

Ultraform® (POM)

Product Brochure



Ultraform® in the web:
www.plasticsportal.eu/ultraform

 **BASF**
We create chemistry

Ultraform® (POM)

is the trade name for BASF's product line of thermoplastically processable copolymeric polyoxymethylenes. The Ultraform® family encompasses engineering plastics with different characteristics suitable for use in complex and highly durable components.

Ultraform® meets the requirements made of a technical material especially well. It combines high stiffness and strength with outstanding resilience, favorable sliding friction behavior and excellent dimensional stability, even under the effect of mechanical forces, in contact with numerous chemicals, fuels and other media as well as at elevated temperatures.

Ultraform® (POM)

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Ultraform® in automotive construction

Ultraform® gives designers an engineering plastic that shows many of the properties required in the automotive industry. Ultraform® offers excellent fuel and chemical resistance, low swelling, good long-term thermal stability and electrical insulation capacity.



Ultraform® has long been successfully used in numerous applications in the automotive industry, for instance,

- in the fuel system for tank caps, in components of fuel-carrying modules (flanges, fuel pumps, filter housings, swirl pots), for level gauges, in tank venting systems (roll-over valves)
- for the steering and controls of torque roll restrictors, ball cups and ball bearings, levers, linkages, sensor components
- in the interior for loudspeaker grids, clips, fastening and spring elements, pushbuttons, deflection fittings and mechanical parts in safety belts
- in doors and windows, for example, for components to raise and lower windows and for the cranks of sliding sunroofs
- in the exterior, for clips and elements for fastening add-on parts, for windshield wiper clips, windshield washer nozzles, electro-mechanical adjustment mechanisms for mirrors and headlights
- in the engine compartment for clips located away from the engine and for fastening elements
- in the electrical & electronic area for clips, fastening elements and plug-in connectors.





Mirror adjustment mechanism



Roll-over valve



Loudspeaker grills

Ultraform® for home and recreation

Ultraform® has been showing what it is made of for many years, also in the household and recreation realms. Thanks to its outstanding mechanical properties at elevated temperatures and its superior resistance to hot water, Ultraform® has stood the test in millions of espresso and coffee-making machines.

Other applications:

- parts of plumbing fixtures and inserts for showerheads
- components in watering and irrigation systems
- gas meters
- sliding and fastening parts for curtains
- functional parts in the hardware of doors and windows
- clasps, clips and fastening elements in sports and recreation
- zippers
- shock-absorbing elements in washing machines
- functional parts and inserts in dishwashers
- components in vacuum cleaners
- tablet dispensers
- functional parts in toys: springs, clamps, gear wheels, motor and gear modules, sliding elements
- functional parts in furniture joints and drawer runners



Gas meter housing



Brewing unit



Sprinkler nozzle



Toy truck



Shower head



Toilet flush



Spring clip

Ultraform® in industrial and medical applications

Owing to its extremely versatile and tailor-made properties as well as its high reliability even under demanding conditions, Ultraform® is used in numerous industrial applications.

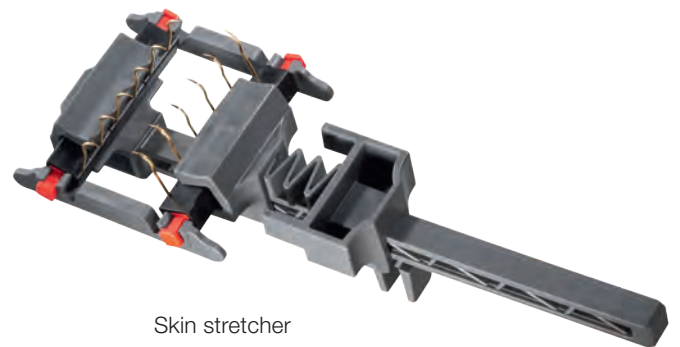
Applications for machine and plant construction as well as precision engineering: Fastening elements, ball bearings and roller bearings, gear wheels, gear parts, valves, impellers, deflection rollers, thread guides for textile machines, links and connecting elements in conveyor chains and belts.

The grade Ultraform® PRO is adapted specifically for the requirements and needs of the medical industry. The suffix PRO (**P**rofile Covered **R**aw Materials **O**nly) expresses that only very specific raw materials that are subject to strict controls are used, and points to an expanded service package for medical technology, also including formulation consistency.

Ultraform® PRO is ideal for use with functional components such as valves, springs, gears and snap-in mechanisms. Furthermore, for guiding and sliding elements which are used in various substance contributor systems, for example in insulin pens, inhalers, auto-injectors and dispensers.



Semi-finished parts



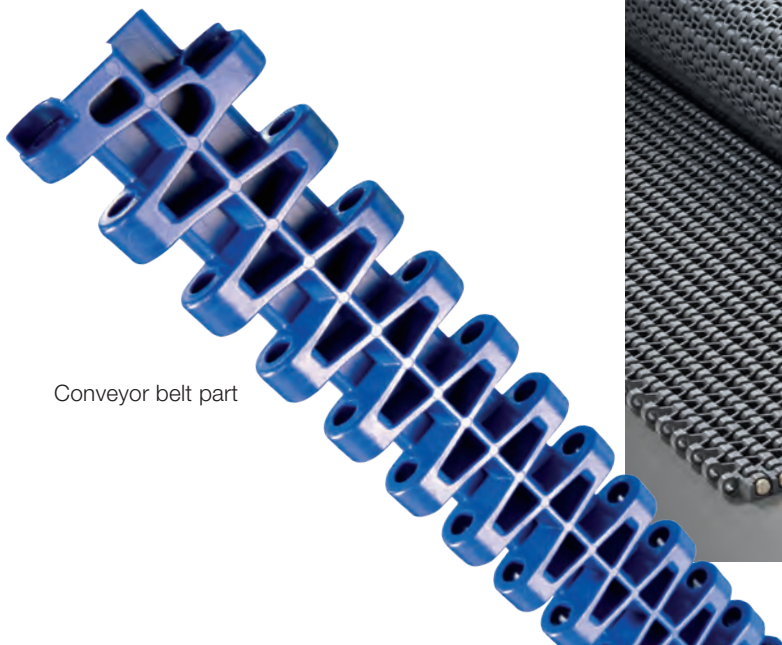
Skin stretcher



Implantation aid



Functional parts



Conveyor belt part

Conveyor belt



The properties of Ultraform®

In view of its property profile, Ultraform® belongs to the engineering plastics. It can be thermoplastically processed and has a partially crystalline structure with a high degree of crystallization. Ultraform® is produced by the copolymerization of trioxan and another monomer. It consists of linear chains in which the co-monomers are firmly incorporated in a statistically distributed manner. These co-monomer units account for the high stability of Ultraform® during processing and when exposed to long-term heat and to chemicals. It surpasses by far the resistance of homopolymeric polyoxymethylene.

Mechanical properties

The special aspect of Ultraform® is its ideal combination of strength, stiffness and toughness, all of which can be ascribed to the structure of the product. Owing to its high crystallinity, Ultraform® is stiffer and stronger than other engineering plastics, especially within the temperature range from 50°C to 120°C. Ultraform® does not undergo any transitions between the low glass-transition temperature of approximately -65°C and the melting temperature of approximately 170°C. This translates into relatively constant mechanical properties over a fairly wide temperature range that is very attractive from a technical point of view (Fig. 1).

At room temperature, Ultraform® has a pronounced yield point at about 8-12% strain. Below this limit, Ultraform® exhibits good resilience, even under repeated loading, and is therefore especially suitable for elastic elements.

In addition, it has high creep strength and a low tendency to creep (Fig. 2).

This combination of characteristics in association with good tribological properties makes it very suitable for engineering applications.

Ultraform® absorbs very little water: approx. 0.2% under normal conditions (DIN EN ISO 291) and only approx. 0.8% on complete saturation with water at 23°C. Its physical properties are so slightly affected by this that it is of little importance for practical purposes.

The mechanical properties can be widely varied by employing suitable elastomeric additives, mineral fillers and glass fibers. Elastomer-modified Ultraform® grades largely retain their POM-like properties but exhibit a substantially higher level of impact resistance and a higher energy absorption capacity. Depending on the degree of modification, the rigidity and hardness of these grades is reduced.

Mineral-filled and especially fiberglass-reinforced Ultraform® grades, in contrast, exhibit increased strength, stiffness and hardness.

Fig. 7 shows the impact strength versus rigidity for selected grades.

Behavior under long-term static loading

The tensile creep test in accordance with ISO 899-1 and the stress relaxation test in accordance with DIN 53441 provide information about extension, mechanical strength and stress relaxation behavior under sustained loading.

The results are illustrated as creep modulus plots (Fig. 2) and creep curves (Fig. 3).

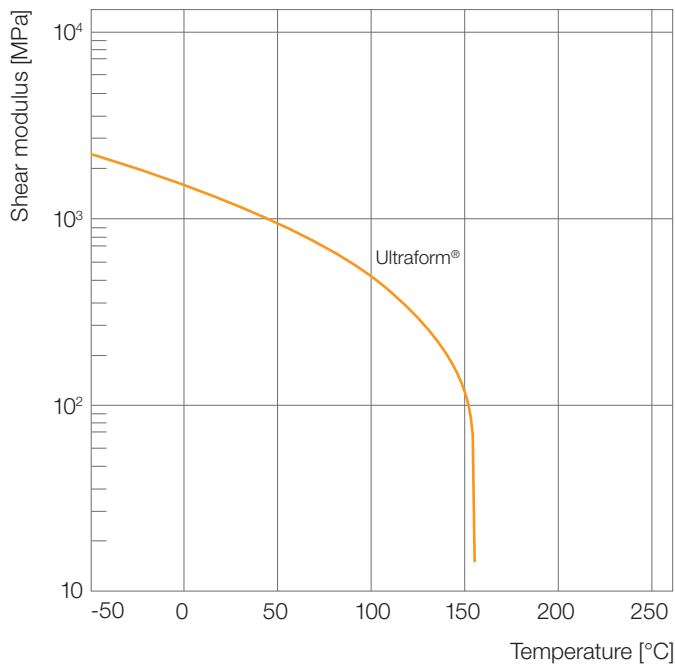


Fig. 1: Shear modulus as a function of the temperature (measured according to ISO 6721)

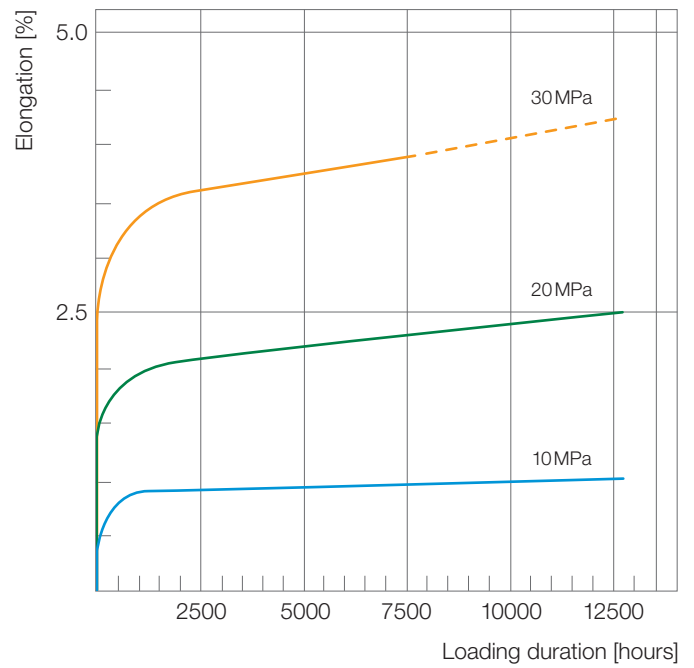


Fig. 3: Creep curves for Ultraform® N2320 003 at 23°C, measured in accordance with ISO 899-1

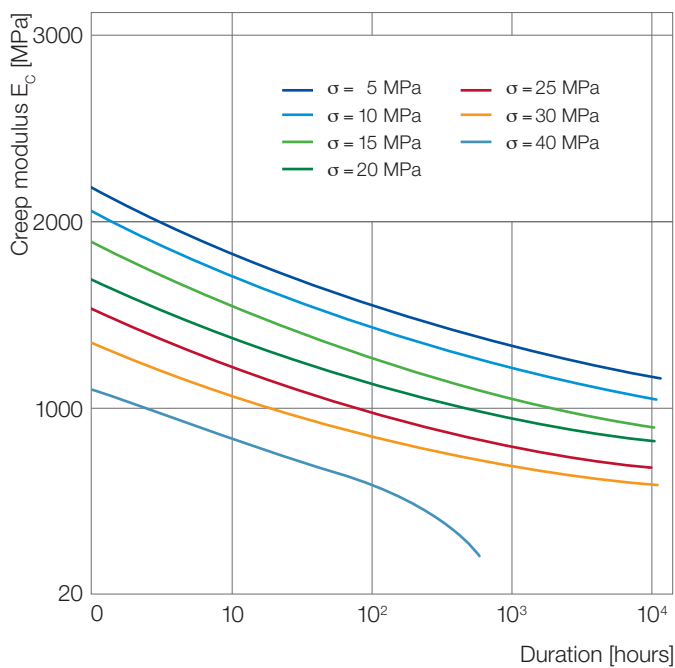


Fig. 2: Creep modulus E_c of Ultraform® N2320 003 as a function of loading duration (measured in accordance with ISO 899-1 under standard climatic conditions, 23°C/50% r.h.)

Figs. 4 and 5 show the isochronous stress-strain curves for standard and glass-fiber reinforced Ultraform®.

The graphs reproduced here are just a selection from our extensive collection of test results. Further values and diagrams for different temperature and atmospheric conditions can either be obtained from the Ultra-Infopoint or from the plastics materials database “Campus” on the internet.

Design data obtained from uniaxial tensile loading tests can also be used to assess a material's behavior under multiaxial loads.

The PC programs “Snaps”, “Screws” and “Beams” developed by BASF can be used for the analysis of construction elements such as snap and screw connections and beams subjected to flexural stresses

The creep strength values determined for pipes made from Ultraform® reflect a multiaxial stress condition and the all-round action of water (Fig. 6).

Impact strength

Parts made from Ultraform® stay impact-resistant over a wide range of temperatures. Due to its very low glass transition temperature (about -65 °C) Ultraform® still exhibits outstanding impact resistance and adequate notched impact resistance at temperatures as low as -30 °C.

Impact-resistant grades with graduated modification are available for applications with high demands on toughness. Fig. 7 shows a plot of impact strength versus rigidity for these and other grades. A substantial gain in impact strength is obtained at the expense of a moderate loss in rigidity.

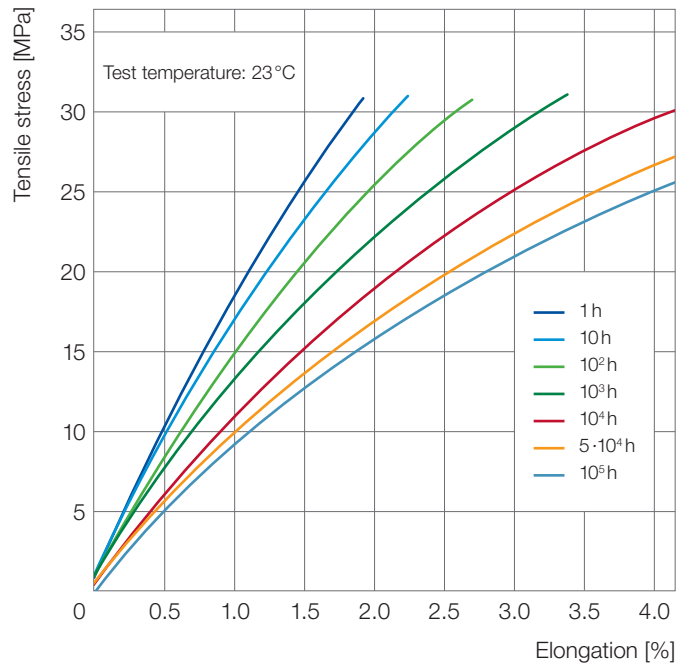


Fig. 4: Isochronous stress-strain curves for Ultraform® N2320 003, measured in accordance with ISO 899-1

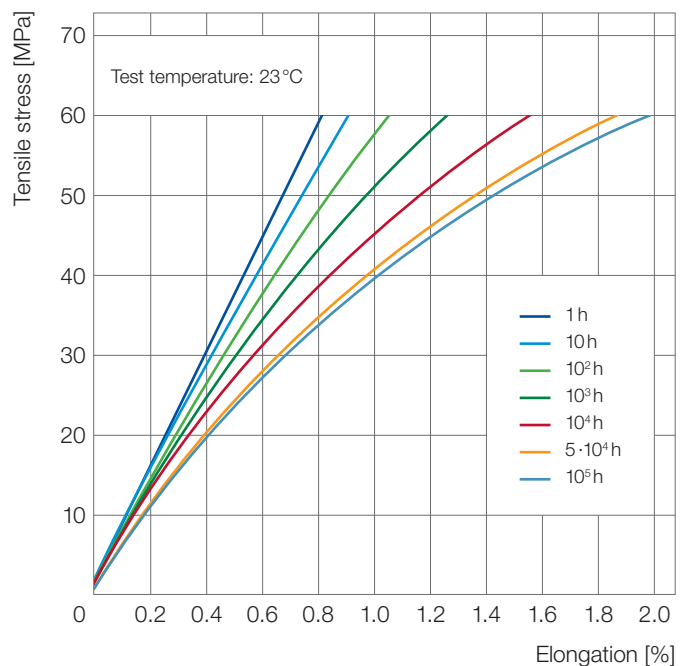


Fig. 5: Isochronous stress-strain curves for Ultraform® N2200 G53, measured in accordance with ISO 899-1

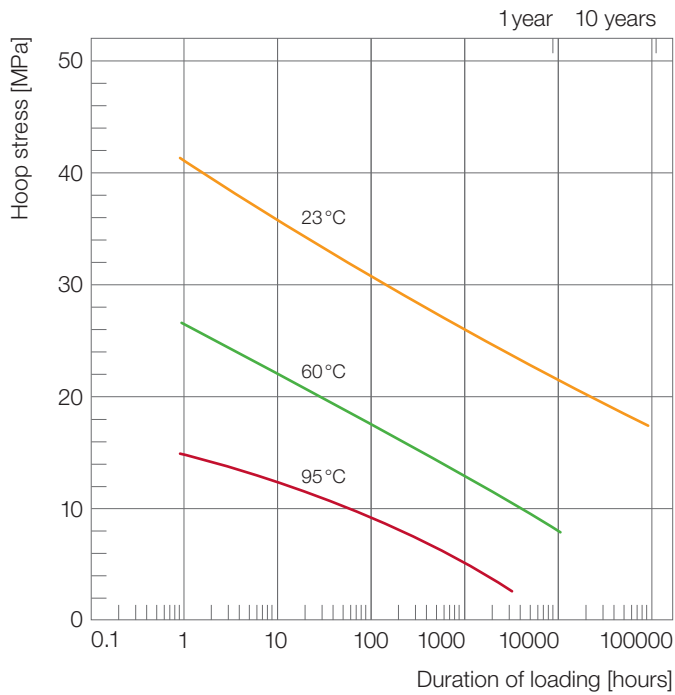


Fig. 6: Creep strength of pipes made from Ultraform® H4320 at various temperatures, with water inside and outside

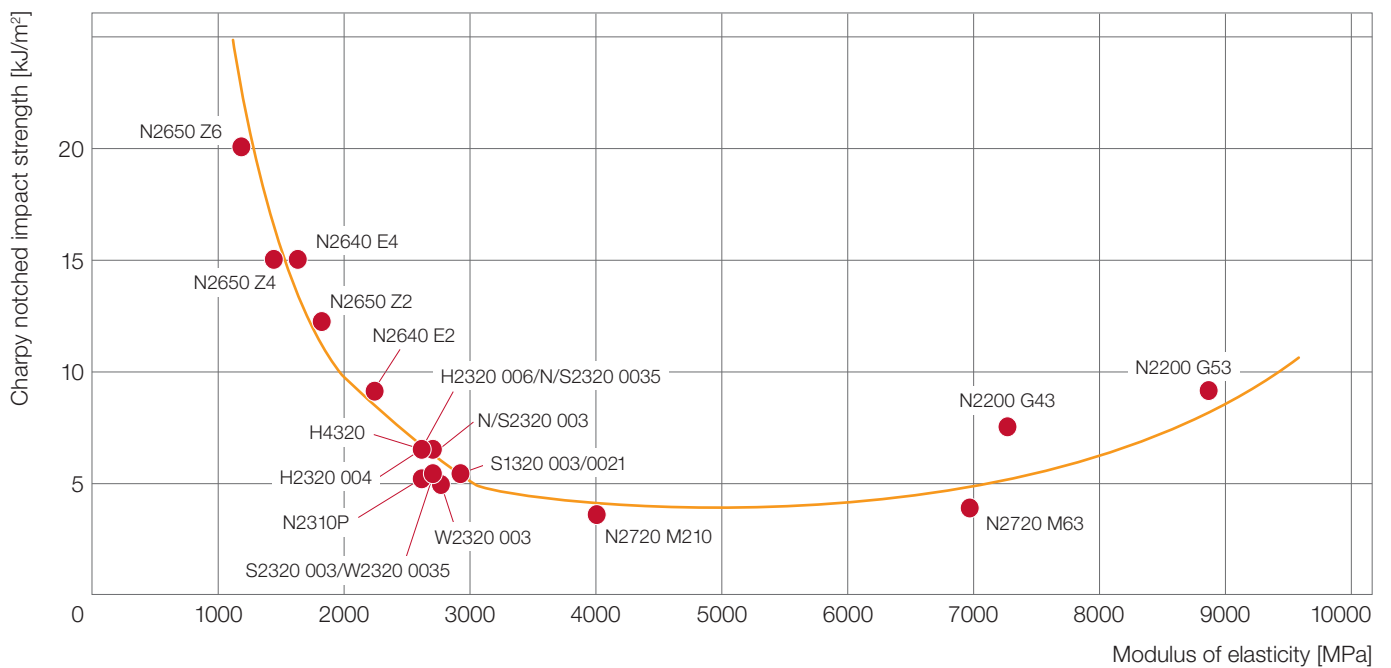


Fig. 7: Impact strength vs. stiffness for selected Ultraform® grades

Behavior under cyclic loads, flexural fatigue strength

Engineering parts are frequently subjected to stress by dynamic forces, especially alternating or cyclic loads, which act periodically in the same manner on the structural part. The behavior of a material under such loads is determined in fatigue tests in flat bending or rotating bending tests (DIN 50100) up to very high load-cycle rates. The results are presented in what are known as Wöhler diagrams obtained by plotting the applied stress against the load-cycle rate achieved in each case (Fig. 8).

The flexural fatigue strength is defined as the stress level a sample can withstand for at least 10^7 cycles.

It can be gathered from the graph that in the case of Ultraform® N2320 003 the stress remains practically constant above about 10^7 load cycles.

When the test results are applied in practice, it has to be taken into account that at high load alternation frequencies, the workpieces may heat up considerably due to internal friction. In such cases, just as at higher operating temperatures, lower flexural fatigue strength values have to be expected.

Tribological properties

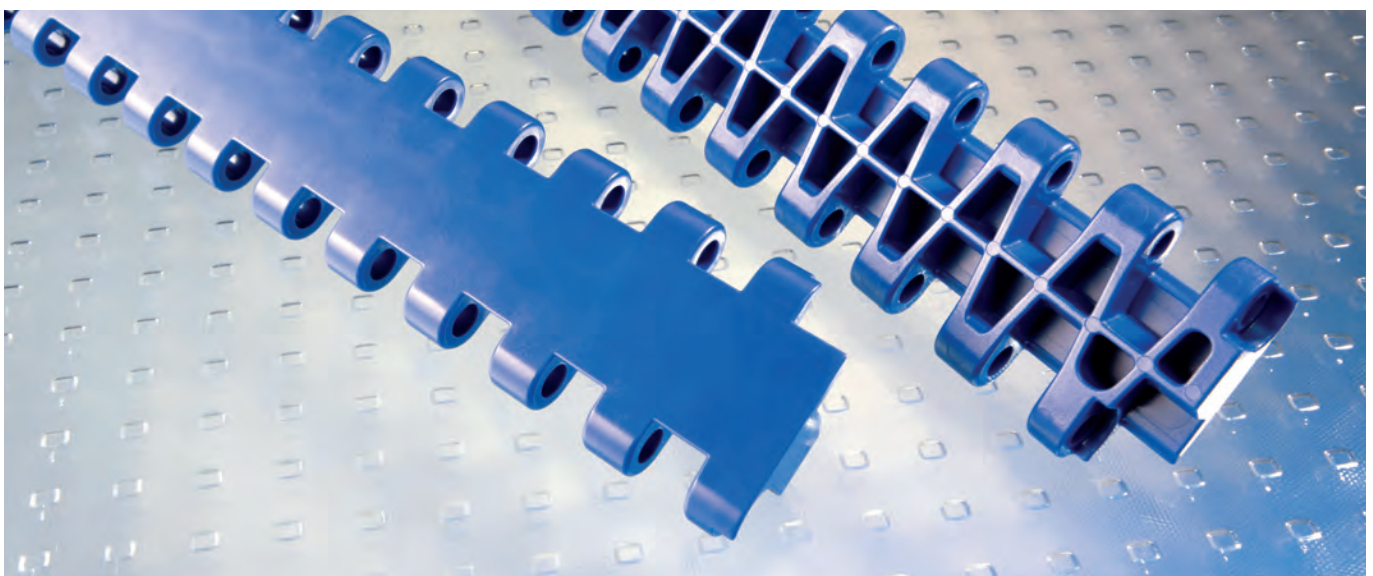
The smooth, hard surface and highly crystalline structure of this material allow its application for functional parts subjected to sliding friction. Even in the case of solid friction only slight wear is to be expected at the coefficients of sliding friction likely to be in operation. The coefficient of sliding friction of Ultraform® becomes smaller as the surface roughness of the paired material increases, but wear caused by sliding friction will increase.

The special grades of Ultraform® W2320 003 TR, N2310 P, N2770 K and N2720 M210 display a marked improvement in their sliding and abrasion behavior. N2720 M210 exhibits optimal properties, even at elevated surface pressures or greater roughness of the sliding counterpart. Generally speaking, N2310 P and N2770 K against steel and W2320 003 TR against plastics are best suited for applications in precision mechanics.

Figure 9 shows the coefficient of sliding friction and the rate of wear due to sliding friction of Ultraform® N2320 003 and N2310 P as a function of the average roughness height. The properties of Ultraform® N2310 P prove to be particularly favorable at low roughness heights of the sliding counterpart (Figure 10).

Wear and friction are system properties which depend on many parameters such as the nature of the paired materials, temperature, speed, loading, etc. While results obtained from tests allow some assessment of tribological properties, they are no substitute for performance testing carried out under practical conditions on the pair of materials actually planned.

Conveyor belt parts



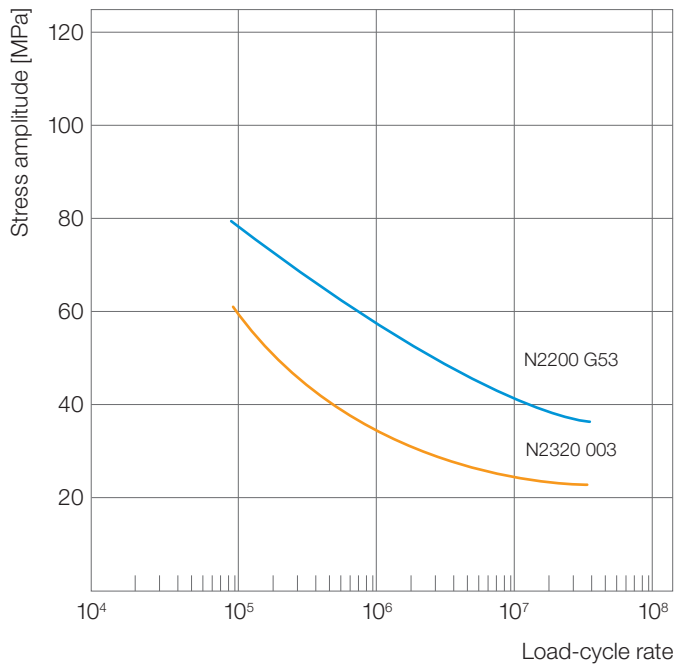


Fig. 8: Wöhler diagram for unreinforced and reinforced Ultraform® determined in the flexural fatigue tests in accordance with DIN 50100. Normal climatic conditions 23/50 in accordance with DIN EN ISO 291, load cycle frequency: 10Hz

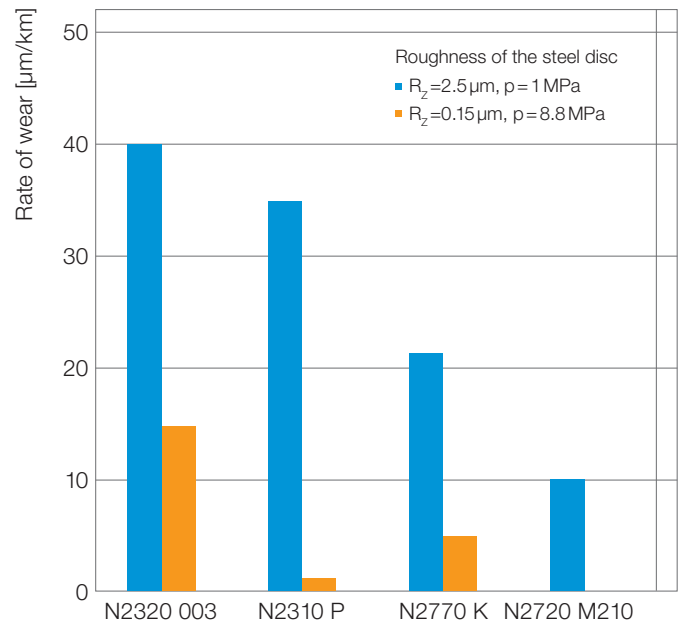


Fig. 10: Rate of wear of modified grades as a function of the roughness of the sliding counterpart (steel disk); v=0.5 m/s; max. 40°C

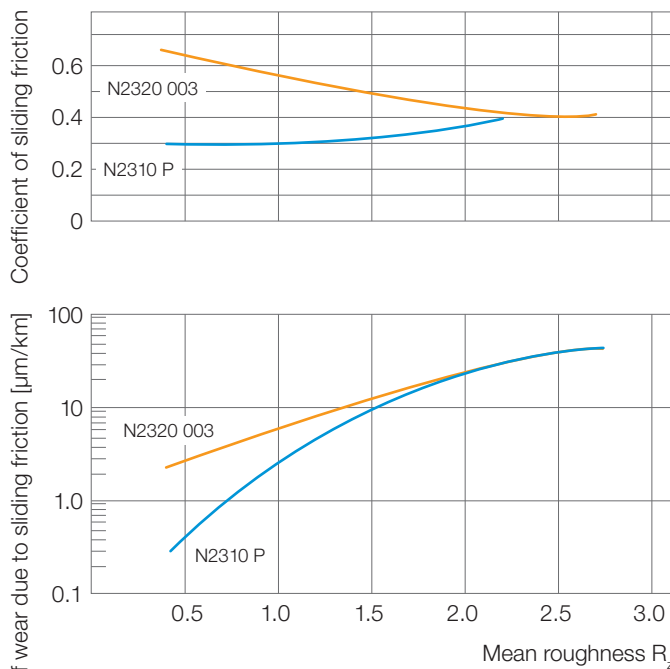


Fig. 9: Coefficient of sliding friction and rate of wear due to sliding friction of Ultraform® N2320 003 and N2310 P as a function of the average roughness height. Sample technically dry. Sliding counterpart: steel disk, HRC 54 to 56, 40°C, p = 1MPa, v = 0.5m/s

Thermal properties

The standard Ultraform® grades have a narrow melting range of approx. 164 °C to 168 °C. Up to the neighborhood of this melting range Ultraform® moldings can be briefly subjected to thermal stresses without the material being damaged.

Figures 11 and 12 show the influence exerted by temperature on the strength-related properties of this material. At a temperature of 80 °C, for instance, Ultraform® N2320 003 still displays the strength of high-density polyethylene at room temperature. The advantage of fiberglass-reinforced products such as Ultraform® N2200 G53 in terms of stiffness and strength is retained, even at an elevated temperature.

The long-term thermal stability of Ultraform® in air is also exceptionally high, as 12-month storage tests at 100 °C and 120 °C have shown (Fig. 13). From these a maximum long-term service temperature of approximately 100 °C can be derived.

Parts made from glass-fiber reinforced Ultraform® can withstand prolonged exposure to temperatures of up to 120 °C without deterioration in material properties due to heat aging (Fig. 14).

It has to be expected that sustained exposures to temperatures above 110 °C will eventually cause discoloration. Ultraform® also exhibits good long-term thermal stability in the presence of water, neutral oils, greases, fuels and many solvents.

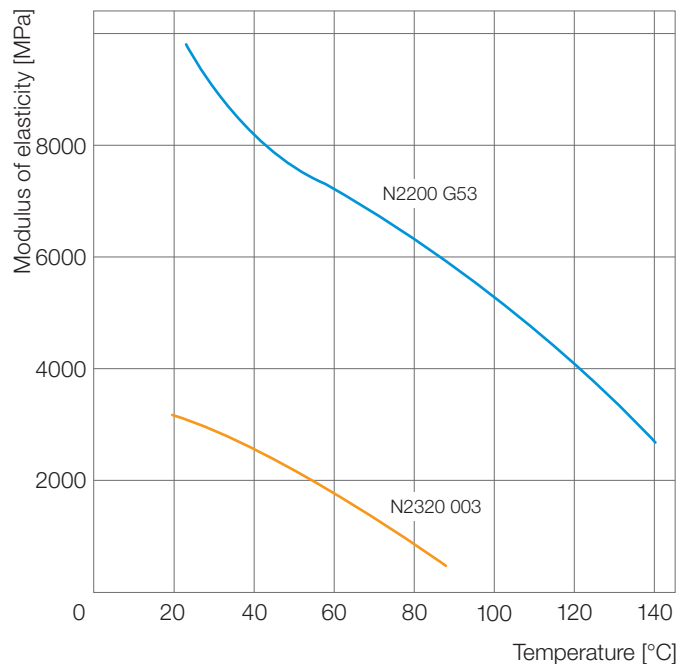


Fig. 11: Modulus of elasticity of unreinforced and reinforced Ultraform® measured in accordance with ISO 527 as a function of temperature

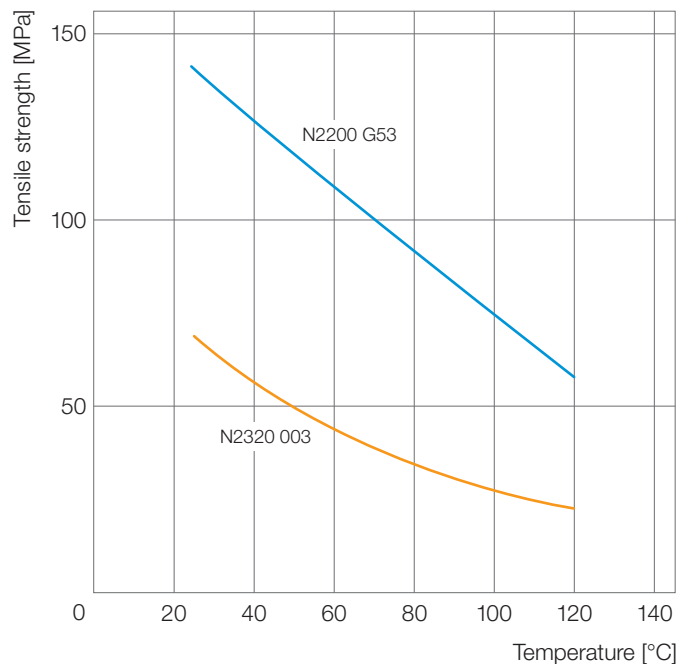


Fig. 12: Tensile strength of unreinforced and reinforced Ultraform® measured in accordance with ISO 527 as a function of temperature

Behavior on exposure to light and weather

When POM is used in the open air, the general sensitivity to UV radiation has to be borne in mind. After prolonged exposure to the action of sunlight the parts lose their surface gloss and become brittle. Treatment with UV stabilizers, as in Ultraform® N2320 U035 for example, approximately doubles the service life. Certain pigments e.g. carbon black can also provide additional protection.

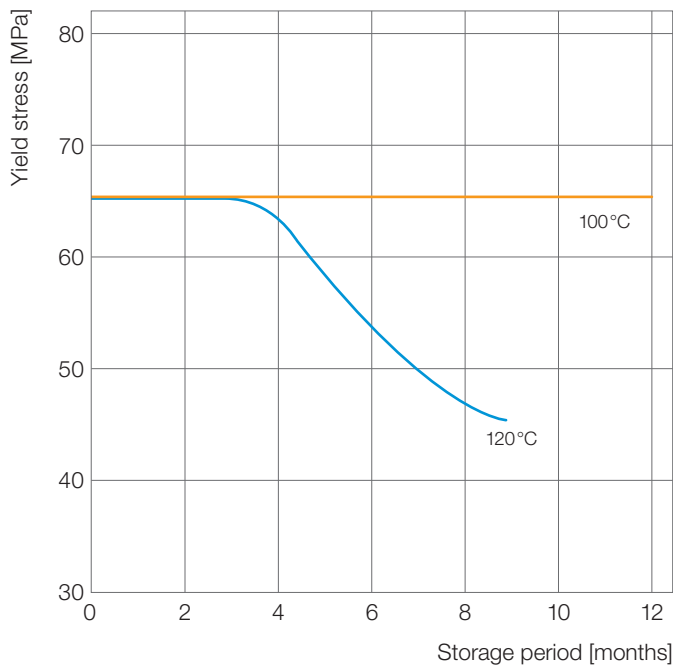


Fig. 13: Storage in air at 100°C and 120°C. Yield stress of Ultraform® N2320 003 as a function of the aging period (measured in accordance with ISO 527, $v = 50 \text{ mm/min.}$)

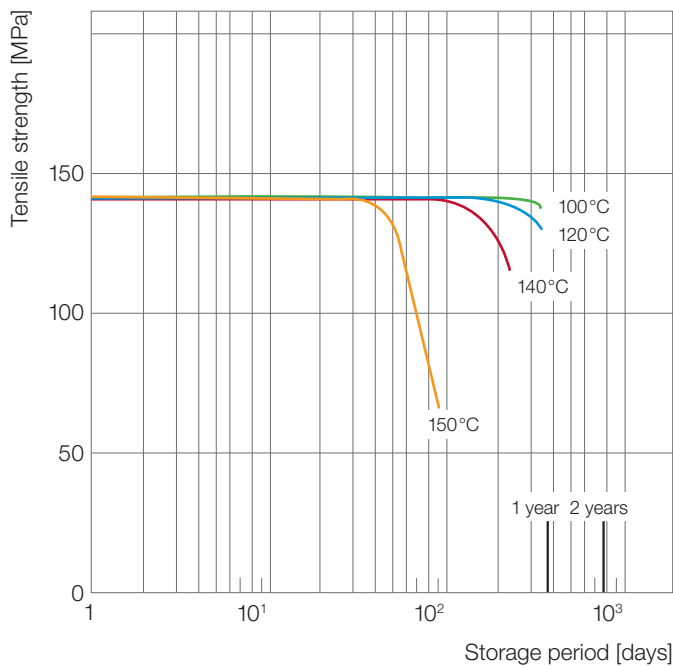


Fig. 14: Tensile strength of Ultraform® N2200 G53 measured in accordance with ISO 527 as a function of the storage period at 100°C, 120°C, 140°C and 150°C

Resistance to water, fuels and chemicals

A polymeric thermoplastic material is chemically resistant to certain ambient conditions if the surrounding medium does not cause any degradation, that is to say, a reduction of the molecular weight or a shortening of the polymer molecules. The chemical resistance depends on the concentration, on the duration of exposure and on the temperature of the medium. The swelling (reversible absorption and release of a substance, for example, a solvent) and the stress crack formation (disentanglement of convoluted polymer molecules without chemical degradation) have to be distinguished from the chemical resistance.

Ultraform® displays good to very good long-term chemical resistance against the following media: water, washing liquors, aqueous solutions of salts and most of the commonly employed organic solvents (such as alcohols, esters, ketones, aliphatic and aromatic hydrocarbons), fuels (also those containing ethanol and methanol, for example, M15, CM15, CM15A, CM15_AP, E85, FAM-B, biodiesel) as well as against fats and oils, braking fluids and coolants, even at elevated temperatures.

Some solvents and fuel components, particularly short-chain alcohols like ethanol and methanol, cause a slight (reversible) swelling.

There are only a few solvents that are known to dissolve Ultraform®, and this usually only takes place at elevated temperatures.

Stress cracking formation due to solvents or other chemicals is not known to occur in Ultraform®.

Figures 15 to 18 show the often superior resistance of Ultraform® in comparison to similar homopolymeric or copolymeric competitive products when exposed to hot water and fuels. This advantage makes Ultraform® suitable for many applications, for example, in the plumbing sector, in espresso and coffee-making machines, in dishwashers as well as in vehicle fuel systems.

Ultraform® is attacked by oxidizing agents and organic and inorganic acids (pH < 4).

Contact with strong acids (e.g. hydrochloric acid, sulfuric acid) should be avoided at all costs. On the other hand alkalis have no effect, even at elevated temperatures.

Detailed information may be found in the brochure "Resistance of Ultramid®, Ultraform® and Ultradur® to chemicals" and can also be obtained at the Ultra-Infopoint.



Shower head insert

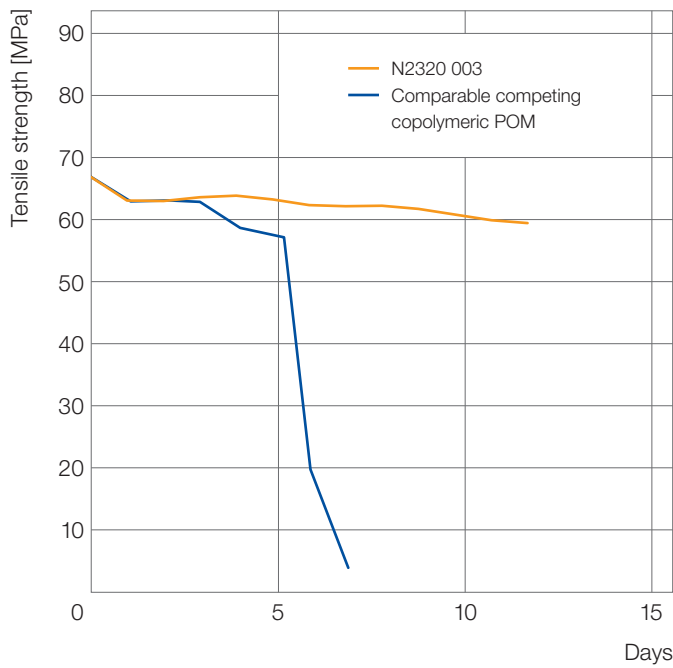


Fig. 15: Hot water storage of tensile bars at 130°C in an autoclave

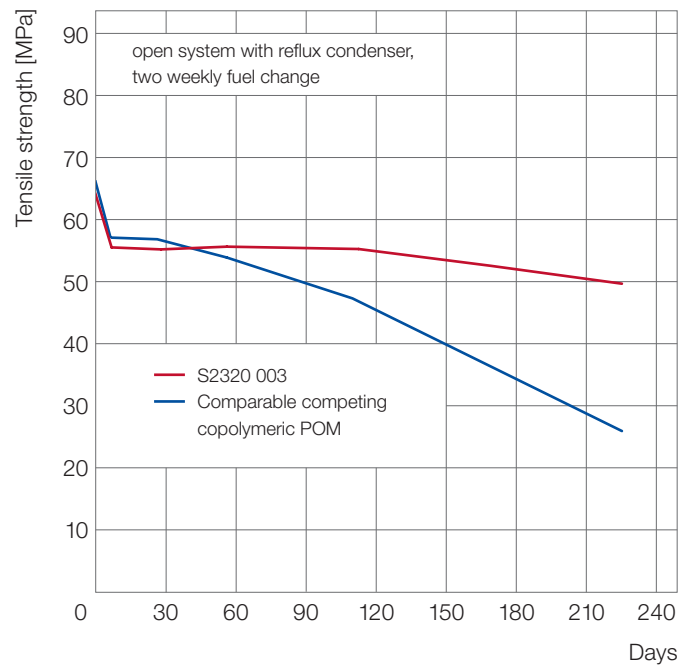


Fig. 17: Storage of Ultraform® S2320 003 in fuel CM15_AP (peroxide number 50) at +60°C

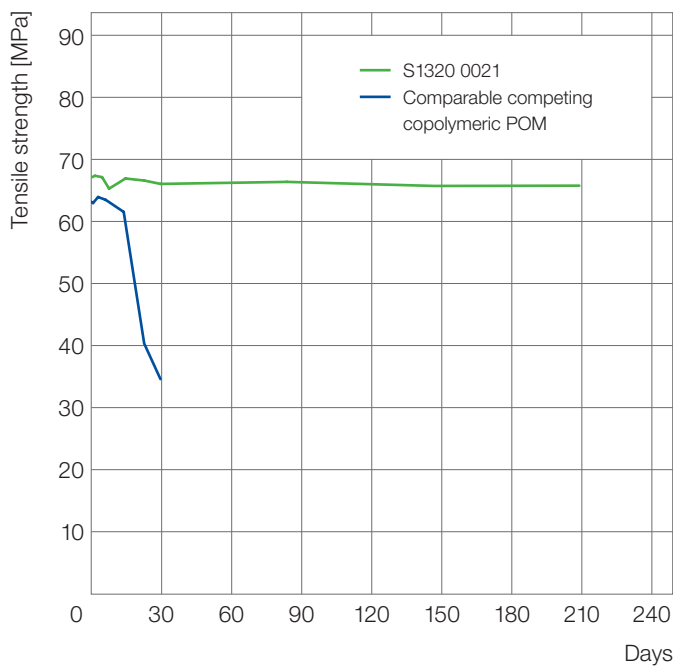


Fig. 16: Storage of hot diesel stabilized Ultraform® S1320 0021 in biodiesel DIN EN 14214 at +140°C

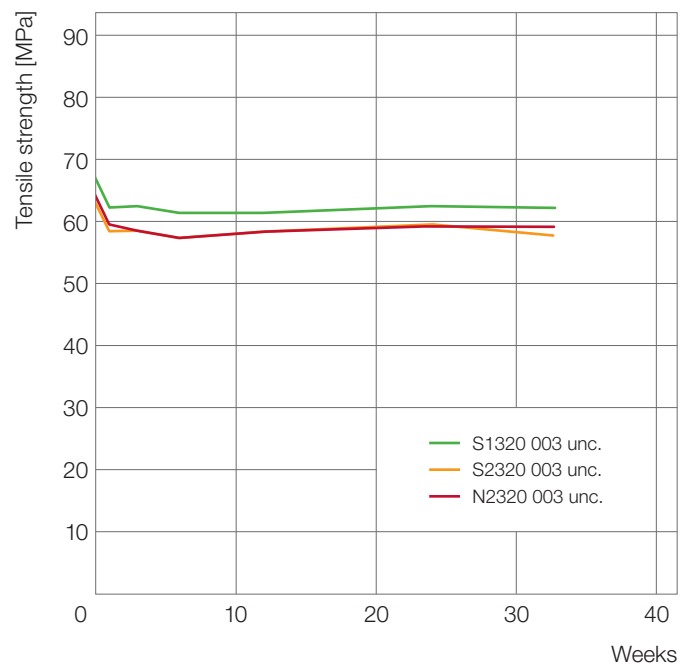


Fig. 18: Storage of Ultraform® in fuel CE85_A at +65°C (85% ethanol, with aggressive additives)

Sterilization

Properly and flawlessly manufactured parts made of Ultraform® can be sterilized in hot steam at 121°C and, with some limitations, even at 134°C, over the course of many cycles, whereby the high-molecular grades perform best. Plasma sterilization is also a good option.

Repeated sterilization in ethylene oxide can be carried out at room temperature without problems employing familiar methods, but this hardly plays a role any more because of the absorption and subsequent release of toxic ethylene oxide.

Great caution is advisable in case of sterilization using ionizing radiation. Chemical disinfection is not recommended.

Behavior on exposure to high-energy radiation

Polyacetals are only moderately resistant to electron and gamma rays. Ultraform® behaves fundamentally in the same way with respect to these two types of radiation. Depending on the total radiation dose, a more or less pronounced degradation occurs, along with brittleness. A total dose of 25kGy (2.5Mrad) can already affect the mechanical properties and the color of the parts.

Fire behavior

Polyoxymethylenes ignite on exposure to flame and continue to burn after the ignition source has been removed. A flame-retardant treatment is not offered.

Ultraform® has a UL 94 flammability rating of “HB”.

The combustion rate required by FMVSS 302 of <100mm/min is met by Ultraform® test specimens having a thickness of 1.0mm and over.

Electrical properties

Ultraform® has good electrical insulation properties and high dielectric strength. The very low moisture absorption of the material does not impair this property, making parts made from Ultraform® highly suitable for use in consumer electronics and telecommunications.

In the field of electric power engineering, Ultraform® is widely used for functional and drive parts which are not used directly as supports for current-carrying parts.

Electrically conductive special grades such as, for example, Ultraform® N2520 L, are available for applications that call for low electric surface resistance.

Product line

The Ultraform® product line encompasses grades for processing by means of extrusion and injection molding. The following product groups exist:

Grades with a high melt strength and high molecular weight

for the extrusion of thin-walled as well as thick-walled tubes and panels, hollow profiles and semi-finished products having wall thicknesses of up to 50cm and more. These are made into gear wheels, bearings and other machine elements by means of non-cutting procedures.

H2320 004	for thin-walled semi-finished parts
H4320	for thick-walled semi-finished parts
E3320	for thick-walled pipes

E3320 is likewise suited for extrusion blow molding. H4320 can be used for the injection molding of thick-walled, nearly void-free parts.

Standard injection-molding grades

in various viscosity classes. As a rule, they can be processed rapidly, without deposits and are also easy to demold.

H2320 006	for thick-walled parts
N2320 003/0035	standard grades
S2320 003/0035	easy flowing
W2320 003/0035	very easy flowing
Z2320 003/0035	extremely easy flowing

Impact-modified injection-molding grades

for applications that make particularly high demands in terms of the toughness. There are TPU-modified grades (N2650 Z2/Z4/Z6) as well as grades containing rubber (N2640 E2/E4), each with differing contents of impact modifiers. The products containing rubber exhibit a number of advantages for processing technology such as, for instance, high weld line strength.

Mineral-filled injection-molding grades

with differing mineral contents for low-warpage and dimensionally stable molded parts that display increased stiffness, hardness and heat distortion resistance.

Glass fiber-reinforced injection-molding grades

with differing glass fiber contents for applications entailing very high demands in terms of strength, stiffness, hardness, creep resistance and dimensional stability under heat.

Grades with special treatment for purposes of

- improving light resistance, UV resistance and weathering resistance (N2320 U03, W2320 U035 LEV)
- optimizing sliding and abrasion characteristics (e.g. N2310 P, N2770 K, W2320 003 TR)
- achieving a certain electrical surface conductivity or volume conductivity, for instance, to reliably and permanently prevent static charging (N2520 L, N2320 C)
- enhancing the fatigue strength against diesel fuel at high temperatures (S1320 0021)
- increasing the contrast for printing by means of an Nd:YAG laser (W2320 003 BK11020)
- producing especially low-odor parts, e.g. for the interior of vehicles (e.g. N2320 0035 LEV, N2650 Z2/Z4/Z6 LEV)

A detailed overview of the product line can be requested from the Ultra-Infopoint.

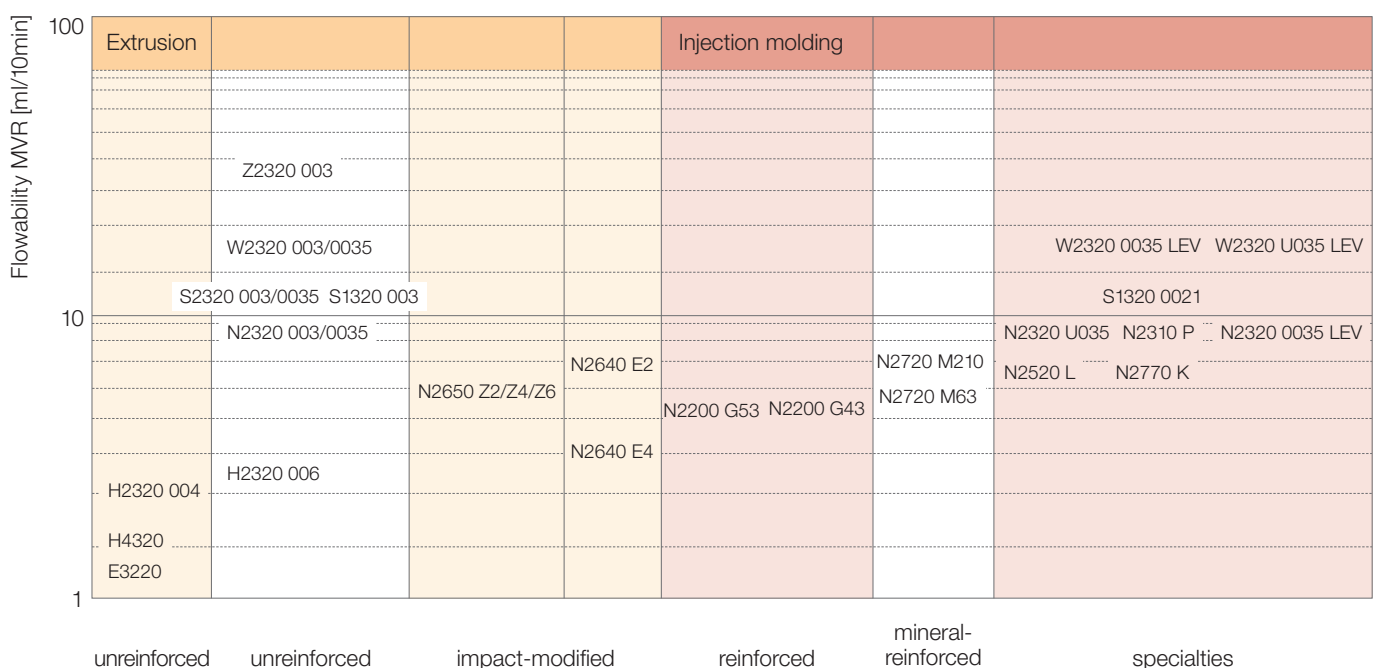


Fig. 19: Selection of grades from the Ultraform® range

The processing of Ultraform®

Ultraform® can be processed by all methods suitable for thermoplastics. The most important methods are injection molding and extrusion. Injection molding allows even the most complicated moldings to be mass-produced very economically. The extrusion process is used to manufacture rods, pipes, profile sections and sheet, most of which are further machined by cutting tools to form finished parts.

In the following, different topics about the processing of Ultraform® will be elaborated. Further information can be found on the internet at www.plasticsportal.eu or via the Ultra-Infopoint (ultraplaste.infopoint@basf.com). Detailed information about processing are given in the respective processing data sheets.

General notes

Preliminary treatment

The granules or pellets in their original packaging can generally be processed without any special preliminary treatment. However, granules or pellets which have become moist due to prolonged or incorrect storage must be dried in suitable dryers, e. g. dehumidifying dryers, for approx. 3 hours at about 100°C to 110°C.

Start-up and shutdown

The processing machine containing Ultraform® is started up in the usual manner for thermoplastics. The barrel and nozzle heaters are set to achieve melt temperatures of 180°C to 220°C. After this the optimum processing conditions must be determined in trials. See also "Safety notes".

When there are relatively long work stoppages or a shut down, if possible run the machine empty and reduce the barrel temperature.

When the processing machine is re-started, care should be taken to ensure that the die is first heated up to about 200°C. This measure prevents blockage of the machine and hot runner nozzle by a cold plug of material.

Self-coloring

Ultraform® can be colored during processing. The following should be observed in this context:

- Only colorants and auxiliaries that do not affect the thermal stability of Ultraform® and that are themselves stable under the prevailing processing conditions can be utilized to color Ultraform®.
- In actual practice, coloring systems on the basis of powdered pigments, liquid colors and masterbatches (polyolefin or preferably POM substrate material) are successfully employed. Uniformity of the color distribution can usually be achieved by means of elevated back pressure.
- The presence of pigments (type and amount) as well as the presence of a masterbatch support material alter the mechanical and tribological properties as well as shrinkage and warpage behavior of Ultraform® by comparison with the uncolored material. Tests on finished parts will provide information as to whether the demands made of the parts are being met.
- In most cases, good results can already be obtained with conventionally configured processing installations to which a colorant metering unit has simply been added. If very high demands are being made, it is recommended that special mixing elements be employed.
- If self-colored parts are used in contact with food, the special provisions of food legislation must be observed (see "Safety notes").

Additional information can be found in the brochure "Self-coloring of Ultraform®".

Re-processing

Ground-up waste material consisting of sprues, rejects and the like can be recovered by mixing it back in. However, they must not be dirty or damaged during the preceding processing. Factors that can influence the material degradation are:

- severe shearing
(high screw speeds, gates that are too small, etc.)
- temperature too high or residence time too long
- incompatible pigments used in self-coloring
- foreign material or other impurities
- moisture.

The grinding procedure can also damage the plastic. Mills running at a low speed have proven their worth for the grinding operation; any adhering dust should be removed. Prior to the re-processing, it is recommended to dry any ground-up material that has been stored for a prolonged period of time. In actual practice, 10 to 15 percent, occasionally even up to 30 percent of ground-up material, is admixed.

In the case of fiberglass-reinforced products, the glass fibers can be shortened during the processing and also during the grinding. If large quantities of such a type of ground-up material are admixed to the new material, then the shrinkage, the warpage and especially the mechanical properties can be affected.

The addition of ground material to the original granules can adversely affect the normal feed behavior. For that reason it should only be added to a production run if it is certain that it will not disturb the processing conditions or impair the properties (e. g. impact strength) of the finished parts.

Compatibility with other thermoplastics

The Ultraform® grades can be mixed with one another and with other polyoxymethylenes. Due to the limited homogenizing action of the processing machine, excessively large differences in viscosity must be avoided. Ultraform® is immiscible with most other thermoplastics. Even small amounts of such extraneous materials become evident in the form of a laminate structure, particularly in the vicinity of the sprue. The result is the well known delamination effect.

Contamination of Ultraform® by thermoplastics exercising a destructive effect on POM, e. g. PVC, must be avoided without fail. Mixtures with thermoplastics containing halogen-based flame retardants must also be excluded. Even small amounts can bring about uncontrolled and rapid decomposition of Ultraform® during processing.

When ground material is added, it is therefore important to take special care that the material is clean, free of dust and homogeneous.

When changing over to other thermoplastics or from other thermoplastics to Ultraform®, it is advisable to purge the barrel with a granular PE or PP material or suitable cleaning compounds.

In general, once the required temperatures have been set, production can be resumed, the first few moldings being rejected. When changing over from PVC to Ultraform® and vice versa it is essential to purge the processing machine thoroughly and then clean it mechanically.



Toy dragon

Injection molding

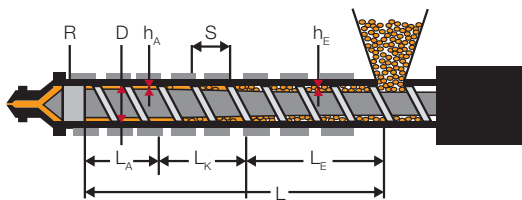
Injection molding is the most important method for processing Ultraform®. Ultraform® can be processed on all commercial molding machines provided that the plasticizing unit has been correctly designed.

Injection unit

Three-section screw

The usual single-flighted, three-section screws are suitable for the injection molding of Ultraform®. In modern machines the effective screw length is 20-23 D and the pitch is 0.8-1.0 D. The tried and tested geometry for three-section screws is shown in Fig. 16. Feed and melt of the granules is substantially determined by the temperature control on the barrel and the depth of the screw flight. Recommended flight depths for different screw diameters are set out in Fig. 21. When using shallow-flighted screws the plasticizing power is somewhat lower than in standard screws. They pick up less material than deep-flighted screws. However, gentler melt, shorter residence times in the barrel and better homogeneity of the melt are achieved. This yields advantages for the quality of molded parts made from Ultraform®.

Processing in degassing screws is inadvisable.



D	outer diameter of the screw		
L	effective screw length	20-23	D
L_E	length of the feed section	0.5-0.55	L
L_K	length of the compression section	0.25-0.3	L
L_A	length of the metering section	0.2	L
h_A	flight depth in the metering section		
h_E	flight depth in the feed section		
S	pitch	0.8-1.0	D
R	non-return valve		

Fig. 20: Screw geometry – terms and dimensions for three-section screws for injection-molding machines

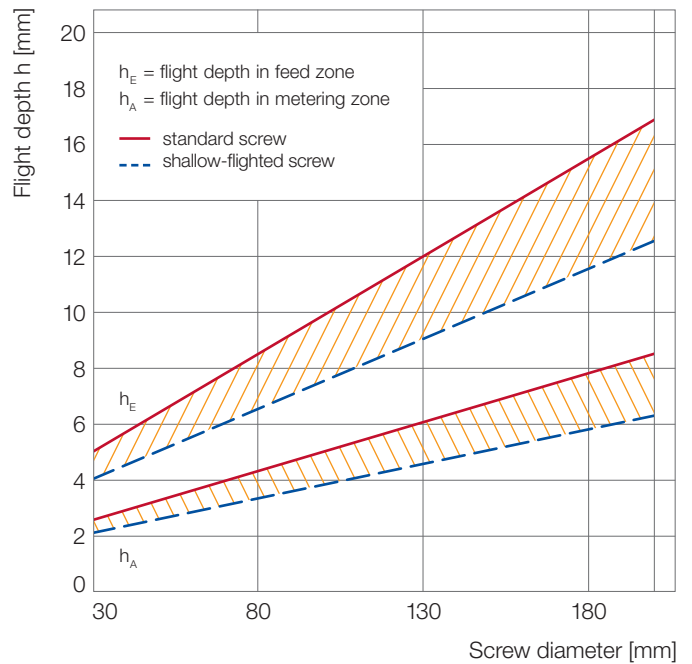


Fig. 21: Screw flight depths for three-section screws in injection-molding machines

Injection nozzle, non-return valve

An open injection nozzle is generally adequate for the injection molding of Ultraform®. Apart from its simple design ensuring smooth flow, this type of nozzle has the advantage that any gaseous decomposition products formed as a result of thermal damage can escape without pressure build-up. This can arise when residence times are unintentionally long, at high melt temperatures, during stoppages or other interruptions. A shut-off nozzle prevents outflow of the melt during plastication and when the nozzle is retracted from the mold.

For optimum production the screw should also be equipped with a good-fitting non-return valve to prevent the melt flowing back over the screw flights during the injection and holding pressure phases.

Protection against wear

When glass-fiber reinforced Ultraform® is processed, hard-wearing plasticizing units, e.g. bimetallic barrels and armored screws, screw tips and non-return valves, should be used.

Injection mold

Gate and mold design

All known gate types can be used for the injection molding of Ultraform®. The relevant construction guidelines for the design of gates and molds for injection-molded parts made from thermoplastics also apply to Ultraform®. Runners and gates must not be too small.

Due to the low melt viscosity, surface contours are reproduced extremely accurately. Accordingly, the inner surfaces of the mold must be impeccably finished. The same applies to the mold parting surfaces. The parting line must not cause flash formation but must ensure adequate venting of the mold.

Use of metal inserts

Metal inserts can be encapsulated without any trouble. They should, however, be preheated to 80-120°C before insertion in the mold so that no internal stresses arise. The metal parts must be free of grease and be knurled, grooved or similar to ensure good anchorage. Care has to be taken that the metal edges are well rounded.



Loudspeaker grills

Mold temperature control

A well thought-out and effective temperature control system is of special importance since the temperature of the mold has a major impact on the surface finish, shrinkage, warpage and tolerances of the moldings.

The temperature regulation should be selected in such a way that the same temperature is present in all of the shaping areas. In special cases, it can sometimes be necessary to systematically select divergent temperatures. Thus, for instance, the warpage of the molded parts can be influenced to a certain extent by systematically selecting different temperatures in the mold halves. This is only possible with separate circulation systems.

As with all partially crystalline thermoplastics, it is also the case with Ultraform® that the mechanical properties of an injection-molded article are determined in part by the degree of crystallinity. The crystallinity increases as the mold temperature rises. The hardness, stiffness and strength increase as the mold temperature rises (Fig. 22). The toughness values (Fig. 23) behave in precisely the opposite way.

Generally speaking, it is sufficient to regulate the temperature within the range from 60°C to 90°C. Precision parts require mold temperatures between 90°C and 120°C. If there is a need for especially high dimensional stability, the mold temperature should be set at least as high as the temperature at which the molded part will be used later on.

In order to avoid heat losses, it is recommended that insulation be fitted between the mold and platen.

Processing by injection molding

Processing temperature

As a rule melt temperatures of 180°C to 220°C are sufficient. Complex molds with long flow paths and thin walls may in exceptional cases require temperatures up to 230°C. Higher processing temperatures involve the risk of thermal degradation. This is prevented if the production conditions allow a short cycle time and hence a correspondingly low residence time of the melt in the injection molding cylinder.

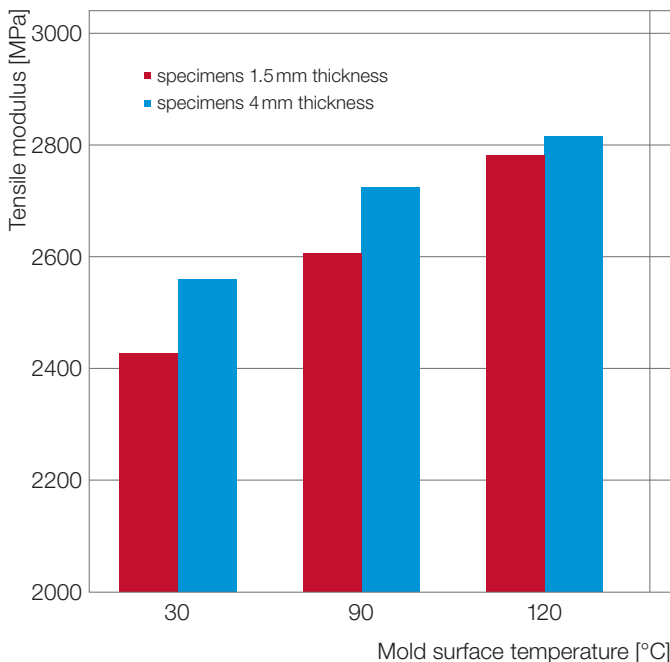


Fig. 22: Ultraform® N2320 003 – influence of the mold surface temperature on the stiffness of tensile bars with different thickness

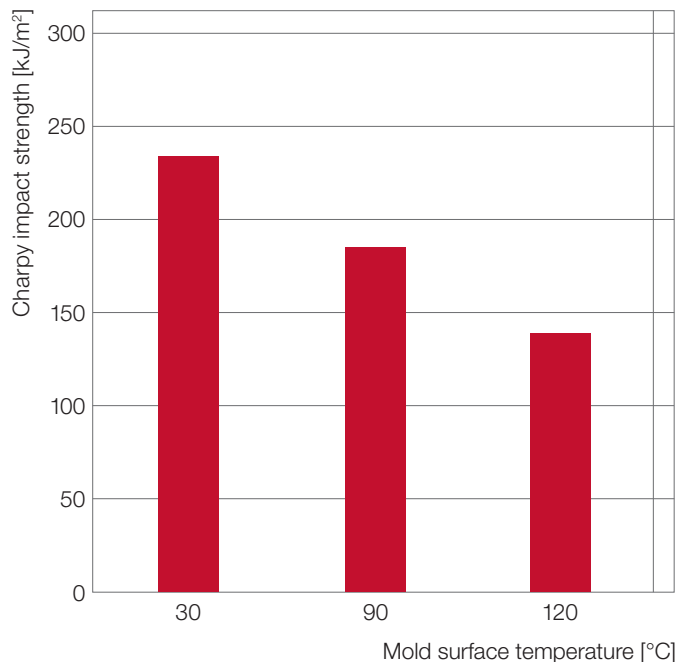


Fig. 23: Ultraform® N2320 003 – influence of the mold surface temperature on the charpy impact strength (ISO 179/1eU)

Continuous measurement of the melt temperature by a machine nozzle with an integrated thermocouple is recommended.

The individual heater bands in the injection molding machine can frequently be set to the same temperature. If cycle times are long, the first heater band (near the hopper) should be set to a slightly lower temperature to prevent premature melting of the pellets in the feed zone.

Feed characteristics

Ultraform® is drawn in without problem by standard screws (Figs. 20, 21). The screw geometry, screw speed, back pressure and temperature control at the barrel determine the feed behavior of the granules and their plastication.

The cooling possible in most injection molding machines in the region of the hopper allows adjustment of the feed behavior if required. In special cases, a dropping temperature profile (e.g. 220°C to 205°C) has to be set from the hopper to the die for Ultraform® N2310 P.

The peripheral speed of the screw should not exceed 0.3 m/s.

Mold filling

The quality of the finished parts also depends on the speed at which the mold is filled. A filling rate which is too high promotes alignment of the molecules and results in anisotropic mechanical properties. On the other hand a filling rate which is too low yields parts with poor surface finish.

Particular care has to be taken that air in the mold cavity can escape easily at suitable points when injecting the melt, so that burn marks due to compressed air (Diesel effect) are not produced. An insufficient ventilation of the mold increases mold deposits. Fig. 24 shows a well-ried system for ventilation.

In cases where material accumulation is unavoidable (by design), the formation of voids is counteracted by making the holding pressure sufficiently high and the holding pressure time sufficiently long so that the contraction in volume occurring on cooling of the melt is compensated. The precondition for this is a sufficiently large and well sited gate so that the melt in this region does not solidify too early before the end of the holding pressure time and as a result seals the still plastic molding in the interior against the holding pressure of the melt.

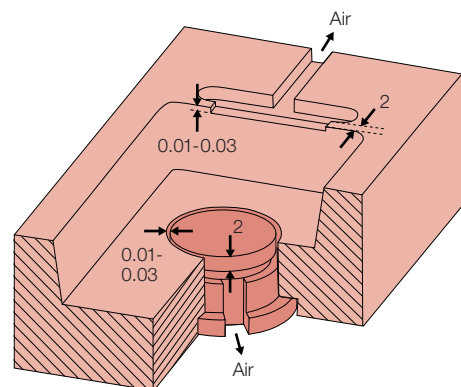


Fig. 24: Mold venting system (all dimensions in mm)

Flow characteristics

Ultraform® H4320, the high-molecular-weight resin with the highest viscosity, is a preferred material for extrusion. It is also suitable, however, for the production of particularly tough injection-molded parts having relatively thick walls (>3 mm).

Ultraform® N2320 003 is the standard grade for moldings of normal wall thickness (> 1.5 mm) and flow paths which are not too long. The free-flowing Ultraform® S2320 003 is recommended when the walls are thinner and the flow paths longer.

Ultraform® W2320 003 and the especially easy-flowing Ultraform® Z2320 003 are available when due to the upper processing temperature limit complete filling of the mold with Ultraform® S2320 003 is no longer possible.

The flow characteristics of these grades as a function of the wall thickness as revealed by the spiral flow test are shown in Fig. 25. Although this test is not standardized, it nevertheless allows a practice-based assessment. The flowability or the flow path of a product depends not only on the processing parameters, such as injection pressure, injection speed, melt and mold temperature, but also on the design of the mold and of the machine. Fig. 26 provides an overview of how flow depends on the melt temperature. Despite having good flow properties, Ultraform® injection molding grades do not tend to form flash.

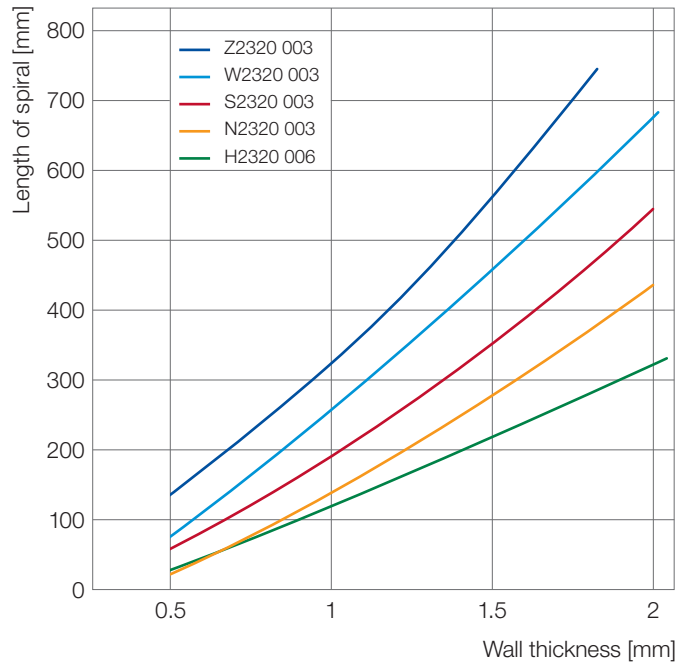


Fig. 25: Flowability as a function of wall thickness (spiral flow test). Screw diameter: 30 mm, mold: test spirals, injection pressure: 1000 bar, melt temperature: 210 °C, mold surface temperature: 80 °C

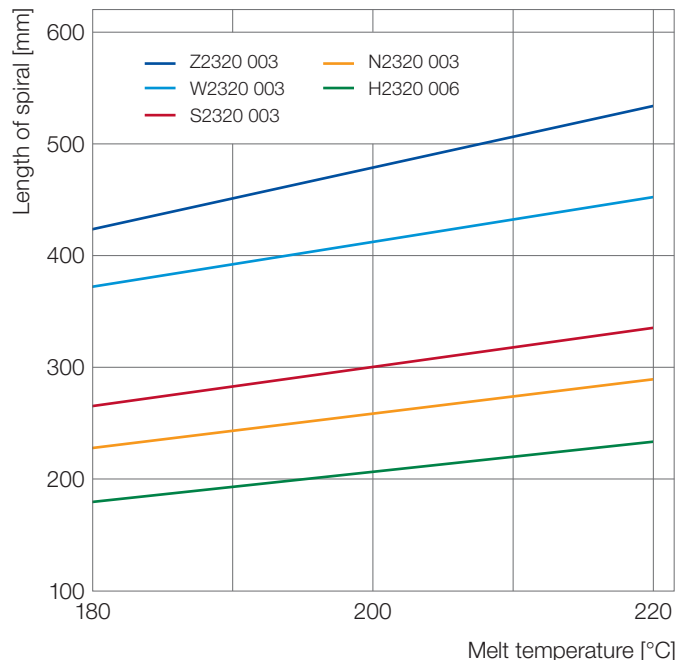


Fig. 26: Flowability as a function of melt temperature. Screw diameter: 30 mm, mold: 1.5 mm test spirals, cycle time: 20 s, injection pressure: 1000 bar, mold surface temperature: 80 °C

Processing speed

Factors governing the cycle time in injection molding are on the one hand the time it takes for the melt to cool from the processing temperature to the ejection temperature, and on the other hand the rate of solidification, which in the case of semicrystalline thermoplastics is closely related to the rate of crystallization.

In the case of thin-walled parts the processing speed is mainly determined by the rate of crystallization, while for thick walls it is principally determined by the rate of the plastic's heat conduction.

The Ultraform® grades are characterized by high solidification rates and are therefore exceptionally suitable for the economic production of thin-walled parts.

Demolding

Ultraform® can be readily demolded. Even with high mold surface temperatures it has no tendency to stick to the mold walls. The draft angles in injection molds are normally 1 to 2 degrees. Smaller drafts are possible for Ultraform® as a result of the high contraction in volume. However, the ejector must have a large contact area.

The general rule is that the ejector pins should not be too thin relative to the part, otherwise the moldings are damaged by indentation of the ejector pins when cycle times are short or the mold temperature is high.

The mold cooling channels should be designed in such a way that the molding is cooled as uniformly as possible and as a result can solidify largely free of warpage.

Shrinkage and aftershrinkage

Shrinkage is defined as the difference between the dimensions of the cavity of the mold and those of the molding at room temperature. It is normally determined 24 hours after production and expressed in percent (ISO 294-3/4). As accurate a prediction as possible of the anticipated shrinkage is important, especially for the mold maker.

The dimensions of the mold must be designed in such a way that moldings with the desired final dimensions can be produced. Although shrinkage is primarily a property of the material, it is additionally determined by the shape and wall thickness of the injection-molded part and by the processing conditions (mold surface temperature, melt temperature, holding pressure, injection speed, position and size of the gate). The interaction of these different factors usually makes it very difficult to predict shrinkage exactly. The test box as depicted in Figure 27 has proven its suitability for ascertaining the practice-relevant shrinkage dimensions. Usually the length A is evaluated as the measure of the shrinkage of the bottom of the box.

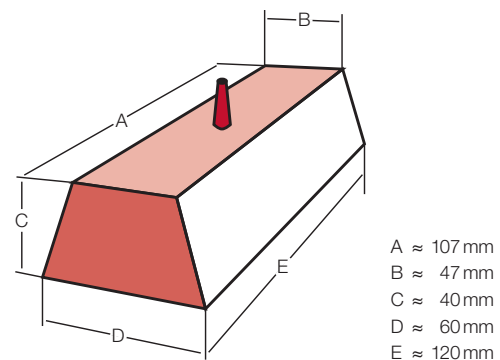


Fig. 27: Test box

The greatest influence on the shrinkage comes from the temperature of the mold surface and from the wall thickness of the molded part. Figure 28 shows this dependence with reference to test boxes having wall thicknesses of 1.5mm, 5mm and 8mm. It can be seen that shrinkage increases rapidly as the mold temperature rises. Here the mold temperature is always to be taken as the measured surface temperature and not the temperature of the temperature control medium.

With reference once more to the test box, Fig. 29 shows the dependence of shrinkage on holding pressure. Higher holding pressures partially compensate for shrinkage.

Other factors, such as the melt temperature or the injection speed for example, do not affect the shrinkage of Ultraform® to any great extent. It only increases slightly as the melt temperature rises and the injection speed falls.

Over time the dimensions of injection moldings may alter slightly owing to temperature-dependent and time-dependent post-crystallization and also in small measure to the relaxation of internal stresses and alignments.

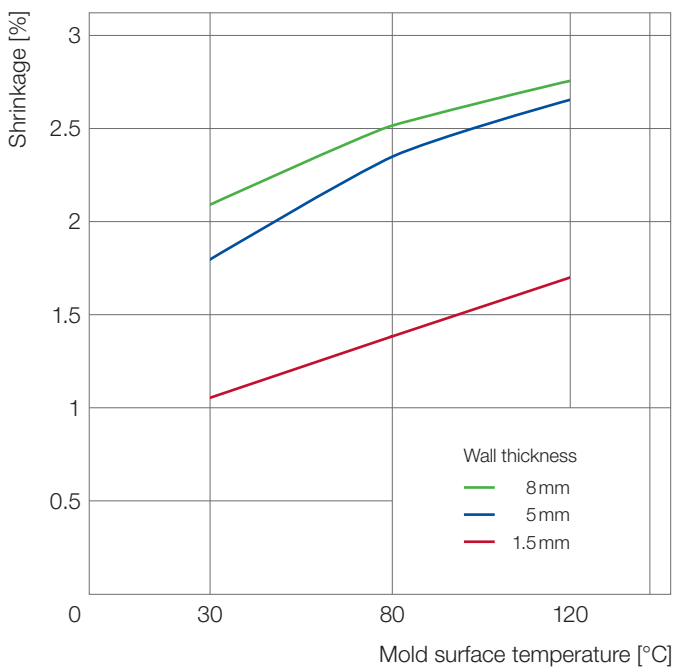


Fig. 28: Shrinkage of test boxes molded from Ultraform® N2320 003 one hour after molding (distance A)

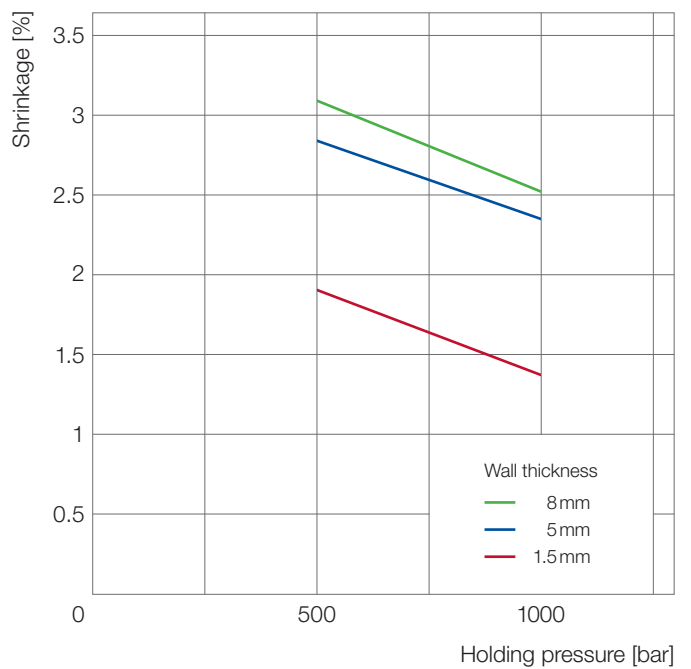


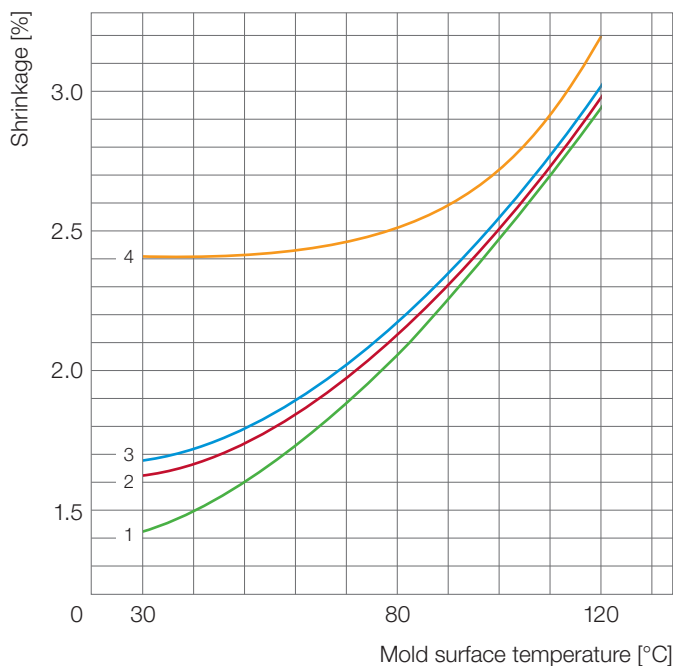
Fig. 29: Shrinkage of test boxes molded from Ultraform® N2320 003 one hour after molding (distance A)

Fig. 30 shows the shrinkage measured on the test box after an hour (Curve 1), 14 days and 60 days (Curves 2 and 3). The parts were stored at room temperature. Aftershrinkage, i. e. the increase in shrinkage due to postcrystallization, is visible from the curves. Curve 4 shows the shrinkage of the same parts after 24 hours at a temperature of 120°C.

Annealing is worthwhile when injection-molded parts made from Ultraform® are to be exposed to relatively high temperatures in later use. The tempering anticipates the change in dimensions otherwise to be expected as a result of post-crystallization. As Fig. 30 shows, however, tempering can be dispensed with when injection molding is carried out at high mold temperatures.

Shrinkage of the glass-fiber reinforced Ultraform® N2200 G53 is substantially smaller than that of the unreinforced grades. However, due to the orientation of the glass fibers, the shrinkage is anisotropic. Depending on the shape, gate position and processing conditions, this can cause warpage of the moldings.

By contrast, the mineral-filled Ultraform® N2720 M63 is largely characterized by isotropic shrinkage. Fig. 31 shows shrinkage parallel and perpendicular to the direction of flow for free shrinkage of unreinforced, glass-fiber reinforced and mineral-filled Ultraform®.



- Curve 1 Processing shrinkage 1 hour after production
- Curve 2 Shrinkage after 14 days at room temperature
- Curve 3 Shrinkage after 60 days at room temperature
- Curve 4 Shrinkage after tempering for 24 hours at 120°C

Fig. 30: Shrinkage and aftershrinkage of Ultraform® N2320 003 as a function of mold temperature, time and temperature determined on the basis of a box having a wall thickness of 1.5 mm. Mold: test box with walls 1.5 mm thick, melt temperature: 210°C, holding pressure: 500 bar, dimension measured: A = 107 mm

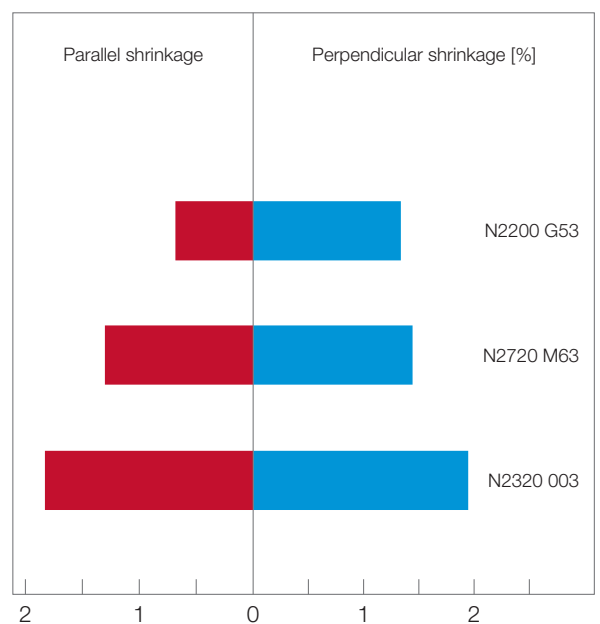


Fig. 31: Shrinkage of unreinforced, glass-fiber reinforced and mineral-filled Ultraform® parallel and perpendicular to the direction of flow for free shrinkage determined for sheet measuring 110x110x2 mm; melt temperature: 200°C, mold surface temperature: 80°C

Extrusion

The main form of Ultraform® used for extrusion is the high-molecular weight grade H4320. Another grade Ultraform® H2320 004, is available for extruding small pipes and slab stock.

Up to a few years ago the most common type of screw for POM was the short-compression zone screw.

On the basis of BASF experience, Ultraform® can be processed to particular advantage using three-section screws having a total length L of 20 to 25 D and a constant pitch of about $1D$. Table 1 contains suggested screw geometries for the most frequently used extruder sizes. Material stresses and degradation due to friction can be significantly reduced by means of a feed zone of appropriate length and an extended compression section having a maximum compression ratio of 3:1.

Length of section				Flight depths		
Overall length	L	20-25	D	D mm	h_E mm	h_A mm
Feed section	L_E	8	D	45	7.7	2.8
Compression section	L_K	3-5	D	60	9.3	3.3
Metering section	L_A	9-12	D	90	10.8	3.8

D = screw diameter

h_E = flight depth in the feed section

h_A = flight depth in the metering section

Table 1: Guide values for the screw geometry (extrusion)

Production of semi-finished parts

Thick-walled hollow and solid profiles are usually manufactured by the cooled-die extrusion method. The dimensions for the standard sizes of such POM profiles and the quality requirements for them are standardized as follows:

- DIN 16980 and DIN 16985 Round-section rod (new: DIN EN 1549)
- DIN 16986 Sheet
- DIN 16809, 16978 and 16983 Hollow rod

The requirements of DIN 16985 can be very reliably fulfilled by Ultraform® H4320, because this grade, when correctly processed, has very little tendency to discolor or to produce voids. Compared with products, this type allows processing speeds which are significant higher.



Fuel filter housing

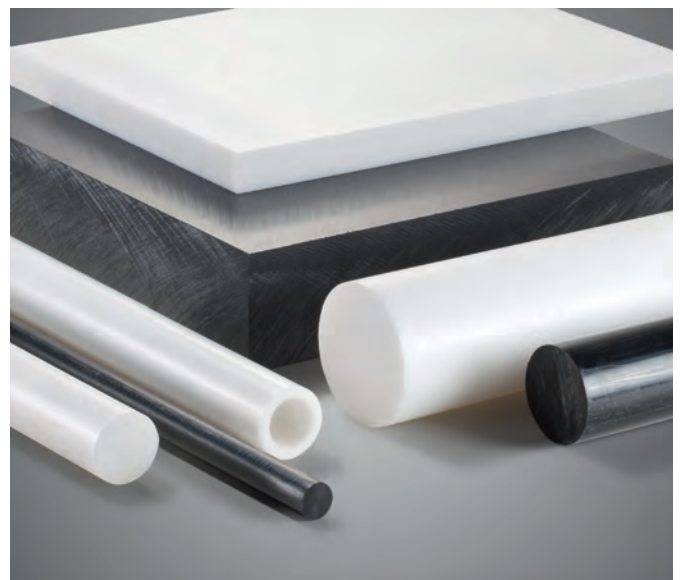
The necessarily long residence time of the melt in the extrusion of semi-finished parts requires that the melt temperature be kept as low as possible. For thicker rod, for example, the melt temperature should not exceed 175°C to 180°C.

Volume shrinkage can be compensated by high pressure and an output rate adapted to the wall thickness.

Stresses can arise due to the different solidification and cooling of the melt, which varies according to time and place. These can be removed by subsequent heat treatment. Tempering is essential when high demands are placed on dimensional stability. It can be carried out in air, liquid wax or oil at temperatures of 130°C to 150°C, mostly 140°C to 145°C. Lower temperatures are not effective. The duration depends on the wall thickness (10 minutes per 1mm wall thickness).

Ultraform® H4320	
Rod diameter	60 mm (4-aperture die)
Extruder	45 mm Ø, 22 D
Screw	
– Section length	$L_A = 9 D, L_E = 9 D, L_K = 4 D$
– Flight depth	$h_E/h_A = 7.5/2.5 \text{ mm}$
Temperature control	
– Extruder	200/180/170°C
– Adapter	175°C
– Die heated	175°C
– Die cooled	20°C
Screw speed	42 min ⁻¹
Take-off rate	20 mm/min (per rod)
Output	17 kg/h

Table 2: Processing examples for the production of round-section rods



Semi-finished parts

Production of tubes and pipes

Smaller Ultraform® tubes are mainly used to protect and guide Bowden cables. They have an outer diameter of 3 to 10mm and a wall thickness in the range 0.4-1.0mm.

The vacuum water bath method is recommended for the production of tubes and pipes. For calibration, draw plates (set) arranged one behind the other or radially slotted or drilled calibration sleeves are suitable. In both cases the internal diameter of the calibration unit is set approximately 2.5% greater than the desired outer diameter of the tube to be produced. Based on experience, this difference corresponds to the shrinkage in processing. In order to be in a position to utilize the off-take speeds possible with this product, the ratio of the die diameter of the pipe extrusion head to the internal diameter of the calibration tube must lie approximately in the range 2:1 to 4:1, depending on the size of the tube. The die gap of the pipe extrusion head should be 3 to 4 times the size of the desired wall thickness of the tube.

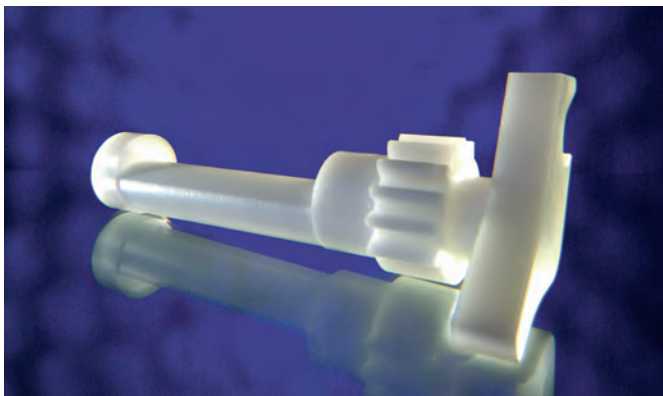
The rapid solidification requires that the distance between the pipe extrusion head and the calibration unit be kept as small as possible. If the spacing is too great the outer skin of the molten tube will have solidified so much at the inlet that the tube can no longer be reliably calibrated.

Large, thick-walled pipes are preferably produced by the vacuum water bath method.

With standard equipment and standard extrusion grades, such as Ultraform® H4320, it is possible to produce pipe with a maximum wall thickness of 8 mm. For thicknesses greater than this, the melt flows increase in the direction of gravity, causing a growing difference in thickness between the upper and lower sides of the pipe.

Pipe dimensions (external diameter x wall thickness)	3.5 · 0.9mm
Extruder Ø	45, 20D mm
Screw – Section lengths: $L_E / L_K / L_A$ – Flight depths: h_E / h_A	8D/3D/9D 7.7/2.7 mm
Temperature control – Extruder – Adapter – Die body/die aperture	180...180°C 180°C 170/170°C
Pipe extrusion head – Die Ø – Mandrel Ø – Gap	12 mm 6 mm 3 mm
Vacuum water bath – Draw plate Ø – Water temperature	3.6mm 18°C
Distance between pipe extrusion head and calibration unit	approx. 3cm
Screw speed	26 min ⁻¹
Off-take speed	16 m/min
Output	approx. 10 kg/h

Table 3: Examples of the production of pipes from Ultraform® H2320 004



Semi-finished part

Production of sheet

Ultraform® H2320 004 is excellent for producing sheet with thicknesses between 1 and 6 mm. Standard sizes are defined in DIN 16 977 and the quality requirements in DIN 16985.

Sheet is produced on commercial installations aligned horizontally with slot dies, three-roll polishing stack followed by an off-take unit. The lips of the slot dies should extend as close as possible to the nip. The temperatures of the rolls depend on the sheet thickness and vary between 130°C and 170°C.

The throughput and off-take rate are matched to one another in such a way that a small, uniform bead is formed over the width of the roll ahead of the nip. In this way the tolerance and surface quality of the sheet can be adjusted in optimum manner. By using vented extruders, the surface quality can be improved still further. Otherwise pre-drying of the pellets is recommended (3 hours at 100°C to 110°C).

Sheet cross-section	770 mm · 1.6 mm		
Extruder	90 mm Ø, 30 D		
Screw	$L_E = 9D, L_K = 1.5D, L_A = 6D$ $0.5D$ $L_{E1} = 4.5D, L_{K1} = 1D, L_{A1} = 7.5D$ $h_E/h_A = 10.8/4 \text{ mm}$ $h_{E1}/h_{A1} = 16.8/5.6 \text{ mm}$ 800 mm wide		
– Section lengths			
– Venting			
– Flight depths			
– Die			
Temperature control	150/160/160/170/170/155/155/155 °C		
– Barrel	(while extruder is running)		
– Adapter	180 °C		
– Die	throughout 185 °C		
Three-roll stack	300 mm roll diameter		
	Temperature (set)	top	170 °C
		center	145 °C
		bottom	140 °C
Screw speed	25 min ⁻¹		
Melt temperature	200 °C		
Off-take rate	0.63 m/min		
Output	68 kg/h		

Table 4: Example of the production of sheet from Ultraform® H2320 004

Manufacture of monofilaments

Ultraform® H2320 004 and H2320 006 are suitable for manufacturing stiff bristles and technical monofilaments with a diameter of up to about 0.5 mm. A quick cooling-phase and recking is important.

Blow molding

Ultraform® E3320 makes it possible to produce elaborate hollow bodies by extrusion blow molding.

When blow molding Ultraform®, it is generally necessary to ensure good and homogeneous processing of the melt. It is recommended that a screw with an effective screw length of no less than 20 D and a low channel depth be used so that the melt can be processed homogeneously. Maddock, rhombus-shaped mixing elements, barrier webs and other suitable screw elements can further enhance the processing.

Appropriate temperature control which differs from traditional blow molding is also required. Controlling the temperature of the feeding zone to a temperature between 100°C and 230°C helps to melt the granules. The zones next to the feeding zone should be heated up from 180°C to 230°C. Constant temperature control or a temperature profile which declines slightly toward the tip of the extruder with melt temperatures of around 200°C helps to produce a stable melt and components with good mechanical properties.

The blow molding tool should preferably have a temperature of over 90°C. Controlling the temperature of the tool helps to mold the tool cavity well. The blow pressure to be chosen depends on the component, but in most cases it will be between 4 bar and 10 bar.

Fabrication and finishing processes

Machining

Semi-finished parts made from Ultraform® can be machined with all conventional machine tools. As a general rule of thumb cutting speeds should be high and feed rate low.

Joining methods

Parts made from Ultraform® can be joined at low cost by a variety of methods. The mechanical properties of Ultraform®, especially its toughness, allow the use of self-tapping screws. Ultraform® parts can be connected without difficulty to one another or to parts made from other materials by means of rivets and bolts.

Snap-in and press-fit connections can also withstand high stresses. Ultraform®'s outstanding elasticity and strength, even at high temperatures, are particularly suitable for this form of construction.

Ultraform® parts can be welded by heating-element (thermal contact and radiation) methods, and by ultrasonic, vibration and spin welding methods. Only high-frequency welding is not feasible for Ultraform® on account of the low dielectric dissipation factor.

The laser irradiation welding method is suitable for combinations of parts molded from Ultraform® which is transparent to IR radiation (e.g. natural-colored) and parts molded from Ultraform® absorbing IR radiation (e.g. black). In this way very clean welded joints can be produced without flash.

Ultrasonic welding is preferred in cases where short welding times and ready integration into fully automated production flows are required. The strongest welded joints are achieved with the heating-element method.

Apart from the welding method and the welding parameters, the geometry of the mating surfaces is of great importance for the quality of the welded joints. It is therefore advantageous to choose the best method at the design stage and then to design the mating surfaces accordingly.

Adhesive bonding

In order to activate the non-polar material, it is necessary to pre-treat the surfaces, e.g. by etching, priming or corona discharge.

Adhesive bonding is possible only with pressure-sensitive adhesives. The joint obtained is impervious to gas, air and moisture, but has only low mechanical strength.

Since the pre-treatment, primer and adhesive form a single system, adhesives suppliers or the BASF Application Engineering experts should be contacted to provide help in solving bonding problems.

Printing, embossing, varnishing and metallization

Ultraform®'s hard, smooth surface and high resistance to chemicals have an adverse effect on the bonding strength of coatings. The usual methods of pre-treating plastics do not afford satisfactory results.

The use of certain printing inks in conjunction with a subsequent, brief flame treatment or with high-temperature ageing translates into high adhesive strength without the need for any special pre-treatment. Please consult the BASF Applications Engineering experts for the clarification of any specific questions.

Embossing films are available for hot stamping which exhibit adequate adhesion even without pre-treatment of the surfaces.

Electroplating

Surface pre-treatment is necessary for the production of electroplated moldings. Parts made from Ultraform® can be electroplated by the method commonly used for ABS. The first stage in the process, however, etching with chromosulfuric acid, is replaced by acid treatment in dilute sulfuric or nitric acid.

It is imperative that the use of baths containing hydrochloric acid be avoided.

To remove any superficial acid residues the parts are then immersed in a weakly alkaline bath and rinsed thoroughly. The rest of the process is as for ABS.

Using this method relatively firm anchorage of the metal layer to the molding is achieved, as has been confirmed by cyclical temperature tests in the automotive and sanitary ware industry.

Laser marking

Table 5 provides an overview of the suitability of undyed and black Ultraform® to be marked by various lasers. Nd:YAG lasers having a wavelength of 1064 nm are often employed for printing. In general, black Ultraform® grades – color code “black 11020” in particular – enable high-contrast lettering and images with Nd:YAG lasers.

Laser	Wavelength	Uncolored Ultraform®	Ultraform® black 120
UV	308 nm	–	light marking
UV	355 nm	–	light marking
Nd:YAG “green”	512 nm	–	light marking
Nd:YAG	1064 nm	–	light marking
CO ₂	10.6 μm	engraving	engraving

Table 5: Laser marking performance of Ultraform®



General information

Safety notes

Safety precautions during processing

Ultraform® decomposes when subjected to excessive heat. The decomposition products formed in this case consist essentially of formaldehyde, a gas which has a pungent smell even at very low concentrations and irritates the mucous membranes. Decomposition can rapidly result in the build-up of a high gas pressure in the barrel of the processing unit.

If the die is sealed there may be a sudden release of pressure via the filling hopper. If the dies and filling opening are blocked there is a risk that, as a result of the rising gas pressure in the barrel, the bolts between the barrel and the barrel head on the one hand or between the cylinder head and die on the other hand will shear and endanger human life. It is therefore essential to check the correct operation of the measurement and control devices before the processing machine is started up. Fully automatic systems must be capable of early detection and elimination of technical malfunctions in the processing machine.

When Ultraform® is properly processed, as a rule, only very little formaldehyde appears in the area of the processing equipment. In contrast, if the melt is severely or especially improperly stressed, for example, due to processing at an excessively high temperature and/or with a long residence time of the melt in the processing machine, a stronger formaldehyde odor can be the result. In case of such an operational malfunction, which is also noticeable in the form of brownish burn streaks on the molded parts, the cylinder of the processing machine should be flushed by spraying the melt outside. At the same time the barrel temperature must be reduced. Nuisances caused by odors can be prevented by cooling the damaged material in a water bath.

Measures should be taken to ensure ventilation and venting of the work area, preferably by means of an extraction hood over the barrel unit.

Gas sampling devices for monitoring the country-specific occupational exposure limits for formaldehyde are available on the market.

Contamination of Ultraform® by thermoplastics that cause decomposition of polyacetals, e.g. PVC or plastics containing halogenated fire protection agents, must be avoided under all circumstances. Even small quantities can cause uncontrolled and rapid decomposition of the Ultraform® during processing.

Pellets and finished parts must not be allowed to come into contact with strong acids (especially concentrated hydrochloric acid) since they cause Ultraform® to decompose.

Toxicology-procedures

No detrimental effects to people engaged in the processing of Ultraform® have come to light when the material has been correctly processed and the work areas have been well ventilated.

The country-specific occupational exposure limits for formaldehyde must be observed.

Food legislation

The uncolored standard-grades of our Ultraform® product line (e.g. N2320 003, N2320 FC Aqua®, S2320 003, S2320 FC Aqua®, W2320 003, H2320 006, H4320) are in conformity with the current regulations for food contact in Germany, Europe and the USA with respect to their composition. The conformity of these products is furthermore guaranteed by the production in compliance with the GMP (good manufacturing practice) **Food Contact** standard. In case of detailed information about the food contact status for a certain standard grade, a coloured Ultraform® or a special grade please contact BASF (plastics.safety@basf.com) directly. We are pleased to send you a food contact compliance letter with respect to the regulations in force at present.

Delivery and storage

Ultraform® is supplied as cylindrical or lenticular granules. The products are normally dried ready for processing and supplied in moisture-tight packaging.

Ultraform® is not classed as hazardous within the meaning of CLP Regulation (EC) no. 1272/2008 and is therefore not considered a dangerous good for transportation. Further information can be found in the product safety data sheets.

Ultraform® is classed as not hazardous to water.

Standard packaging is 25 kg bags and 1,000 kg octabins; it can also be supplied in other types of packaging or in silo trucks by agreement. All containers are tightly sealed and should not be opened until immediately prior to use.

Storage and Transport

Ultraform® is not subject to change when it is stored in dry, ventilated rooms. After relatively long storage (>1 year) or when handling material from previously opened containers, preliminary drying is recommended in order to remove any moisture which has been absorbed. Please follow the instructions for storage given in the product safety data sheet.

Color

Ultraform® is supplied in both colored and uncolored form. Uncolored Ultraform® has a white-opaque natural color. A number of products are available in shades of black. Individual grades can be supplied in a variety of shades upon request.

Disposal

All Ultraform® grades can be incinerated in accordance with official regulations. The calorific value of unreinforced grades is 29,000 to 32,000 kJ/kg (Hu according to DIN 51900).

Recovery

Waste materials, e.g. Ultraform® moldings and sprue, can be recycled provided the polymer is clean and has not been thermally degraded. After relatively long storage, the ground material should be dried before being returned it to reprocessing. The maximum permissible proportion of ground material depends on the dimensional and mechanical requirements imposed on the moldings and must be determined in trials. Further information in section "Reprocessing".

(Integrated) management system

QHSE management

Quality, environment and energy management are key elements of BASF's corporate policy. Customer satisfaction is a significant target. The ongoing improvement of our products and services in terms of quality, environment, safety and health is our primary goal.

The BASF business unit Performance Materials Europe uses an integrated management system that covers issues such as quality, environment (including energy), Responsible Care®, safety and health.

The business unit is recognized by an accredited certification company for its:

- Quality Management System according to ISO 9001 and ISO TS 16949
- Environment Management System according to ISO 14001
- Energy Management System according to ISO 50001

Nomenclature

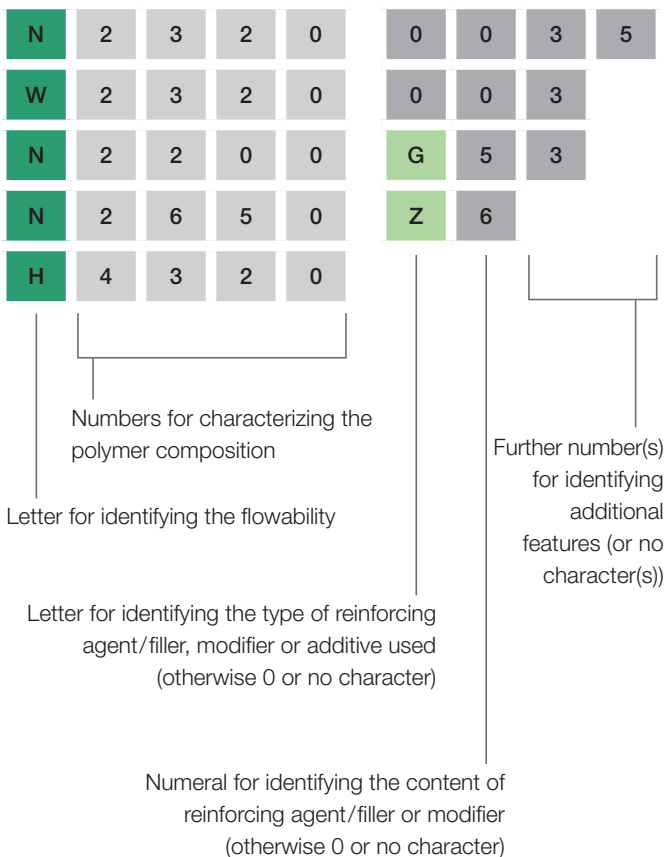
Structure

The name of Ultraform® commercial products generally follows the scheme below:



Technical ID

The technical ID is made up of a series of letters and numbers which give hints about the melt flow rate, the type of reinforcing agents, fillers, modifiers or additives used, their content in the material and special features if applicable. The following classification scheme is found with most products:



Letters for identifying the melt flow rate

The melt flow rate corresponds to the position of the letters in the alphabet: The later the letter appears in the alphabet, the higher the melt flow rate. Usually one of the letters E, H, N, S, W or Z is used. The following rule applies:

- E Lowest flow rate, lowest MVR value
- Z Highest flow rate, highest MVR value

Letters for identifying the type of reinforcing agent, filler, modifier or additive used

- E Impact-modified with rubber
- G Glass fibers
- K Chalk
- L Conductive carbon black
- M Mineral
- P Special lubricant
- U UV-stabilized
- Z Impact-modified with thermoplastic polyurethane

Characteristic numbers for describing the content of reinforcing agents, fillers or modifiers

The numbers 2, 4, 5, 6 and 9 are usually found. The greater the number, the higher the content. The following rule applies:

- 2 approx. 10% by mass
- 4 approx. 20% by mass
- 5 approx. 25% by mass
- 6 approx. 30% by mass
- 9 approx. 45% by mass

Suffixes

Suffixes are optionally used in order to indicate specific processing or application-related properties. They are frequently acronyms whose letters are derived from the English term.

Examples of suffixes:

- Aqua® Meets specific regulatory requirements for drinking water applications
- FC Food Contact; meets specific regulatory requirements for applications in contact with food
- LEV Low Emission Version; low in odors
- PRO Profile Covered Raw Materials Only; meets specific regulatory requirements and needs for medical applications

Color

The color is generally made up of a color name and a color number.

Examples of colors:

- Uncolored
- Black 00120
- Black 00140 (in the case of products that are modified with thermoplastic polyurethane)
- Black 00160 (in the case of products that are modified with rubber)

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Selected Product Literature for Ultraform®:

- Ultramid® – Product Brochure
- Ultraform® – Product Range
- Ultramid®, Ultradur® and Ultraform® – Resistance to Chemicals

Note

The data contained in this publication are based on our current knowledge and experience. In view of the many factors that may affect processing and application of our product, these data do not relieve processors from carrying out own investigations and tests; neither do these data imply any guarantee of certain properties, nor the suitability of the product for a specific purpose. Any descriptions, drawings, photographs, data, proportions, weights etc. given herein may change without prior information and do not constitute the agreed contractual quality of the product. It is the responsibility of the recipient of our products to ensure that any proprietary rights and existing laws and legislation are observed. (June 2016)

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Additional information on specific products:

[www.plasticsportal.eu/name of product](http://www.plasticsportal.eu/name_of_product)

e. g. www.plasticsportal.eu/ultraform

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If you have technical questions on the products,
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