Engineering plastics for the E&E industry

Products, applications, typical values

Further information on individual products:

www.ultramid.de

www.ultradur.de

www.ultrason.de

www.plasticsportal.eu/ultraform

BASF

We create chemistry

Engineering plastics for the E&E industry

Plastics used in electrical applications have to show excellent electrical performance, good mechanical properties as well as high dimensional stability under heat. In daily operation, they have to guarantee insulation and therefore secure handling. They have to reduce fire risk in the event of an electrical defect or exposure to external sources of ignition.

With a lot of applications, the plastic is used for designing the exterior of components as well. This is why design requirements, e. g. for surface quality, haptics, and colors, are becoming more and more important.

Engineering plastics for the E&E industry

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Ultramid® (PA)

Ultramid® (PA: polyamide) has good electrical insulation properties, useful sliding friction performance, and excellent mechanical strength. It is available in a wide range of flame-retardant grades, and is therefore used in almost every sector of industrial control units, connection technology, electronics as well as in household appliances.

The fundamental chemical structure of polyamides makes them highly suitable for use with halogen-free flame retardants. Ultramid® compounds mainly use halogen-free flame retardants, giving extremely low smoke density and smoke toxicity in the event of a fire (Fig. 1). This is becoming more and more important, e. g. in material specifications for rail vehicles, aircraft, and public buildings. The flame-retardant Ultramid® grades are particularly successful in complying with these more stringent requirements. Values for tracking resistance also compare favorably with those of halogen-containing flame retardant systems (Fig. 2).

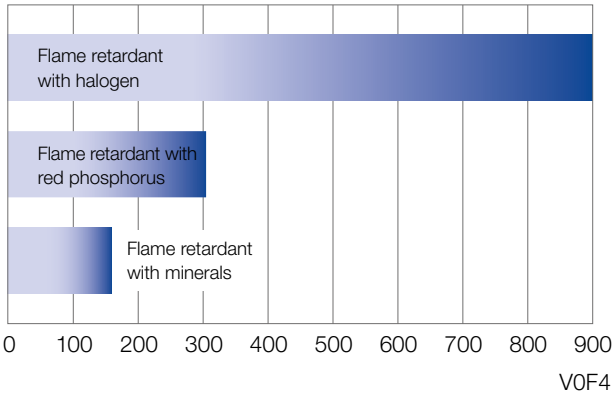


Fig. 1: NF X 10-702 smoke density after four minutes

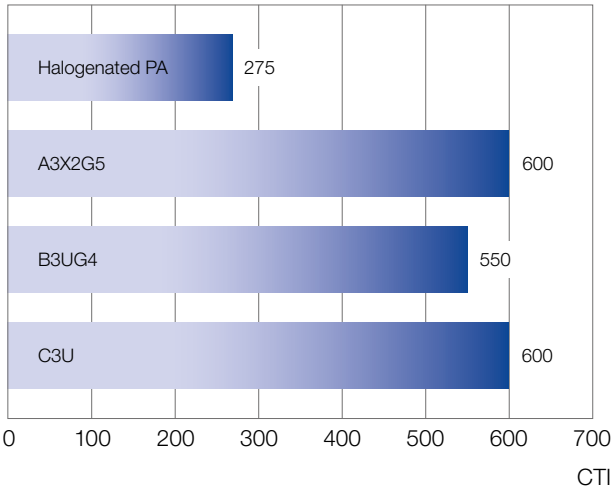


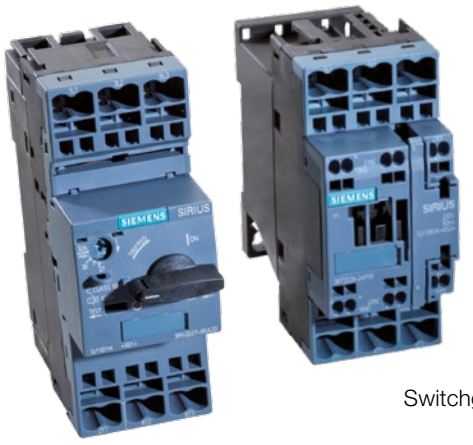
Fig. 2: IEC 112 tracking resistance of flame-retardant polyamides

Control unit for dual-clutch transmission

The Ultramid® grades A3X2G5, A3X2G7, A3X2G10, A3XZG5, and Ultramid® T KR 4365 G5 combine excellent mechanical and tribological properties with high tracking resistance and good fire performance. They meet the requirements of UL94 V-0 and 5VA and display the best flame-retardant additive stability in their material class. The comparative tracking index (CTI) according to IEC 60112 can reach up to 600. In control units, for example, this guarantees a constantly high level of security as far as the electrical functions are concerned. These products can also be processed easily and cost-effectively.

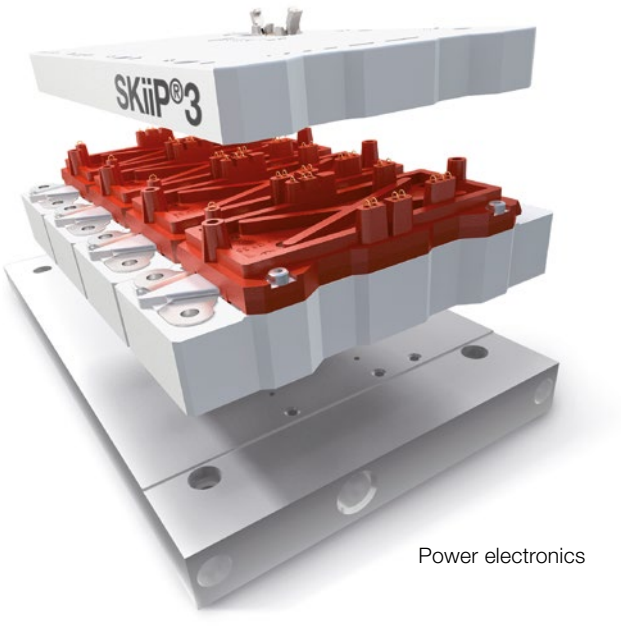
They are a preferred material for many electrical engineering applications and most often used in industrial switchgear and automation. The A3X grades are also the materials of choice for automotive engineering applications where flame retardancy is required.

Ultramid® A3X2G5, A3X2G7 and A3XZG5 are UL-listed for outdoor applications (f1). The Inclined Plane Tracking test (tracking and erosion) is passed at a test voltage of 1,000 V for more than 60 minutes (according to ASTM D-2303, time-to-track method). The chemical resistance and the stress cracking resistance are also excellent. These products are outstandingly well suited to use in photovoltaic applications.



Switchgear

Generator
brush holder



Power electronics

Ultramid® (PA)

For connection technology in solar installations, a suitable grade is Ultramid® A3XZG5 with its excellent impact resistance even at low temperatures. This means it can even pass the UL 1703 cold-impact test (steel ball drop test) at -35°C.

The high stiffness of Ultramid® A3X2G7 makes it particularly suitable for plug connectors in photovoltaic systems: very slim plugs can be designed which nevertheless comply with the stringent requirements.

Photovoltaic connectors

Test results: 1 kV, time-to-track ≥ 60 min.:

Ultramid® A3XZG5	115 min.
Ultramid® A3X2G5	109 min.
Ultramid® A3X2G7	153 min.

Table 1: Values of selected Ultramid® types, Inclined Plane Tracking (IPT), ASTM 2303

Photovoltaic connectors

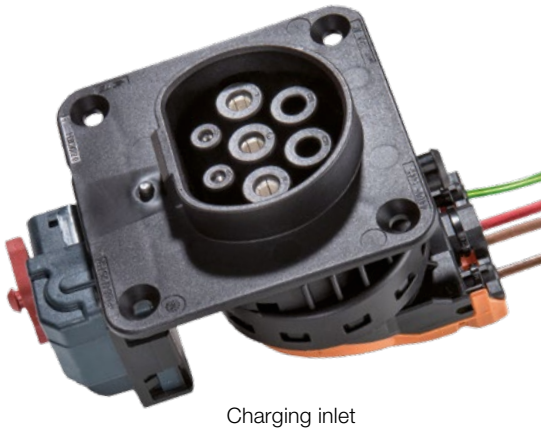
Photovoltaic junction box

Due to their high melting point of 295 °C, the partially aromatic products Ultramid® T KR 4365 G5 (PA 6/6T GF25 FR) and Ultramid® T KR 4340 G6 (PA 6/6T GF30 FR) are suitable for applications such as modern soldering processes using lead-free solder at elevated temperatures. Ultramid® T KR 4340 G6 is also light colorable.

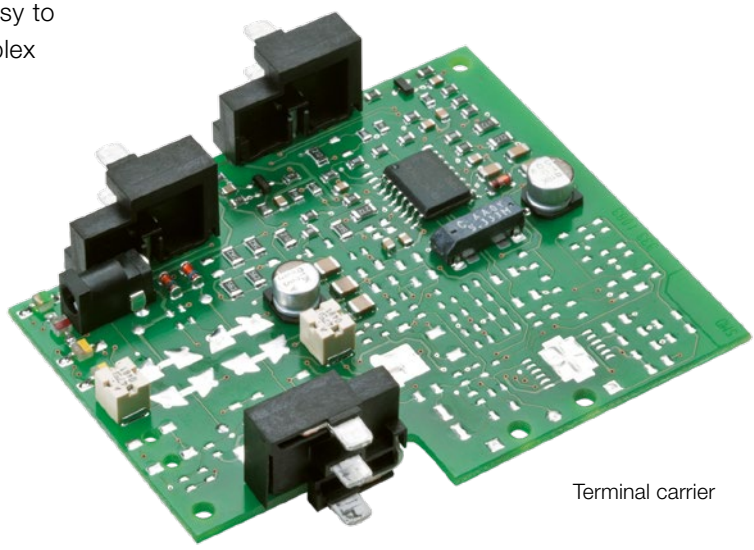
When the injection-molding grades Ultramid® A3U42G6, A3UG5, C3UG4, B3UG4, B3U30G6, and B3UGM210 are used, application-specific colors can be combined with the extensive property profile of reinforced thermoplastics with UL 746 C compliance.

Ultramid® A3U41G5 SI displays a particularly interesting property profile when, in addition to very good flame-retardant properties, improved surfaces are required even for larger components, for example in the automotive sector, electric mobility, and energy storage systems. The halogen-free injection-molding grade also displays excellent long-term heat aging resistance.

Ultramid® A3U42G6 contains a halogen-free flame-retardant system newly developed for electrical applications and fulfills the UL 94 V-0 standard even at 0.4 mm. Moreover, thanks to the use of an innovative heat stabilizer, the product delivers outstanding long-term heat aging resistance, resulting in high RTI values. Ultramid® A3U42G6 is also very easy to process and thus universally suitable for complex molded parts.



Charging inlet



Terminal carrier

Ultramid® (PA)

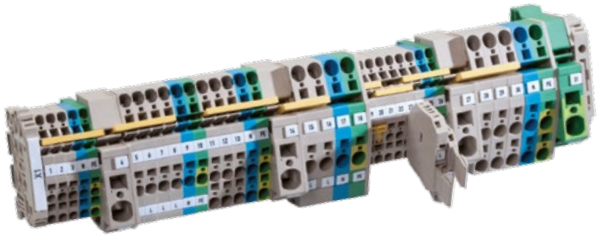
Ultramid® B3UGM210 is a light-colorable plastic with a mineral flame-retardant system showing extremely low smoke density (Fig. 1) and smoke toxicity in the event of a fire. It achieves UL 94 class V-0. Its thermal conductivity is very high for plastics: 1 W/m · K. This grade is particularly suitable for switchgear in buildings and industrial plants, in rail vehicles as well as for thermal management in electronics applications.

The grades Ultramid® B3UG4, B3U30G6 and C3UG4 achieve UL 94 class V-2. They were developed mainly for electrical systems in buildings, in particular for circuit breakers. Ultramid® B3U30G6 is an advance on the well-established product Ultramid® B3UG4, providing another significant increase in stiffness and improving the flowability. The result is increased design freedom, for example in the field of miniaturization.

Ultramid® C3U and A3U30 are unreinforced PA grades featuring exceptional flowability and toughness. Ultramid® A3U30 also achieves UL 94 class V-0 at a wall thickness of 0.25 mm – and is to date the only material in this class to do so. Both of these products can be produced in many colors. Sample plaques achieve GWIT 775 °C in the glow-wire test. These two unreinforced flame-retardant grades are used wherever high toughness is required combined with exceptionally good fire performance. The current main application is terminal blocks for electrical systems in buildings and industrial control units.

The injection-molding grades Ultramid® A3K R01 and B3S R03 are free-flowing, quick to process and inherently flame-retardant. Ultramid® A3K R01 achieves UL 94 class V-2 from a wall thickness of 0.4 mm and is particularly suitable for industrial parts which are subject to high loading such as bearings and gear wheels as well as electrical insulating parts such as terminal blocks and cable connectors. Ultramid® B3S R03 is UL 94 V-2-listed from a wall thickness of 0.8 mm. It is used for CEE connectors, screwed cable glands, and thin-walled industrial components such as housings, fittings, grips, fixing clamps and other small parts.

Circuit breaker



Terminal blocks

Ultradur® (PBT)

Ultradur®, the polybutylene terephthalate (PBT) from BASF, has a specific combination of properties making it an ideal material for particular applications in electrical engineering and electronics. It shows not only high stiffness and good thermal resistance but also exceptional dimensional stability and excellent long-term electrical and thermal performance.

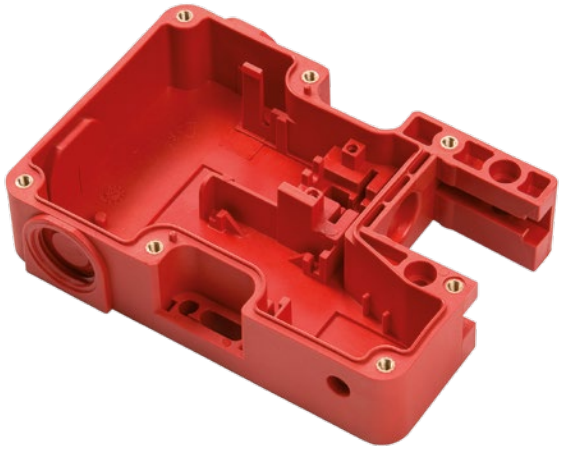
Flame-retardant PBT has hitherto almost always used halogenated flame retardant systems. Halogen-free solutions providing high efficiency have been rarely available to date because they are difficult to achieve. BASF can supplement the existing range of flame-retardant PBT with several Ultradur® grades with halogen-free flame-retardant and excellent property profiles.

Ultradur® B4441 G5 has a flame retardant system which is halogen-free and color-neutral. It achieves UL 94 class V-0 even at 0.4 mm and passes the GWIT 775 °C glow-wire test. This grade is therefore highly suitable for household appliances, plug connectors and automation applications. It can also be used for automotive electronics components like control devices and sensors, if these require flame retardant equipment.

Ultradur® B4450 G5 contains another innovative halogen-free flame retardant system. Specific features here are very high tracking resistance (CTI 600) and exceptionally good contact corrosion performance. Compliance with UL 94 V-0 is achieved for thicknesses starting at 1.5 mm. The product is laser-markable (1,064 nm) if it is uncolored, light-colored or black.

Preferred application sectors are electrical systems in rail vehicles, circuit breakers, plug connectors, and electronic switching elements for higher voltages (e. g. rail vehicles, alternative drives, and photovoltaic systems).

Airbag connectors



Safety switch housing

Steering angle sensor

Ultradur® (PBT)

The well-established flame-retardant Ultradur® B4406 grades are available without reinforcement and also with 10 %, 20 % and 30 % glass fiber content. They feature good mechanical properties, high dimensional stability, and exceptional flame retardance: all colors and glass fiber contents achieve UL 94 V-0 from 0.4 mm wall thickness. If particularly high requirements are placed on mechanics and flowability, the very free-flowing Ultradur® B4406 G6 High Speed is used. Examples of application sectors for these PBT grades are plug connectors, coil formers, and other components of circuit breakers or low-voltage industrial switchgear.

Connectors

Contact of polyesters with water, also in the form of air humidity, leads to hydrolytic cleavage of the polymer chains and hence to a weakening of the material, particularly at elevated temperatures. Important material properties such as strength, elasticity and toughness are affected when the material is subject to hydrolytic damage.

ESP control unit

In application cases when moisture acts on the component at relatively high temperatures and over a particular period of time, additives are generally used as hydrolysis stabilizers. These additives counteract chain cleavage by hydrolysis, significantly delay hydrolytic degradation and can thus prolong the lifetime of a component considerably. The development of hydrolysis-stabilized Ultradur® grades provides materials which combine the proven good properties of Ultradur® with a much higher resistance to the effects of moisture. So it is even possible to manufacture applications for the highest stress classes. For the E&E industry, BASF offers the flame-retardant and hydrolysis-stabilized grade Ultradur® B4450 G5 HR.

Switchgear

Ultrason® (PESU, PSU, PPSU)

BASF's Ultrason® grades are amorphous thermoplastics with high temperature resistance which are based on polyethersulfone (PESU), polysulfone (PSU), and polyphenylsulfone (PPSU). Particular features are their high dimensional stability and good mechanical properties that are substantially independent of temperature (Fig. 3).

Ultrason® is inherently flame-retardant and in many formulations requires no additional flame retardant to achieve UL 94 V-0 starting at a thickness of 1.5 mm. This property profile together with good electrical insulation properties, high heat-aging resistance, and good hydrolysis resistance makes Ultrason® particularly suitable for highly stressed components over a wide temperature range from -50 to +180 °C.

Typical examples of applications for Ultrason® in electrical engineering and electronics are:

- coil formers, plug connectors, parts for circuit breakers and relays
- viewing windows for indicator lamps and switching boards, lamp sockets, lamp covers and reflectors
- heat shields, sensors, chip carriers, chip trays

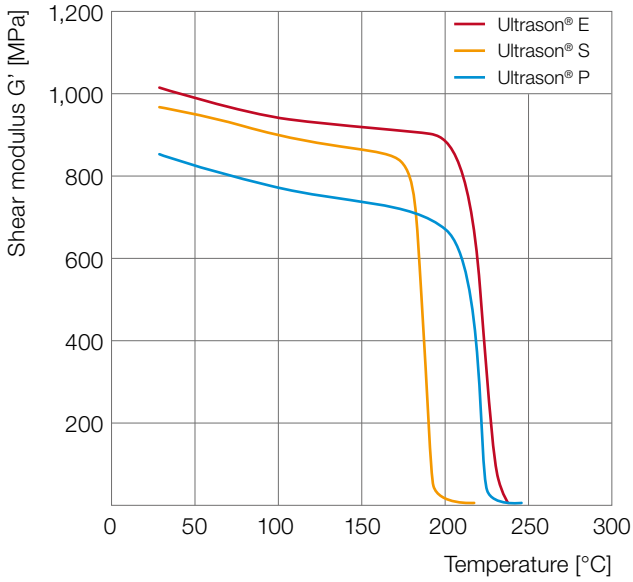
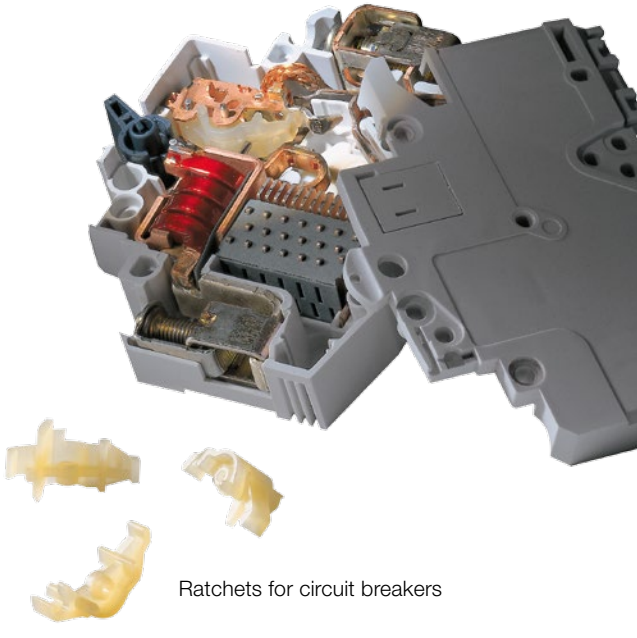


Fig. 3: ISO 6721 shear modulus curves

Sheathing for fuses



Ratchets for circuit breakers

Elastollan® (TPU)

The high-performance material Elastollan®, the thermoplastic polyurethane (TPU) from BASF, has a versatile property profile that makes it an ideal material for applications in signal transmission and energy transfer. Besides a high level of resistance to abrasion and mechanical wear, Elastollan® also has a wide range of strengths: The hydrolytic resistance and the outstanding low-temperature flexibility and resistance to microbes represent considerable advantages in particular for the polyether-based Elastollan® grades used in industrial applications. The polyester-based Elastollan® grades are noted above all for their resistance to oil and grease.

As a leading supplier of flame-retardant TPUs, BASF's Elastollan® FHF and HFFR ranges provide high-quality products which combine efficient, halogen-free flame retardance with the outstanding mechanical properties that are typical of TPUs. Based on their flammability from HB up to V-0 (according to UL94), they are used in a wide variety of industrial applications. Typical areas of application are flame-retardant cable jacketing and connectors in automation engineering and also cables and film applications in the automotive, aviation, and construction industries.

Cables, connectors and grommets made of Elastollan®: Direct overmolding of cables, even when using different Elastollan® grades, produces a dense, highly durable compound structure comprising the cable jacket, contact carrier, and grommet. Every single one of these elements is also noted for its high resistance to wear and abrasion.

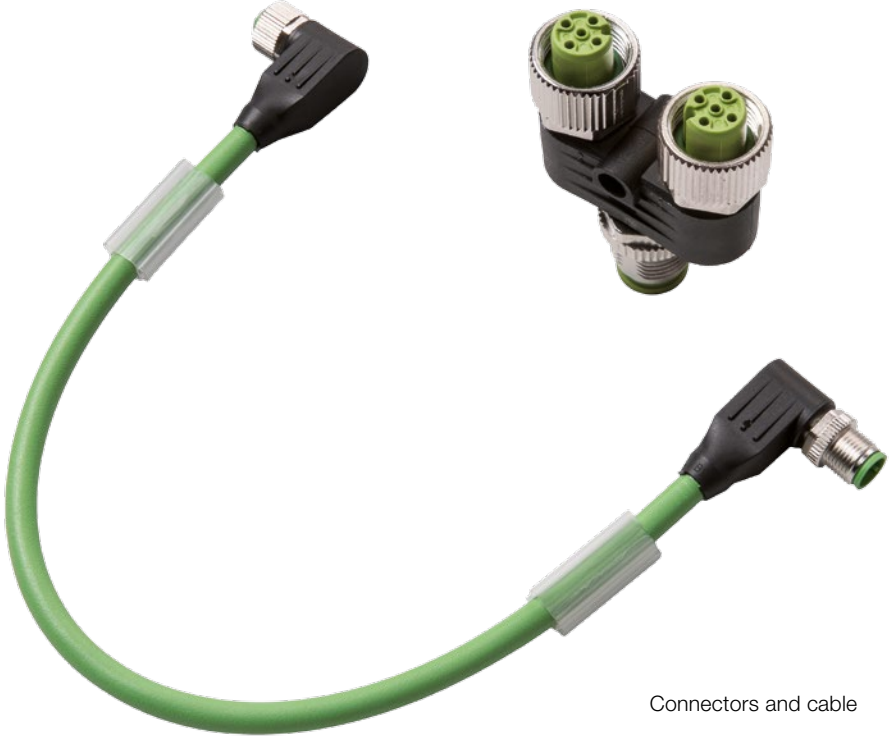
Cable

The polyether-based Elastollan® grades offer a persuasive choice thanks to their excellent cut resistance and high tear and tear propagation resistance over a wide temperature range. This ensures that no weak spots occur even in highly stressed cable sheaths and tubes. Grades that have proven to be particularly suitable for extruded cables, power lines and control cables are Elastollan® 1185 A10 FHF, 1185 A10 HFFR, 1190 A10 FHF and 1192 A11 FHF. Elastollan® 1192 A11 FHF has improved fire-retardant properties which allow it to be used as a cable jacketing for thin-walled UL-approved lines. Elastollan® 1185 A10 HFFR has particularly low smoke density and toxicity, as required in railway applications, for example.

Injection-molded connectors, strain relief sleeves and cable crossovers, which are used primarily in industrial applications, are manufactured predominantly from the unreinforced polyether grades Elastollan® 1185 A10 FHF, 1185 A10 HFFR, 1195 A. If higher levels of toughness are required, the polyether grades Elastollan® 1154 D10 FHF and 1280 D10 FHF are a particularly good choice. Elastollan® 1175 A10 W has established itself in automotive manufacturing for strain relief sleeves for ABS and ESP cables.

Contact carriers and connectors, which need to have very good impact strength with high stiffness combined with good elongation, a low coefficient of thermal expansion and low shrinkage, can be fabricated particularly efficiently using the glass fiber-reinforced, polyester-based Elastollan® R3000. This Elastollan® grade also displays outstanding electrical properties with a tracking resistance of 600.

Connector



Connectors and cable

Overview: Engineering plastics and their applications

	Product	UL 94	GWIT ≥ 775 GWFI ≥ 850 d = 1.5 mm	Halogen-free flame retardant	Symbol
Ultramid® unreinforced	A3K R01	V-2, 0.4	+	+[1)]	PA66
	A3U30	V-0, 0.25	+	+	PA66 FR
	C3U	V-0, 0.4	+	+	PA66/6 FR
	B3S R03	V-2, 0.8	+	+[1)]	PA6
Ultramid® reinforced	A3UG5	V-0, 0.75		+	PA66 GF25 FR
	A3U41G5 SI	V-0, 0.75		+	(PA66+PA6) GF25 FR
	A3U42G6	V-0, 0.4		+	(PA66+PA6) GF30 FR
	A3X2G5	V-0, 0.8		+	PA66 GF25 FR
	A3XZG5	V-0, 1.5		+	PA66-I GF25 FR
	A3X2G7	V-0, 0.75		+	PA66 GF35 FR
	A3X2G10	V-0, 1.5		+	PA66 GF50 FR
	B3UG4	V-2, 0.71		+	PA6 GF20 FR
	B3U30G6	V-2, 0.75		+	PA6 GF30 FR
	B3UGM210	V-0, 1.5		+	PA6 GF10 M50 FR
	T KR4365 G5	V-0, 0.75	+	+	PA6/6T GF25 FR
	T KR4340 G6	V-0, 0.4	+	+	PA6/6T GF30 FR
Ultradur® unreinforced	B 4520	HB, 0.75	+	+[1)]	PBT
	B 4406	V-0, 0.4			PBT FR
Ultradur® reinforced	B 4406 G2	V-0, 0.4			PBT GF10 FR
	B 4406 G4	V-0, 0.4			PBT GF20 FR
	B 4406 G6	V-0, 0.4			PBT GF30 FR
	B 4406 G6 HSP	V-0, 0.4			PBT GF30 FR
	B 4441 G5	V-0, 0.4	+	+	PBT GF25 FR
	B 4450 G5	V-0, 1.5		+	PBT GF25 FR
	B 4450 G5 HR	V-0, 1.5		+	PBT GF25 FR
Ultrason® unreinforced	E 2010	V-0, 1.5	+	+[1)]	PESU
	E 3010	V-0, 1.5		+[1)]	PESU
	P 3010	V-0, 1.5		+[1)]	PPSU
Ultrason® reinforced	E 2010 G4	V-0, 1.5	+	+[1)]	PESU GF20
	E 2010 G6	V-0, 1.5	+	+[1)]	PESU GF30
	S 2010 G6	V-1, 1.5		+[1)]	PSU GF30
Elastollan® unreinforced	1175 A10 W	V-0, 0.9		+	TPU FR
	1185 A10 FHF	V-0, 0.75		+	TPU FR
	1190 A10 FHF	V-0, 0.76		+	TPU FR
	1192 A11 FHF	–		+	TPU FR
	1154 D10 FHF	V-2, 0.76		+	TPU FR
	1280 D10 FHF	V-2, 0.45 & 3		+	TPU FR
	1185 A10 HFFR	–		+	TPU FR
Elastollan® reinforced	R 3000	HB, 0.75 & 3		+[1)]	TPU GF20

[1)] Product does not contain flame-retardant additive

	Electrical household appliances	Terminal blocks	Connectors	Circuit breakers	Low-voltage switch gears	Photovoltaics	Automotive construction	Railway vehicles	Cable jacketing
	●	○	○			○	○		
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● Main field of application ○ Other fields of application

Ultramid® (PA)

Unreinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Condition	–	–
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	%/°C/°C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultramid® A3K R01	Ultramid® A3U30	Ultramid® C3U	Ultramid® B3S R03
PA66	PA66 FR	PA66/6 FR	PA6
1,130	1,180	1,160	1,130
8-9	2.2-2.8	8-9	9-10
2.5-3.1	7-8	2.6-3.2	2.6-3.4
V-2 (0.4)	V-0 (0.25)	V-0 (0.4)	V-2 (0.75)
bk, 1.5	–	–	–
3	0.25	0.4	–
960 (1)	960 (0.8)	960 (0.4)	850 (≤ 1.5)
775 (≤ 1.5)	775 (≤ 1.5)	775 (≤ 1.5)	775 (≤ 1.5)
28	–	34	–
–	–	60	–
–	–	0.41	–
+	–	+	+
–	–	R22: HL3 / R23: HL3	–
dry/moist	dry/moist	dry/moist	dry/moist
3.2/5	3.5/–	3.6/6	3.3/7
250/2,000	200/–	200/3,000	300/3,000
$10^{13}/10^{10}$	$10^{14}/10^{11}$	$10^{13}/10^{9}$	$10^{13}/10^{10}$
$-/10^{10}$	$-/10^{15}$	$-/10^{10}$	$-/10^{10}$
600	600	600	600
75	80	70	65
220	215	210	180
200	–	200	180
101/118	–	107/123	87/97
125	130	120	130
0.33	0.33	0.33	0.33
1,700	1,500	1,700	1,700
70-100/–	60-80/60-90	60-100/60-120	70-100/–
dry/moist	dry/moist	dry/moist	dry/moist
3,100/1,100	3,700/1,800	3,500/1,500	3,500/1,200
85/50	75/50	75/45	90/45
5/20	3.5/15	4/20	4/20
–	–	–	–
–/700	–	–/890	–/1,100
2,900/–	3,600/1,800	3,000/–	3,000/–
–	120/55	–	–
N/N	55/120	80/N	250/N
–	45/–	–	200/–
5/20	3/4	6/35	4/50
4/–	–	4/–	3/–
5.5/N	–	4.5/11	5/N
6/–	–	3.5/–	5/–
260	260	243	220
120, 275/5	–	160, 275/5	160, 275/5
280-300	270-280	250-270	250-270
60-80	60-80	60-80	40-60
0.85/290/60	0.9/270/80	0.8/270/60	0.55/260/60
1.38/1.68	1.5/1.7	1.25/1.27	0.87/1
Easy-flowing injection-molding grade that can be processed quickly for highly stressed technical parts such as bearings and gear wheels; also electrically insulating parts such as terminal blocks and cable connectors.	Halogen-free injection-molding grade with flame retardant, used for example for electrical insulating parts with very small wall thicknesses.	Halogen-free injection-molding grade with flame retardant, used for example for impact-resistant electrical insulating parts such as contact carriers and plug connector strips.	Easy-flowing, finely crystalline injection-molding grade for very fast processing. Uses include thin-walled technical parts, for example housings, fittings, grips, small parts and fixing clamps.

Ultramid® (PA)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Condition	–	–
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Stress at break	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	% / °C / °C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultramid® A3UG5	Ultramid® A3U41G5 SI	Ultramid® A3U42G6	Ultramid® A3X2G5	Ultramid® A3XZG5
PA66 GF25 FR	(PA66+PA6) GF25 FR	(PA66+PA6) GF30 FR	PA66 GF25 FR	PA66-I GF25 FR
1,390	1,390	1,450	1,340	1,320
4-4.6	–	4.7-5.1	5.7-6.3	4.7-5.3
1.1-1.5	–	1.5-1.7	1.2-1.6	1-1.4
V-0 (0.75)	V-0 (0.75)	V-0 (0.4)	HB (0.4) V-0 (0.81)	V-0 (1.5)
	5VA (1.6)	5VA (1.6)	5VA (3)	bk: 5VA (2.3)
bk/gr, 0.75	–	–	bk, 1.6	bk23187, 0.75
0.75	–	–	0.6	1.5
960 (0.75)	960 (0.75)	960 (1)	960 (0.8)	–
775 (≥ 2)	–	–	–	–
32	–	–	27	28
250	–	112	217	–
0.38	–	0.37	0.42	–
–	–	–	+	+
R22: HL3/R23: HL3	–	R22: HL3/R23: HL3	–	–
dry/moist	dry/moist	dry/moist	dry/moist	dry/moist
3.8/4.6	–	–	3.7/5	3.8/4
170/1,000	–	–	200/1,000	200/300
10^{14}/10^{11}	–	>10^{13}/10^{10}	10^{13}/10^{10}	10^{13}/10^{10}
–/10^{15}	–/–	–/10^{10}	–/10^{10}	–/10^{10}
600	400	550	550	575
245	220	230	250	240
260	–	250	250	250
–	–	–	220	180
130/155	–	–	139/157	–
120	150	150	120	120
0.34	–	–	0.33	0.33
1,300	–	–	1,500	–
–	–	22-24/70-110	25-35/60-80	20-30/60-70
dry/moist	dry/moist	dry/moist	dry/moist	dry/moist
9,500/6,100	10,000/6,000	11,000/7,500	8,000/6,000	6,500/4,500
145/90	145/90	145/95	140/100	105/70
–	–	–	–	–
3/5	3/5.5	3/5	3/4.5	6/11
–	–	–	–/3,500	–/2,000
9,500/6,100	–	11,000/7,500	7,100/–	5,500/–
230/160	–	230/160	–	115/100
65/65	60/60	70/75	65/70	90/100
63/–	–	55/60	60/65	85/80
7.5/9	7.5/9	8/11	13/17	25/30
–	–	7/7	–	–
10/14	–	10/12	12/17	24/–
–	–	–	–	10/10
260	260	260	260	260
25, 275/5	40, 275/5	20, 275/5	30, 275/5	–
280-300	280-300	280-300	280-300	280-300
80-90	60-100	80-90	60-90	80-90
0.4/290/80	–	0.4/290/80	0.5/290/80	0.55/290/80
0.4/1.2	0.35/0.9	0.35/0.8	0.48/1.23	–
Glass fiber-reinforced injection-molding grade that is flame-retardant without halogens; light colorable; outstanding mechanical and electrical properties.	Glass fiber-reinforced injection-molding grade that is flame-retardant without halogens; outstanding mechanical and electrical properties.	Glass fiber-reinforced injection-molding grade that is flame-retardant without halogens; light colorable; outstanding mechanical and electrical properties.	Glass fiber-reinforced injection-molding grade with improved flame-retardant properties for components with increased stiffness requirements; flame retardant based on red phosphorus; outstanding mechanical and electrical properties.	Impact-modified, glass fiber-reinforced injection-molding grade with improved flame-retardant properties; flame retardant based on red phosphorus; for components requiring high stiffness and enhanced toughness such as photovoltaic connectors and junction boxes.

Ultramid® (PA)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Condition	–	–
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Stress at break	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	% / °C / °C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultramid® A3X2G7	Ultramid® A3X2G10	Ultramid® C3UG4	Ultramid® B3UG4
PA66 GF35 FR	PA66 GF50 FR	PA66/6 GF20 FR	PA6 GF20 FR
1450	1600	1310	1310
4.4-5	3.7-4.3	–	6.6-7.2
1-1.4	0.7-1.1	2-2.4	2-2.4
HB (0.4) V-0 (0.75) bk: 5VA (1.5)	V-2 (0.4) V-0 (1.5)	V-2 (0.8)	V-2 (0.71)
bk23187, 0.75	–	–	bk, 0.71
0.75	0.75	3	1.5
960 (1)	960 (1)	960 (1)	960 (1)
–	–	–	–
28	28	–	31
180	184	–	203
0.38	0.36	–	0.55
+	+	–	+
–	–	–	R22: HL2/R23: HL2
dry/moist	dry/moist	dry/moist	dry/moist
3.6/5	3.6/5	–	3.8/–
200/2,000	200/–	–	150/–
$10^{13}/10^{10}$	$10^{13}/10^{10}$	–	$10^{13}/10^{11}$
$-/10^{10}$	$-/10^{10}$	$-/10^{12}$	$-/10^{10}$
600	600	550	550
250	250	195	170
250	250	210	210
220	220	–	200
140/157	125/145	–	160/185
115	115	–	140
0.34	0.35	–	0.4
1,400	1,300	–	1,300
15-20/60-70	15-20/40-50	–	50-55/50-60
dry/moist	dry/moist	dry/moist	dry/moist
11,000/8,500	16,000/12,000	6,000/2,700	6,000/3,000
160/120	180/130	95/45	95/50
–	–	–	–
3/4	2/3	3/6	3/6
–/4,250	–/5,400	–	–/1,500
9,200/–	13,000/–	–	5,700/2,800
–	–	–	150/70
70/70	55/55	35/85	40/110
65/–	50/–	–	35/–
14/18	13/16	–	3/9
10/–	11/–	–	3.4/–
13/20	14/20	–	5/10
–	–	–	4/–
260	260	240	220
25, 275/5	25, 275/5	120, 275/5	80, 275/5
280-300	290-300	250-270	250-275
80-90	80-90	60-80	80-90
0.45/290/80	0.4/290/80	0.5/270/80	0.5/270/80
0.34/1.14	–	–	0.8/0.8
Glass fiber-reinforced injection-molding grade with improved flame-retardant properties; flame retardant based on red phosphorus; very high stiffness and strength; outstanding electrical properties.	Glass fiber-reinforced injection-molding grade with improved flame-retardant properties; flame retardant based on red phosphorus; very high stiffness and strength; outstanding electrical properties.	Injection-molding grade that is flame-retardant without halogens and has outstanding free-flow properties, good electrical properties and low smoke density. Passes glow-wire test GWFI up to 960 °C.	Injection-molding grade that is flame-retardant without halogens and has outstanding free-flow properties, good electrical properties and low smoke density. Passes glow-wire test GWFI up to 960 °C.

Ultramid® (PA)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Condition	–	–
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Stress at break	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	%/°C/°C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultramid® B3U30G6	Ultramid® B3UGM210	Ultramid® T KR 4365 G5	Ultramid® T KR 4340 G6
PA6 GF30 FR	PA6 (GF10+M50) FR	PA6T/6 GF25 FR	PA6T/6 GF30 FR
1,440	1,670	1,380	1,460
5.3-5.9	4.1-4.7	5-6	4.3-5.3
1.5-2	1-1.4	1.1-1.5	1.4-1.8
HB (0.4) V-2 (0.75)	V-2 (0.75) V-0 (1.5)	V-2 (0.37) V-0 (0.75) 5VA (1.5)	V-0 (0.4) 5VA (1)
–	–	–	–
0.75	0.75	0.75	0.4
960 (1)	960 (1)	960 (0.75)	960 (0.4)
–	–	775 (0.75)	775 (0.4)
–	52	26	50
–	10	–	–
–	0.23	–	–
–	+	+	+
–	R22: HL3 / R23: HL3	–	–
dry/moist	dry/moist	dry/moist	dry/moist
4/4.8	4.5/5	4/–	3.9/4.1
200/1,000	150/500	200/–	150/270
$10^{13}/10^{9}$	$10^{13}/10^{10}$	$10^{13}/10^{12}$	$10^{15}/10^{14}$
$-/>10^{14}$	$-/10^{13}$	$-/10^{13}$	$-/10^{14}$
525	600	600	600
180	195	220	220
210	215	–	–
–	200	270	270
–	149/167	125/150	–
140	130	140	160
0.28	1	0.31	0.37
1,200	1,400	1,400	1,200
30/67-90	40-60/40-50	25/50-60	20-25/65-75
dry/moist	dry/moist	dry/moist	dry/moist
8,000/4,300	11,000/6,500	8,300/8,000	11,000/11,000
95/50	110/80	150/140	150/130
–	–	–	–
3.2/10	1.8/2.5	3/–	2.5/2.5
–	–	–/6,400	–
7,800/4,500	10,000/–	–	11,000/11,000
160/90	165/115	–	240/210
35/65	30/30	75/–	65/50
25/25	30/–	–	65/–
3.7/6	2.5/4	13/–	8.5/8
–	2.7/–	–	8/–
3.7/6	2.5/4.5	13/–	–
–	–	–	–
220	220	295	290
150, 275/5	30, 275/5	–	45, 325/5
250-270	290-310	310-330	310-330
80-90	80-90	80-120	80-120
0.5/270/80	0.5/290/80	0.4/320/100	0.1/320/100
0.4/0.9	–	0.55/1	0.4/0.9
Injection-molding grade that is flame-retardant without halogens and has outstanding free-flow properties and good electrical properties. Passes glow-wire test GWFI up to 960 °C.	Injection-molding grade that is flame-retardant without halogens and has very high stiffness, outstanding electrical properties and low smoke density.	Glass fiber-reinforced partially aromatic polyamide for injection-molding; flame retardant based on red phosphorus; good mechanical properties, low water absorption, high melting point, high tracking resistance, resistant to soldering temperatures.	Glass fiber-reinforced partially aromatic polyamide, halogen-free flame retardant; light colorable, outstanding flame-retardant properties, high tracking resistance, resistant to soldering temperatures.

Ultradur® (PBT)

Unreinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	%/°C/°C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultradur® B 4520	Ultradur® B 4406
PBT	PBT FR
1,300	1,450
0.5	0.4
0.25	0.25
HB (0.75)	V-0 (0.4)
–	–
3	0.4
850 (≤ 1.5)	960 (1)
775 (≤ 1.5)	–
20	29
–	–
–	–
+	+
–	–
–	–
3.3	3.3
200	170
10^{14}	10^{14}
10^{13}	10^{13}
550	250
55	60
165	170
200	200
120/140	110/135
130	120
0.27	0.27
1,250	1,500
130-160/–	50-60/–
2,500	3,000
55	65
3.7	3.9
–	–
1,200	–
2,400	–
85	–
N	50
–	–
5	4
3	4
–	–
–	–
223	223
21, 250/2.16	30, 275/2.16
250-275	245-270
40-70	40-70
1.2-1.5/260/60	1.3-1.5/260/60
1.5/1.7	–
Standard injection-molding grade for fabricating functional technical parts.	Standard injection-molding grade with flame-retardant properties, migration-free, for parts requiring enhanced fire resistance, e. g. plug-in connectors and housings.

Ultradur® (PBT)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Stress at break	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	%/°C/°C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultradur® B 4406 G2	Ultradur® B 4406 G4	Ultradur® B 4406 G6	Ultradur® B 4406 G6 High Speed
PBT GF10 FR	PBT GF20 FR	PBT GF30 FR	PBT GF30 FR
1,520	1,600	1,650	1,670
0.4	0.4	0.4	0.4
0.2	0.2	0.2	0.2
V-0 (0.4) 5VA (2)	V-0 (0.4)	V-0 (0.4) 5VA (1.5)	V-0 (0.4) 5VA (1.6)
–	bk, 0.75	–	–
0.75	0.4	0.4	0.4
960 (1)	960 (1)	960 (1)	960 (1)
–	–	–	–
30	30	32	–
–	–	–	–
–	–	–	–
+	+	+	–
–	–	–	–
–	–	–	–
3.5	3.6	3.9	–
150	170	150	–
10^{14}	10^{14}	10^{14}	10^{14}
10^{13}	10^{13}	10^{13}	10^{13}
225	200	200	175
190	200	205	–
215	220	220	–
210	210	210	–
120/130	120/130	125/150	–
140	140	140	140
–	–	0.32	–
1,600	1,500	1,400	–
50/–	28-34/–	20-30/–	–
5,500	8,200	11,300	11,700
95	125	145	140
–	–	–	–
3.3	2.6	2.3	1.9
–	–	7,500	–
–	–	–	–
–	–	–	–
40	48	60	50
40	50	55	–
5	8	10	7
–	–	–	–
–	–	–	–
–	–	–	–
223	223	223	223
15, 275/2.16	11, 275/2.16	8, 275/2.16	12, 275/2.16
250-275	250-275	250-275	250-280
60-100	60-100	60-100	60-100
–	0.7-0.9/260/80	0.5-0.6/260/80	–
–	–	–	–
Injection-molding grade with 10 % glass fibers for parts requiring enhanced fire resistance, e. g. relay housings, coil formers, switch parts, and plug-in connectors.	Injection-molding grade with 20 % glass fibers for parts requiring enhanced fire resistance, e. g. relay housings, plug-in connectors, switch and lighting components.	Injection-molding grade with 30 % glass fibers for parts requiring enhanced fire resistance, e. g. microswitches and capacitor cans, plug-in connectors and switch parts.	Injection-molding grade with 30 % glass fibers, excellent flowability, for parts requiring enhanced fire resistance, e. g. microswitches and capacitor cans, plug-in connectors, and switch parts.

Ultradur® (PBT)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h / 5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Stress at break	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	%/°C/°C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultradur® B 4441 G5	Ultradur® B 4450 G5	Ultradur® B 4450 G5 HR
PBT GF25 FR	PBT GF25 FR	PBT GF25 FR
1,530	1,600	1,580
0.4	0.4	0.4
0.2	0.2	0.2
V-0 (0.4) 5VA (1.5)	V-2 (0.4) V-0 (1.5) 5VA (2)	V-2 (0.4) V-0 (1.5) 5VA (2)
–	–	–
0.4	0.75	0.75
960 (1)	960 (1)	960 (1.5)
775 (1)	675 (1)	–
38	29	–
430	230	–
0.18	0.17	–
+	+	–
R22:HL1/R23:HL2	R22: HL2/R23:HL2	–
–	–	–
3.6	3.8	3.9
137	140	150
10^{14}	10^{14}	$>10^{13}$
$>10^{16}$	$>10^{16}$	$>10^{16}$
525	600	600
210	210	208
220	220	222
210	–	210
–	–	–
140	140	140
–	–	–
–	–	–
20-30/110-120	30-40/120-130	–
9,800	10,000	8,400
110	110	110
–	–	–
2.3	2.2	2.6
–	–	–
10,000	9,700	–
180	180	–
45	45	50
47	45	39
7	6	6
–	–	–
–	–	–
–	–	–
223	223	223
15, 275/2.16	17, 275/2.16	7, 275/2.16
260-280	260-280	260-280
60-100	60-100	60-100
0.5/260/80	0.7/260/80	0.7/260/80
0.44/1.24	0.5/1.3	–
Glass fiber-reinforced injection-molding grade with halogen-free and antimon-free fire-retardant properties; specifically optimized for the glow-wire requirements of IEC 60335; for applications such as plug-in connectors, switch parts, and components of household appliances.	Glass fiber-reinforced injection-molding grade with halogen-free and antimon-free fire-retardant properties; specifically optimized for increased tracking resistance, for example for lighting components, plug-in connectors, switch parts, coil formers, and housings of control units.	Glass fiber-reinforced injection-molding grade with halogen-free and antimon-free fire-retardant properties; specially optimized for good hydrolytic stability and increased tracking resistance.

Ultrason® (PESU, PSU, PPSU)

Unreinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	% / °C / °C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultrason® E 2010	Ultrason® E 3010	Ultrason® P 3010
PESU	PESU	PPSU
1,370	1,370	1,290
2.2	2.2	1.2
0.8	0.8	0.6
V-0 (1.5) 5VA (3)	V-0 (1.5) 5VA (3)	V-0 (1.5)
–	–	–
–	–	–
960 (1)	960 (1)	960 (1)
825 (1)	–	750 (1)
38	38	43
–	–	–
–	–	–
+	+	+
–	–	–
moist	moist	moist
3.8	3.8	3.7
140	140	89
$>10^{13}$	$>10^{13}$	$>10^{13}$
$>10^{15}$	$>10^{15}$	$>10^{15}$
125	125	150
205	207	198
218	218	212
220	220	–
180/–	180/–	–
180	180	–
0.19	0.18	–
1,000	1,000	1,000
52/–	52/–	55/–
2,650	2,650	2,270
85	85	74
6.9	6.9	7.8
–	–	–
–	–	–
–	–	2,400
–	–	–
N	N	N
N	N	N
7	8	75
7.5	8	25
7	8	55
7.5	8	25
225	228	220
70, 360/10	35, 360/10	35, 360/10
340 - 390	350 - 390	350 - 390
140 - 180	140 - 180	140 - 180
0.71/360/160	0.75/370/160	–/360/160
0.82/0.86	0.85/0.9	0.9/1

Unreinforced, medium-viscosity standard injection-molding grade. Abbreviated designation according to ISO 1043 - 1: PESU.

Unreinforced, higher-viscosity injection-molding and extrusion grade, tougher and with improved chemical resistance. Abbreviated designation according to ISO 1043 - 1: PESU.

Unreinforced, medium-viscosity standard injection-molding and extrusion grade with superior toughness, stress cracking and chemical resistance, resistant to superheated steam. Abbreviated designation according to ISO 1043 - 1: PPSU.

Ultrason® (PESU, PSU, PPSU)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746 C
UL 746 C fire/ignition performance (UL 94 + HAI + HWI), min. thickness	mm	UL 746 C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2: 2013-08
Electrical properties		
Condition	–	–
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Temperature limit for application, max. time of use, known value for parts	°C	–
Temperature index for 50 % loss of tensile strength after 20,000 h/5,000 h	°C	IEC 60216
RTI "dielectric strength" at 1.5 mm thickness	°C	UL 746 B
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Coeff. of linear therm. expansion 23 °C - 55 °C (parallel/perpendicular)	10^{-6}/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Stress at break	MPa	ISO 527-1/-2
Yield strain	%	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Tensile creep modulus, 1,000 h	MPa	ISO 899-1
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Izod notched impact strength +23 °C	kJ/m²	ISO 180-A
Izod notched impact strength -30 °C	kJ/m²	ISO 180-A
Processing		
Melting temperature, DSC (10 °C/min)	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature/load	cm³/10 min, °C/kg	ISO 1133
Melt temperature range injection-molding	°C	–
Mold temperature range injection-molding	°C	–
Molding shrinkage, test box, d = 1.5 mm, T_M, T_W	% / °C / °C	–
Molding shrinkage parallel/perpendicular	%	ISO 294-4

Footnote
[1] passed: +

Ultrason® E 2010 G4	Ultrason® E 2010 G6	Ultrason® S 2010 G6
PESU-GF20	PESU-GF30	PSU-GF30
1,500	1,590	1,460
1.6	1.6	0.6
0.6	0.6	0.2
V-0 (1.5)	V-0 (1.5)	V-1 (1.5) V-0 (3)
–	–	–
–	–	–
960 (1)	960 (1)	960 (1)
825 (1)	875 (1)	–
44.5	44.5	40
–	–	–
–	–	–
+	+	+
–	–	–
moist	moist	moist
4.2	4.3	3.7
100	100	60
$>10^{13}$	$>10^{13}$	$>10^{13}$
$>10^{15}$	$>10^{15}$	$>10^{15}$
125	125	125
222	223	185
224	224	187
220	220	180
180/–	190/–	160/–
180	180	160
0.19	0.23	0.22
–	900	1,000
20/–	15/–	22/–
6,900	9,800	8,900
130	150	120
–	–	–
3.2	2.3	2.2
5,600	8,300	8,300
–	–	–
–	–	–
60	55	40
65	60	45
8	10	8.5
8	9.5	8.5
8	10	8.5
8	9.5	8.5
225	225	187
35, 360/10	25, 360/10	30, 360/10
350-390	350-390	350-390
150-190	150-190	130-180
0.45/370/170	0.4/370/170	0.34/360/150
0.36/0.61	0.28/0.58	0.29/0.46
Medium-viscosity injection-molding grade with high stiffness and strength, reinforced with 20 % glass fibers. Abbreviated designation according to ISO 1043-1: PESU-GF.	Medium-viscosity injection-molding grade with high stiffness and strength, reinforced with 30 % glass fibers. Abbreviated designation according to ISO 1043-1: PESU-GF.	Low-viscosity injection-molding grade with high stiffness and strength, reinforced with 30 % glass fibers. Abbreviated designation according to ISO 1043-1: PSU-GF.

Elastollan® (TPU)

Unreinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Electrical properties		
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Thermal conductivity, 23 °C	W/(mK)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kgK)	–
Mechanical properties		
Hardness	Shore	ISO 7619-1 (3s)
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Tensile strength	MPa	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Processing		
Melt mass flow rate MFR, test temperature/load	g/10 min.,°C/kg	ISO 1133
Melt temperature range for injection-molding	°C	–
Mold temperature range for injection-molding	°C	–

Values after tempering (20 h, 100 °C) in conditioned state

Footnote
[1] passed: +
[2] Product not UL listed

Elastollan® 1175 A10 W	Elastollan® 1185 A10 FHF	Elastollan® 1190 A10 FHF	Elastollan® 1185 A10 HFFR[2]
–	–	–	–
1,140	1,230	1,250	1,420
1.4	1.4	–	–
0.5	0.4	–	–
V0 (0.9-1.1) V2 (1.2)	V0 (0.75)	V0 (0.76)	
960 (2)	875 (2)	–	–
875 (2)	850 (2)	–	–
25-26	24	24	32
–	627	–	181 (1.6 mm)
–	0.36	–	0.11
+	+	+	+
6.5	5.5	–	6.2
–	960	–	1,108
10^{9}	10^{9}	–	10^{7}
10^{14}	10^{14}	–	10^{12}
600	600	–	600
–	–	–	–
–	–	–	–
–	0.32	–	–
–	1,500	–	–
75 (A)	89 (A)	90 (A)	86 (A)
–	–	–	–
40	35	25	23
700	600	550	580
N	N	–	N
N	N	–	N
N	N	N	N
N	120	46	77
40, 190/10	35, 200/21.6	35, 200/21.6	10, 180/5
210-220	215-225	215-225	215-225
20-40	20-40	20-40	20-40
Thermoplastic polyether-polyurethane with excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms.	Thermoplastic polyether-polyurethane that is flame-retardant without halogens and has excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms.	Thermoplastic polyether-polyurethane that is flame-retardant without halogens and has excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms.	Thermoplastic polyether-polyurethane that is flame-retardant without halogens and has excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms. Reduced smoke density and toxicity. Specifically for railway applications.

Elastollan® (TPU)

Unreinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Electrical properties		
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Thermal conductivity, 23 °C	W/(mK)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kgK)	–
Mechanical properties		
Hardness	Shore	ISO 7619-1 (3s)
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Tensile strength	MPa	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Processing		
Melt mass flow rate MFR, test temperature/load	g/10 min.,°C/kg	ISO 1133
Melt temperature range for injection-molding	°C	–
Mold temperature range for injection-molding	°C	–

Values after tempering (20 h, 100 °C) in conditioned state

Footnote
[1] passed: +
[2] Product not UL listed

Elastollan® 1192 A11 FHF[2]	Elastollan® 1195 A10/1195 A15	Elastollan® 1154 D10 FHF	Elastollan® 1280 D10 FHF
–	–	–	–
1,250	1,150	1,270	1,320
–	–	1.4	–
–	–	0.4	–
	HB (0.5; 0.75; 3.0)	V2 (0.76 - 1.5) V0 (3)	V2 (0.45 & 3)
–	750 (2)	960 (2)	–
–	775 (2)	875 (2)	–
29 - 29.6	–	–	–
–	–	–	–
–	–	–	–
+	–	+	–
–	7.5	4.5	–
–	400	640	–
–	10^{12}	10^{10}	10^{13}
–	10^{15}	10^{14}	10^{13}
–	600	600	600
–	–	–	–
–	–	–	–
–	–	0.37	–
–	–	–	–
91 (A)	96 (A)	58 (D)	80 (D)
–	–	160	2,300
–	55	30	49
550	500	400	10
–	–	–	44
–	–	–	25
–	N	50	–
–	N	3	–
38, 200/21.6	–	50, 230/2.16	28, 230/2.16
215 - 225	–	225 - 235	210 - 230
20 - 40	–	30 - 60	20 - 40
Thermoplastic polyether-polyurethane that is flame-retardant without halogens and has excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms. Improved fire-retardant properties.	Thermoplastic polyether-polyurethane with excellent strength and low-temperature flexibility, hydrolytic resistance and resistance to microorganisms.	Thermoplastic polyether-polyurethane that is flame-retardant without halogens and has excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms.	Thermoplastic polyether-polyurethane that is flame-retardant without halogens and has excellent hydrolytic resistance, low-temperature flexibility and resistance to microorganisms.

Elastollan® (TPU)

Reinforced Types

Typical values at 23 °C for uncolored products	Unit	Test method
Features		
Symbol	–	–
Density	kg/m³	ISO 1183
Water absorption, equilibrium in water at 23 °C	%	ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C / 50 % r.h.	%	ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL 94
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen index	%	ISO 4589-1/-2
Railway: Spec. optical density of smoke DS max. (20 min.), 25 kW/m², 2 mm	–	EN ISO 5659-2: 2007-04
Railway: Toxicity of smoke CIT NLP acc. to EN 45545-2: 2013-08	–	NF X70-100-1/-2
Testing of materials for automobile interior, burning rate ≤ 100 mm/min, d ≥ 1 mm	–	ISO 3795, FMVSS 302[1]
Electrical properties		
Dielectric constant at 1 MHz	–	IEC 60250
Dissipation factor at 1 MHz	10^{-4}	IEC 60250
Volume resistivity	Ωm	IEC 60093
Surface resistivity	Ω	IEC 60093
CTI, test liquid A	–	IEC 60112
Thermal properties		
Heat distortion temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Heat distortion temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Thermal conductivity, 23 °C	W/(m K)	DIN 52612-1
Specific heat capacity, 23 °C	J/(kg K)	–
Mechanical properties		
Hardness	Shore	ISO 7619-1 (3s)
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Tensile strength	MPa	ISO 527-1/-2
Strain at break	%	ISO 527-1/-2
Charpy impact strength +23 °C	kJ/m²	ISO 179-1eU
Charpy impact strength -30 °C	kJ/m²	ISO 179-1eU
Charpy notched impact strength +23 °C	kJ/m²	ISO 179-1eA
Charpy notched impact strength -30 °C	kJ/m²	ISO 179-1eA
Processing		
Melt mass flow rate MFR, test temperature/load	g/10 min.,°C/kg	ISO 1133
Melt temperature range for injection-molding	°C	–
Mold temperature range for injection-molding	°C	–

Values after tempering (20 h, 100 °C) in conditioned state

Footnote
[1] passed: +
[2] Product not UL listed

Elastollan® R 3000
–
1,380
–
–
HB (0.75 & 3)
–
–
–
–
–
–
–
–
10^{9}
10^{15}
600
120
155
–
–
73 (A)
2,800
–
10
120
70
30
10
25, 230/2.16
225 - 245
40 - 70

Glass fiber-reinforced thermoplastic polyurethane with excellent properties such as very good impact strength, high stiffness coupled with good elongation, a low coefficient of thermal expansion, low shrinkage and good coating properties.

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- Engineering plastics for the E&E industry – Standards and ratings
- Engineering plastics for the E&E industry – Products, applications, typical values
- Engineering plastics for the E&E industry – Poster (not as PDF)
- Engineering plastics for automotive electrics – Products, applications, typical values
- Elastollan® – Thermoplastic polyurethane elastomers (TPU)
- Elastollan® – Thermoplastic polyurethane elastomers (TPU) – Product Range

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. (August 2016)

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