content, long-glass fiber reinforced polyamides contain significantly fewer free, sharp-edged fiber ends which are responsible for causing wear. This effect can significantly extend the lifetime of the plasticizing unit and of the mold.

Design of parts using Ultrasim®

BASF‘s simulation tool Ultrasim® is used in the design of parts from all industries. Examples are found in automotive and mechanical engineering, in construction, in power tools and household appliances, and in parts for use in the sports and leisure sectors.

As well as accurately predicting the behavior of the part on the basis of manufacturing parameters, fiber anisotropy and load direction or speed, with the mathematical part optimization the best possible design under the given conditions can be determined.

With customized models, BASF has developed the calculation tool in such a way that parts which are reinforced with long-glass fibers can also be simulated.

Ultrasim® is therefore a unique tool for optimizing customer parts at a very early stage so that they are able to handle loads. The precise forecasts allow costs and time associated with prototypes or extensive corrections to molds to be avoided.

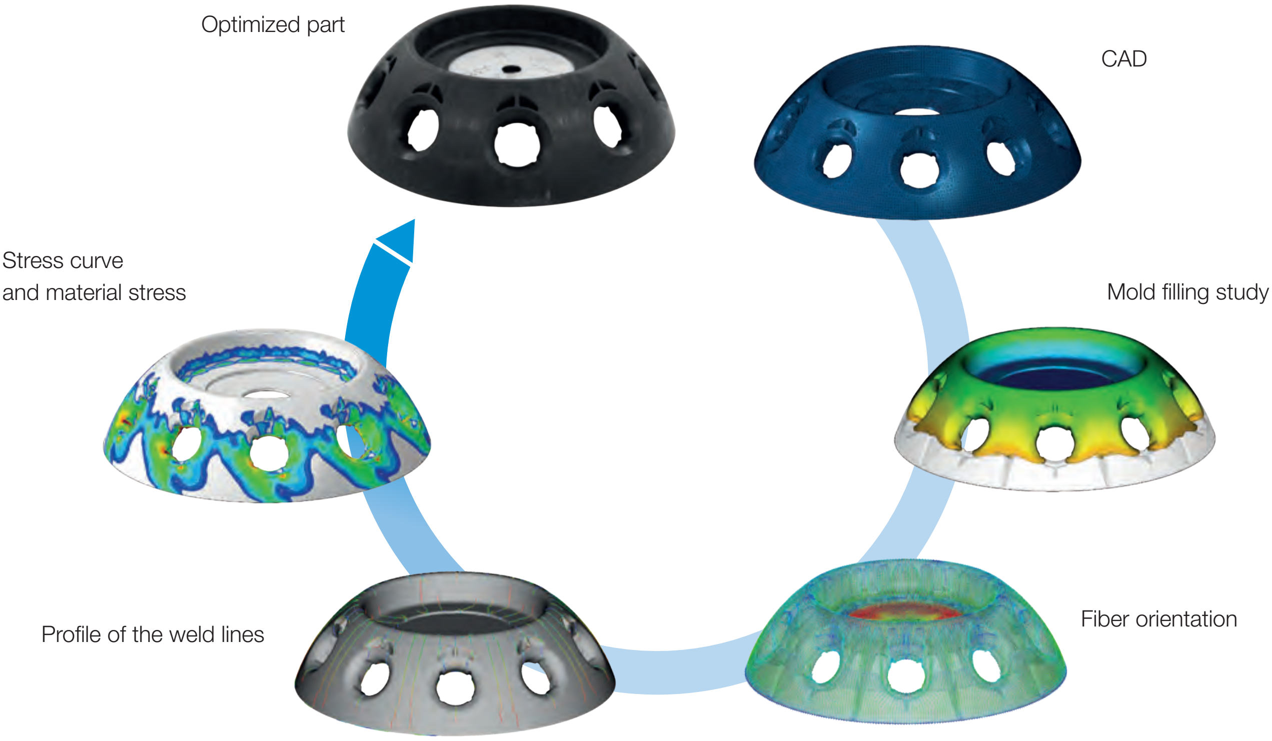


Fig. 26: Process of designing parts using Ultrasim®


LFX

Selected Product Literature for Ultramid®:

- Ultramid® - Product Brochure
- Ultramid® - Product Range
- Ultramid®, Ultradur®, Ultraform® - Resistance against Chemicals

Note

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