



We create chemistry

Engineering plastics for the E&E industry

Products, applications, typical values



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.

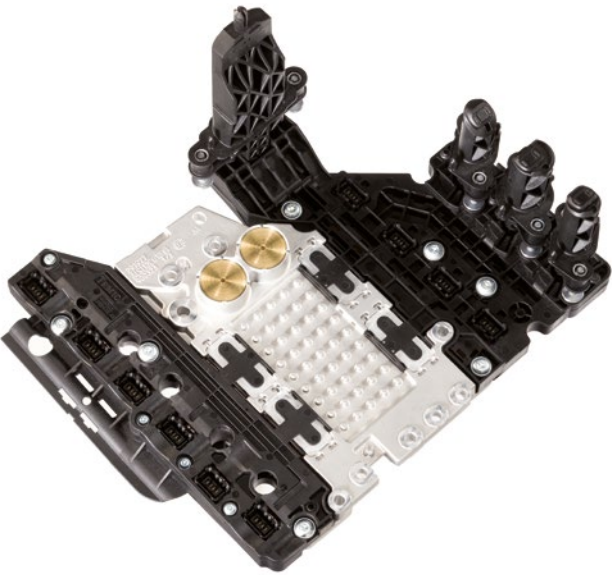
Engineering plastics for the E&E industry

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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).



Control unit for dual-clutch transmission

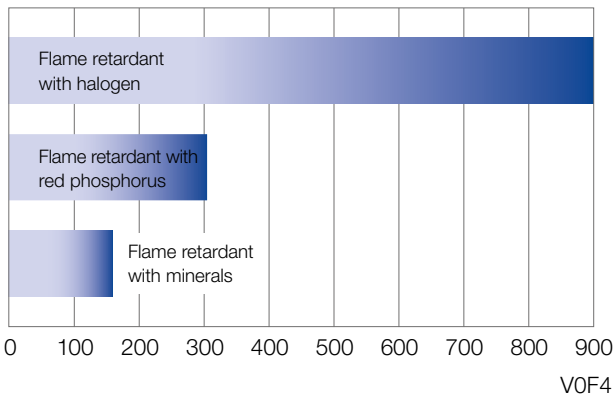


Fig. 1: NF X 10-702 smoke density after four minutes

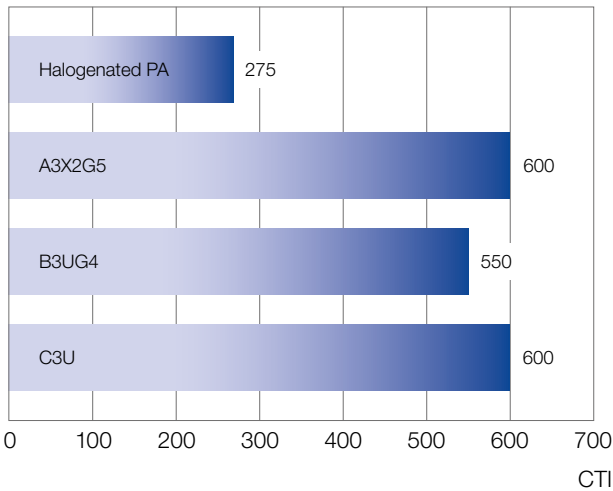
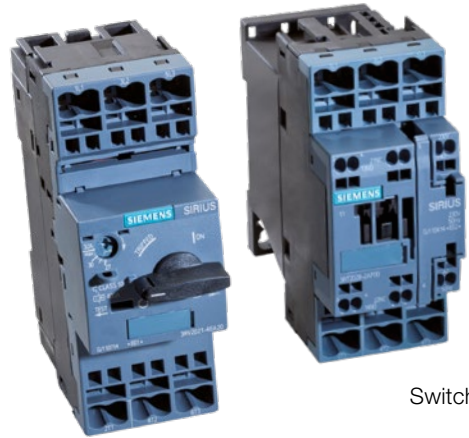


Fig. 2: IEC 112 tracking resistance of flame-retardant polyamides

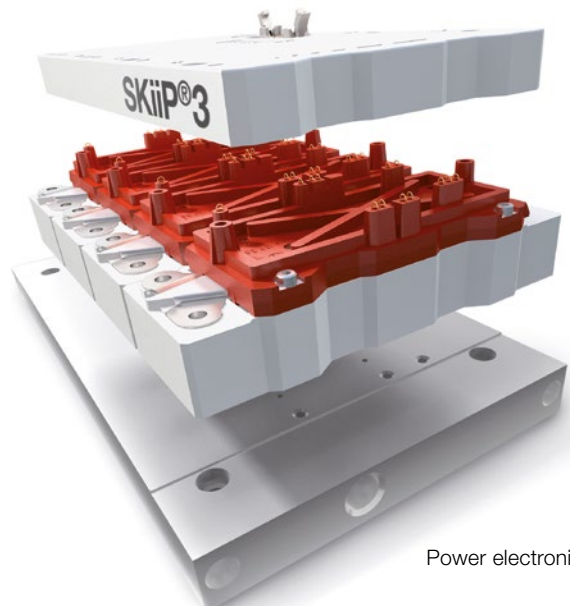
The Ultramid® grades A3X2G5, A3X2G7, A3X2G10, A3XZG5, and Ultramid® T KR 4365 G5 combine excellent mechanical and tribological properties with high tracking resistance and good fire performance. They meet the requirements of UL94 V-0 and 5VA and display the best flame-retardant additive stability in 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.

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 connectors



Photovoltaic junction box

Due to their high melting points, the partially aromatic products based on Ultramid® T (PA6T/6, melting point TM 295 °C) and Ultramid® Advanced N (PA9T, TM 300 °C) are suitable for modern soldering processes using lead-free solder at elevated temperatures, for example. The very low water absorption of the Ultramid® Advanced grades is also beneficial in such applications.

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 746C compliance.

Ultramid® A3U42G6 contains a halogen-free flame-retardant system, which has been newly developed for electrical applications and fulfills the UL94 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 very easy to process and thus universally suitable for complex molded parts.

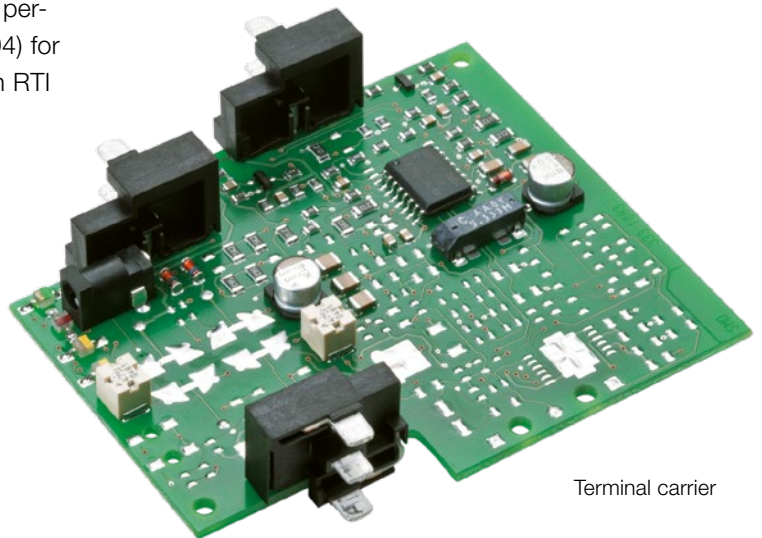
The light-colorable Ultramid® B3U50G6, with a GWIT of 800 °C (1 millimeter), reliably meets the requirement of GWIT 775 °C set by the household appliance standard IEC 60335 -1 and is noted for its particularly high flowability. The product reinforced with 30 percent glass fibers is rated V-0 (according to UL94) for thicknesses starting at 0.75 millimeters, with an RTI value of 150 °C for electrical properties.



Charging inlet



CEE-Stecker



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.

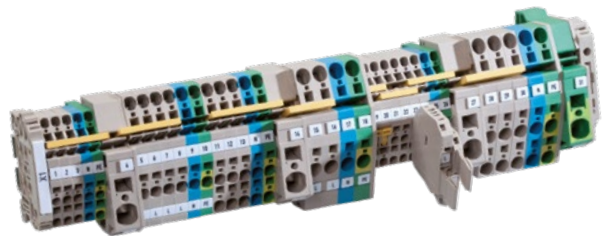
The grades Ultramid® B3UG4, B3U30G6 and C3UG4 achieve UL 94 class V-2. They were developed mainly for electrical systems in buildings, in particular for circuit breakers. Ultramid® B3U30G6 is an advance on the well-established product Ultramid® B3UG4, providing another significant increase in stiffness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

Ultramid® C3U and A3U32 are unreinforced PA grades featuring exceptional flowability and toughness. Ultramid® A3U32 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.

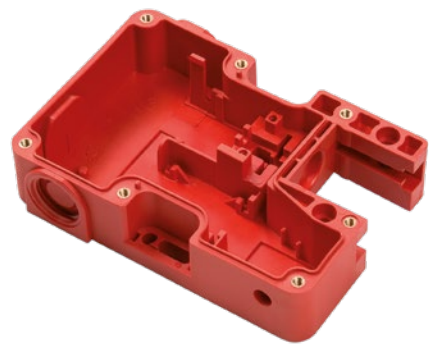
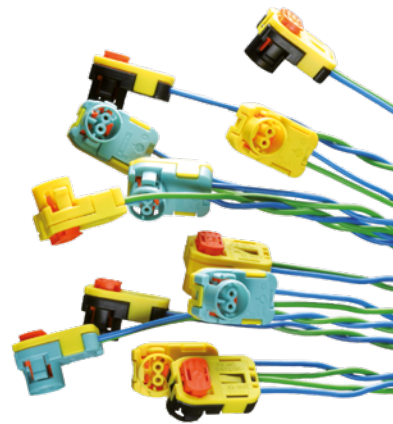
Ultradur® B4441 G5 has a flame retardant system which is halogen-free and color-neutral. It achieves UL 94 class V-0 even at 0.4 mm and passes the GWIT 775 °C glow-wire test. This grade is therefore highly suitable for household appliances, plug connectors and automation applications. It can also be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

The unreinforced Ultradur® B4440 achieves UL94 class V-0 for thicknesses starting at 0.4 mm. It is noted for its particularly high elongation at break (greater than 20 %) and its very high tracking resistance (CTI 600).

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.

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.

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.



Connectors



ESP control unit



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

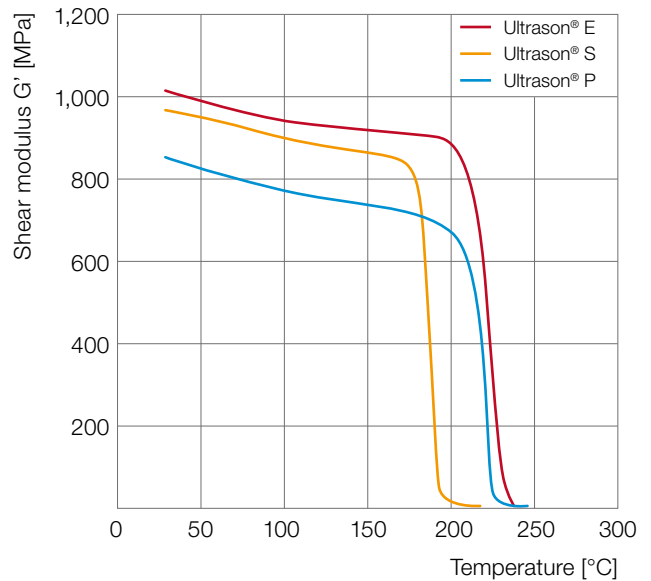
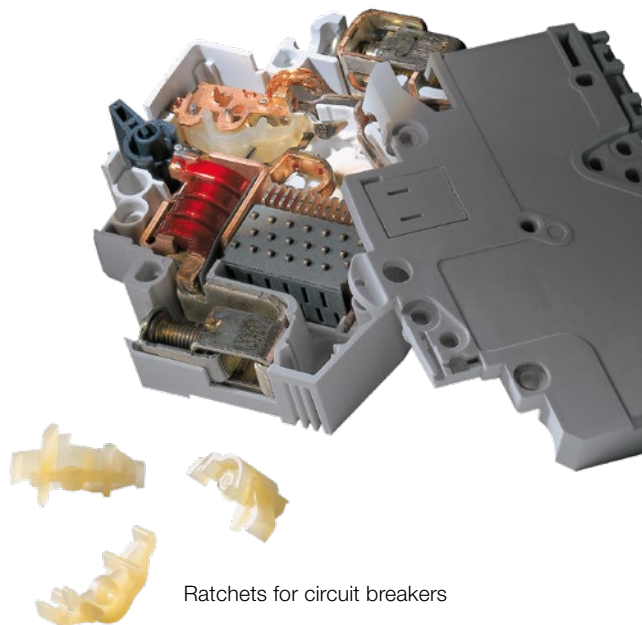


Fig.3: ISO 6721 shear modulus curves



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 10/15. If higher levels of toughness are required, the polyether grade Elastollan® 1154 D10 FHF is 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	RTI _{elec} d = 1.5 mm	GWIT ≥ 775 GWFI ≥ 850 d = 1.5 mm	Halogen-free flame retardant ²⁾
Ultramid® unreinforced	A3K R01	V-2, 0.4	125 °C	+	+ ¹⁾
	A3U32	V-0, 0.25	130 °C	+	+
	C3U	V-0, 0.4	120 °C	+	+
	B3S R03	V-2, 0.8	130 °C	+	+ ¹⁾
Ultramid® reinforced	A3UG5	V-0, 0.75	120 °C		+
	A3U42G6	V-0, 0.4	150 °C		+
	A3X2G5	V-0, 0.8	120 °C		+
	A3XZG5	V-0, 1.5	120 °C		+
	A3X2G7	V-0, 0.75	115 °C		+
	A3X2G10	V-0, 1.5	115 °C		+
	B3UG4	V-2, 0.71	140 °C		+
	B3U30G6	V-2, 0.75	140 °C		+
	B3U50G6	V-0, 0.8	150 °C	+	+
	B3UGM210	V-0, 1.5	130 °C		+
	T KR 4365 G5	V-0, 0.75	140 °C	+	+
	T KR 4340 G6	V-0, 0.4	160 °C	+	+
Ultramid® Advanced reinforced	N3U40G6	V-0, 0.25	120 °C	+	+
Ultradur® unreinforced	B 4520	HB, 0.75	130 °C	+	+ ¹⁾
	B 4406	V-0, 0.4	120 °C		
	B 4440	V-0, 0.4			+ ³⁾
Ultradur® reinforced	B 4406 G2	V-0, 0.4	140 °C		
	B 4406 G4	V-0, 0.4	140 °C		
	B 4406 G6	V-0, 0.4	140 °C		
	B 4406 G6 HSP	V-0, 0.4	140 °C		
	B 4441 G5	V-0, 0.4	140 °C	+	+
	B 4450 G5	V-0, 1.5	140 °C		+
	B 4450 G5 HR	V-0, 1.5	140 °C		+
Ultrason® unreinforced	E 2010	V-0, 1.5	180 °C	+	+ ¹⁾
	E 3010	V-0, 1.5	180 °C		+ ¹⁾
	P 3010	V-0, 1.5			+ ¹⁾
Ultrason® reinforced	E 2010 G4	V-0, 1.5	180 °C	+	+ ¹⁾
	E 2010 G6	V-0, 1.5	180 °C	+	+ ¹⁾
	S 2010 G6	V-1, 1.5	160 °C		+ ¹⁾
Elastollan® unreinforced	1175 A10 W	V-0, 0.9-1.1			+
	1185 A10 FHF	V-0, 0.75			+
	1190 A10 FHF	V-0, 0.76			+
	1192 A11 FHF	V-0, 0.8			+
	1154 D10 FHF	V-2, 0.75			+
	1185 A10 HFFR				+
Elastollan® reinforced	1195 A 10/1195 A15 ¹⁾	HB 0.5, 0.75, 3.0			
	R 3000	HB, 0.75			+ ¹⁾

¹⁾ Product does not contain flame-retardant additive

²⁾ Free of halogens acc. EN 61249-2-47

³⁾ contains small amounts of PTFE

Symbol	Electrical house- hold appliances	Terminal blocks	Connectors	Circuit breakers	Low-voltage switch gears	Photovoltaics	Automotive construction	Railway vehicles	Cable jacketing
PA66	●	○	●			○	○		
PA66-Blend FR(30)	●	●	○		○		○	○	
PA66/6 FR(30)	●	●	○		○		○	○	
PA6	●		○				○		
PA66 GF25 FR(40)			○	○	●		●	○	
PA66-Blend GF30 FR(40)			○	○	●		●	○	
PA66 GF25 FR(52)			○		●	●	○		
PA66-I GF25 FR(52)			○		○	●	○		
PA66 GF35 FR(52)			○		●	●	○		
PA66 GF50 FR(52)			○		●		○		
PA6 GF20 FR(30)			○	●	○	○		○	
PA6 GF30 FR(30)			○	●	○		○		
PA6 GF30 FR(5x)	●		●	●	●		●	○	
PA6 GF10 M50 FR(61)			○	●	●		○		
PA6T/6 GF25 FR(52)	●		○	●	○				
PA6T/6 GF30 FR(40)	●		○	○	○				
PA9T GF30 FR(40)	●		●	○			●		
PBT	●		●				○		
PBT FR(17)			●				○		
PBT-I FR(40)			●				○		○
PBT GF10 FR(17)			●		○		○		
PBT GF20 FR(17)			●		○		○		
PBT GF30 FR(17)			●		○		○		
PBT GF30 FR(17)			●		○		○		
PBT GF25 FR(40)	●		○	○	○		○		
PBT GF25 FR(5x)			○	○	●		●		
PBT GF25 FR(5x)			○	○	○		●		
PESU	○								
PESU									
PPSU	○				○				
PESU GF20	○			○	○		○		
PESU GF30	○			○	○		○		
PSU GF30									
TPU FR							○		●
TPU FR			○				○		●
TPU FR							○		●
TPU FR							○		●
TPU FR			○				○		○
TPU FR							○	○	●
TPU			●						●
TPU GF20			●						

Ultramid® (PA)

Unreinforced Types

Values at 23 °C ¹⁾	Unit	Test method	Condition
Features			
Polymer abbreviation	–	–	–
Density	kg/m³	ISO 1183	–
Water absorption, saturation in water at 23 °C	%	similar to ISO 62	–
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62	–
Flammability			
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695	–
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C	–
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C	–
GWFI (thickness)	°C (mm)	IEC 60695-2-12	–
GWIT (thickness)	°C (mm)	IEC 60695-2-13	–
Oxygen Index	%	ISO 4589-1/-2	–
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥ 1 mm ⁵⁾	–	ISO 3795, FMVSS 302	–
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2	–
Electrical properties			
Relative permittivity at 1 MHz	–	IEC 62631-2-1	tr/lf
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1	tr/lf
Volume resistivity	Ω·m	IEC 62631-3-1	tr/lf
Surface resistivity	Ω	IEC 62631-3-2	tr/lf
CTI, solution A	–	IEC 60112	–
Thermal properties			
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2	–
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2	–
Max. service temperature, up to a few hours ²⁾	°C	–	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216	–
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B	–
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)	E-6/K	ISO 11359-1/-2	–
Mechanical properties			
Tensile modulus of elasticity	MPa	ISO 527-1/-2	tr/lf
Yield stress (v = 50 mm/min), (Stress at break (v = 5 mm/min)*	MPa	ISO 527-1/-2	tr/lf
Yield strain (v = 50 mm/min), (Strain at break (v = 5 mm/min)*	%	ISO 527-1/-2	tr/lf
Flexural modulus	MPa	ISO 178	tr/lf
Flexural stress at max. force	MPa	ISO 178	tr/lf
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy unnotched impact strength, -30 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy notched impact strength, 23 °C	kJ/m²	ISO 179/1eA	tr/lf
Charpy notched impact strength, -30 °C	kJ/m²	ISO 179/1eA	tr/lf
Processing			
Melting temperature, DSC	°C	ISO 11357-1/-3	–
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133	–
Melt temperature injection moulding	°C	–	–
Mould temperature injection moulding	°C	–	–
Molding shrinkage, test box, d = 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4	–

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultramid® A3K R01	Ultramid® A3U32	Ultramid® C3U	Ultramid® B3S R03
PA66	PA66-Blend FR(30)	PA66/6 FR(30)	PA6
1,130	1,180	1,160	1,130
8 - 9	7 - 8	8 - 9	9 - 10
2.50 - 3.10	2.20 - 2.80	2.60 - 3.20	2.60 - 3.40
V-2 (0.4)	V-0 (0.25)	V-0 (0.4)	V-2 (0.75)
sw, 1.5			0.75
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	34	–
+	+	+	+
	HL3 (0.4 - 2 mm)	(R24: HL3)	
3.2/5	3.4/4.2	3.6/6	3.3/7
250/2,000	200/930	200/3,000	300/3,000
1E13/1E10	>1E14 / > 1E11	1E13/1E9	1E13/1E10
* / 1E10	* / >1E13	* / 1E10	* / 1E10
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 / –
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
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 / –
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)
1.50 (1.80)	1.50 (1.70)	1.25 (1.27)	0.87 (1.00)

An easy flowing injection moulding grade for fast processing. Used for highly stressed technical parts, such as bearings, gear wheels and electrically insulating parts such as terminals and cable connectors.

Injection moulding grade with improved flame retardance (free from halogens), used e.g. for electrical insulating parts with very small wall thicknesses.

An injection moulding grade with improved flame retardance (free from halogens), used e.g. for impact resistant electrical insulating parts such as contact bases and plug connector strips.

An easy flowing, finely crystalline injection moulding grade for very fast processing. Parts produced include thin-walled technical parts (eg housing, fittings, grips, small parts and fixing clamps).

Ultramid® (PA)

Reinforced Types

Values at 23 °C ¹⁾	Unit	Test method	Condition
Features			
Polymer abbreviation	–	–	–
Density	kg/m³	ISO 1183	–
Water absorption, saturation in water at 23 °C	%	similar to ISO 62	–
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r. h.	%	similar to ISO 62	–
Flammability			
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695	–
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C	–
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C	–
GWFI (thickness)	°C (mm)	IEC 60695-2-12	–
GWIT (thickness)	°C (mm)	IEC 60695-2-13	–
Oxygen Index	%	ISO 4589-1/-2	–
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥ 1 mm ⁵⁾	–	ISO 3795, FMVSS 302	–
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2	–
Electrical properties			
Relative permittivity at 1 MHz	–	IEC 62631-2-1	tr/lf
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1	tr/lf
Volume resistivity	Ω·m	IEC 62631-3-1	tr/lf
Surface resistivity	Ω	IEC 62631-3-2	tr/lf
CTI, solution A	–	IEC 60112	–
Thermal properties			
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2	–
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2	–
Max. service temperature, up to a few hours ²⁾	°C	–	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216	–
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B	–
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)	E-6/K	ISO 11359-1/-2	–
Mechanical properties			
Tensile modulus of elasticity	MPa	ISO 527-1/-2	tr/lf
Yield stress (v = 50 mm/min), (Stress at break (v = 5 mm/min)*	MPa	ISO 527-1/-2	tr/lf
Yield strain (v = 50 mm/min), (Strain at break (v = 5 mm/min)*	%	ISO 527-1/-2	tr/lf
Flexural modulus	MPa	ISO 178	tr/lf
Flexural stress at max. force	MPa	ISO 178	tr/lf
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy unnotched impact strength, -30 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy notched impact strength, 23 °C	kJ/m²	ISO 179/1eA	tr/lf
Charpy notched impact strength, -30 °C	kJ/m²	ISO 179/1eA	tr/lf
Processing			
Melting temperature, DSC	°C	ISO 11357-1/-3	–
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133	–
Melt temperature injection moulding	°C	–	–
Mould temperature injection moulding	°C	–	–
Molding shrinkage, test box, d = 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4	–

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultramid® A3UG5	Ultramid® A3U42G6	Ultramid® A3X2G5	Ultramid® A3XZG5	Ultramid® A3X2G7
PA66-GF25 FR(40)	PA66-Blend GF30 FR(40)	PA66-GF25 FR (52)	PA66-I GF25 FR(52)	PA66-GF35 FR(52)
1,390	1,450	1,340	1,320	1,450
4 - 4.6	4.8 - 5.2	5.7 - 6.3	4.7 - 5.3	4.4 - 5
1.10 - 1.50	1.60 - 1.80	1.20 - 1.60	1.00 - 1.40	1.00 - 1.40
V-0 (0.75)	V-0 (0.4) 5VA (1.6)	HB (0.4) V-0 (0.81) 5VA (3)	V-0 (1.5) 5VA (2.3)	HB (0.4) V-0 (0.75) 5VA (1.5)
sw/gr, 0.75	sw, 1.6	sw, 1.6	sw, 0.75	sw, 0.75
0.75	0.4	0.6	1.5	0.75
960 (0.75)	960 (1)	960 (0.8)	–	960 (1)
775 (≥ 2)	–	–	–	–
32	37	27	28	27
+	+	+	+	+
HL3 (0.8 - 6mm)	HL3 (1 - 3mm)			
3.8/4.6	3.9/4.1	3.7/5	3.8/4	3.6/5
170/1,000	150/290	200/1,000	200/300	200/2,000
1E14/1E11	>1E13/1E10	1E13/1E10	1E13/1E10	1E13/1E10
* / 1E15	* / 1E13	* / 1E10	* / 1E10	* / 1E10
600	600	550	575	600
245	230	240	240	240
260	250	250	250	250
–	–	220	180	220
130 (155)	140 (166)	139 (157)	–	140 (157)
120	150	120	120	115
0.34	–	0.33	0.33	0.34
1.300	–	1,500	–	1,400
28 (65 - 73)	22 - 24 (70 - 110)	25 - 35 (60 - 80)	20 - 30 (60 - 70)	15 - 20 (60 - 70)
9,500/6,100	11,000/7,500	8,000/6,000	6,500/4,500	11,000/8,500
145* / 90*	145* / 95*	140* / 100*	105* / 70*	160* / 120*
3* / 5*	3* / 5*	3* / 4.5*	6* / 11*	3* / 4*
9,500/6,100	11,000/7,500	7,100/–	5,500/–	9,200/–
230/160	230/160	–	115/100	–
65/65	70/75	65/70	90/100	70/70
63/–	55/60	60/65	85/80	65/–
7.5/9	8/11	13/17	25/30	14/18
–	7/7	–	–	10/–
260	260	260	260	260
25, 275 (5)	15, 275 (5)	30, 275 (5)	–	25, 275 (5)
280 - 300	280 - 300	280 - 300	280 - 300	280 - 300
80 - 90	80 - 90	60 - 90	80 - 90	80 - 90
0.4, 290 (80)	0.4, 290 (80)	0.55, 290 (80)	0.55, 290 (80)	0.55, 290 (80)
0.40 (1.20)	0.35 (0.80)	0.39 (1.04)	–	0.32 (1.02)

Without halogenes and red phosphorus a flame retarded glass fiber reinforced injection moulding grade; light in colour with outstanding mechanical and electrical properties.

Without halogenes flame retarded glass fiber reinforced injection moulding grade; light colorable; outstanding mechanical and electrical properties.

Glass fibre reinforced injection moulding grade with improved flame retardance based on red phosphorus, giving outstanding mechanical and electrical properties for components requiring high stiffness.

An impact-modified, glass fibre reinforced injection moulding grade with improved flame retardance based on red phosphorus; for components requiring high stiffness and enhanced toughness. (eg PV-connectors an PV-junction boxes)

Glass fibre fibre reinforced injection moulding grade with improved flame retardance. Flame retardant based on red phosphorus; giving outstanding electrical properties and very high stiffness and strength.

Ultramid® (PA)

Reinforced Types

Values at 23 °C ¹⁾	Unit	Test method	Condition
Features			
Polymer abbreviation	–	–	–
Density	kg/m³	ISO 1183	–
Water absorption, saturation in water at 23 °C	%	similar to ISO 62	–
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r. h.	%	similar to ISO 62	–
Flammability			
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695	–
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C	–
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C	–
GWFI (thickness)	°C (mm)	IEC 60695-2-12	–
GWIT (thickness)	°C (mm)	IEC 60695-2-13	–
Oxygen Index	%	ISO 4589-1/-2	–
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥1 mm ⁵⁾	–	ISO 3795, FMVSS 302	–
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2	–
Electrical properties			
Relative permittivity at 1 MHz	–	IEC 62631-2-1	tr/lf
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1	tr/lf
Volume resistivity	Ω*m	IEC 62631-3-1	tr/lf
Surface resistivity	Ω	IEC 62631-3-2	tr/lf
CTI, solution A	–	IEC 60112	–
Thermal properties			
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2	–
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2	–
Max. service temperature, up to a few hours ²⁾	°C	–	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216	–
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B	–
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)	E-6/K	ISO 11359-1/-2	–
Mechanical properties			
Tensile modulus of elasticity	MPa	ISO 527-1/-2	tr/lf
Yield stress (v=50mm/min), (Stress at break (v=5mm/min))*	MPa	ISO 527-1/-2	tr/lf
Yield strain (v=50mm/min), (Strain at break (v=5mm/min))*	%	ISO 527-1/-2	tr/lf
Flexural modulus	MPa	ISO 178	tr/lf
Flexural stress at max. force	MPa	ISO 178	tr/lf
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy unnotched impact strength, -30 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy notched impact strength, 23 °C	kJ/m²	ISO 179/1eA	tr/lf
Charpy notched impact strength, -30 °C	kJ/m²	ISO 179/1eA	tr/lf
Processing			
Melting temperature, DSC	°C	ISO 11357-1/-3	–
Melt volume-flow rate MVR, test temperature (load)	cm³/10min, °C (kg)	ISO 1133	–
Melt temperature injection moulding	°C	–	–
Mould temperature injection moulding	°C	–	–
Molding shrinkage, test box, d=1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4	–

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultramid® A3X2G10	Ultramid® B3UG4	Ultramid® B3U30G6	Ultramid® B3U50G6	Ultramid® B3UGM210
PA66-GF50 FR(52)	PA6-GF20 FR(30)	PA6-GF30 FR(30)	PA6-GF30 FR(5x)	PA6-(GF10+M50) FR(61)
1,600	1,310	1,440	1,500	1,670
3.7 - 4.3	6.6 - 7.2	5.3 - 5.9	5.5 - 5.7	4.1 - 4.7
0.70 - 1.10	2.00 - 2.40	1.50 - 2.00	1.50 - 1.70	1.00 - 1.40
V-2 (0.4) V-0 (1.5)	V-2 (0.71)	HB (0.4) V-2 (0.75)	V-0 (0.8) 5VA (1.5)	V-2 (0.75) V-0 (1.5)
	sw, 0.71		BK, GY; 1.5	
0.75	1.5	0.75	0.4	0.75
960 (1)	960 (1)	960 (1)	960 (≥0.75)	960 (1)
–	–	–	825 (≥0.75)	–
27	31	–	–	52
+	+	+	+	+
	HL2 (1 - 3mm)		HL2 (0.8 - 3mm)	
3.6/5	3.8/–	4/4.8	4.1/4.7	4.5/5
200/–	150/–	200/1,000	170/730	150/500
1E13/1E10	1E13/1E11	1E14/1E9	> 1E14/> 1E10	1E13/1E10
*/1E10	*/1E10	*/>1E14	*/>1E10	*/1E13
600	550	475	450	600
250	170	180	210	195
250	210	210	220	215
220	200	–	–	200
125 (145)	160 (185)	–	165 (180)	149 (167)
115	140	140	150	130
0.35	0.4	0.28	–	1
1,300	1,300	1,200	–	1,400
15 - 20 (40 - 50)	50 - 55 (50 - 60)	30 (67 - 90)	20 - 25 (60 - 100)	40 - 60 (40 - 50)
16,000/12,000	6,000/3,000	7,700/3,500	12,000/8,300	11,000/6,500
180*/130*	95*/50*	90*/45*	170*/115*	110*/80*
2*/3*	3*/6*	3.2*/10*	2.5*/3.5*	1.8*/2.5*
13,000/–	5,700/2,800	7,500/2,900	11,200/7,800	10,000/–
–	150/70	160/80	250/180	165/115
55/55	40/110	35/65	65/70	30/30
50/–	35/–	25/25	45/–	30/–
13/16	3/9	3.7/6	6.5/8.5	2.5/4
11/–	3.4/–	–	–	2.7/–
260	220	220	220	220
25, 275 (5)	80, 275 (5)	150, 275 (5)	25, 275 (5)	30, 275 (5)
290 - 300	250 - 275	250 - 275	240 - 265	290 - 310
80 - 90	80 - 90	80 - 90	80 - 90	80 - 90
0.4, 290 (80)	0.5, 270 (80)	0.5, 270 (80)	–	0.5, 290 (80)
–	0.80 (0.80)	0.40 (0.90)	0.25 (0.80)	–

Glass fibre fibre reinforced injection moulding grade with improved flame retardance. Flame retardant based on red phosphorus; giving outstanding electrical properties and very high stiffness and strength.

An halogen-free flameretardant injection molding grade with outstanding free-flow properties, with good electrical properties and low smoke density; resistant to glow wire test GWFI to 960 °C.

Halogen-free flameproofed injection molding grade with outstanding free-flow properties and good electrical properties; resistant to glow wire test to 960 °C.

Without halogenes flame retarded glass fiber reinforced injection moulding grade; light colorable; outstanding mechanical and electrical properties. In particular optimized for the glow wire requirements of IEC 60335.

Halogen-free injection molding grade with very high rigidity, low smoke density and outstanding electrical properties.

Ultramid® (PA)

Reinforced Types

Values at 23 °C ¹⁾	Unit	Test method	Condition
Features			
Polymer abbreviation	–	–	–
Density	kg/m³	ISO 1183	–
Water absorption, saturation in water at 23 °C	%	similar to ISO 62	–
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62	–
Flammability			
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695	–
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C	–
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C	–
GWFI (thickness)	°C (mm)	IEC 60695-2-12	–
GWIT (thickness)	°C (mm)	IEC 60695-2-13	–
Oxygen Index	%	ISO 4589-1/-2	–
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥ 1 mm ⁵⁾	–	ISO 3795, FMVSS 302	–
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2	–
Electrical properties			
Relative permittivity at 1 MHz	–	IEC 62631-2-1	tr/lf
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1	tr/lf
Volume resistivity	Ω*m	IEC 62631-3-1	tr/lf
Surface resistivity	Ω	IEC 62631-3-2	tr/lf
CTI, solution A	–	IEC 60112	–
Thermal properties			
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2	–
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2	–
Max. service temperature, up to a few hours ²⁾	°C	–	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216	–
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B	–
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)	E-6/K	ISO 11359-1/-2	–
Mechanical properties			
Tensile modulus of elasticity	MPa	ISO 527-1/-2	tr/lf
Yield stress (v = 50 mm/min), (Stress at break (v = 5 mm/min))*	MPa	ISO 527-1/-2	tr/lf
Yield strain (v = 50 mm/min), (Strain at break (v = 5 mm/min))*	%	ISO 527-1/-2	tr/lf
Flexural modulus	MPa	ISO 178	tr/lf
Flexural stress at max. force	MPa	ISO 178	tr/lf
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy unnotched impact strength, -30 °C ³⁾	kJ/m²	ISO 179/1eU	tr/lf
Charpy notched impact strength, 23 °C	kJ/m²	ISO 179/1eA	tr/lf
Charpy notched impact strength, -30 °C	kJ/m²	ISO 179/1eA	tr/lf
Processing			
Melting temperature, DSC	°C	ISO 11357-1/-3	–
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133	–
Melt temperature injection moulding	°C	–	–
Mould temperature injection moulding	°C	–	–
Molding shrinkage, test box, d = 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4	–

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultradid® T KR 4365 G5	Ultradid® T KR 4340 G6	Ultradid® Advanced N3U40G6
PA6T/6-GF25 FR	PA6T/6-GF30 FR(40)	PA9T-GF30 FR(40)
1,380	1,490	1,440
5 - 6	4.7 - 5.3	2
1.10 - 1.50	2.00 - 2.40	1
V-2 (0.37) V-0 (0.75) 5VA (1.5)	V-0 (0.4) 5VA (1)	V-0 (0.4) 5VA (1.6)
0.75	0.4	0.25
960 (0.75)	960 (0.4)	960 (1)
775 (0.75)	775 (0.4)	800 (1)
26	50	–
+	+	
4 / –	4 / 4.1	4.1 / 3.5
200 / –	150 / 250	110 / 160
1E13 / 1E12	1E15 / 1E15	> 1E16 / > 1E13
* / 1E13	* / 1E14	* / > 1E15
600	600	600
220	240	260
–	–	–
270	–	–
125 (150)	146 (172)	–
140	160	120
0.31	0.24	–
1,400	1,200	–
25 (50 - 60)	20 - 25 (60 - 70)	20 (55 - 60)
8,300 / 8,000	11,500 / 11,500	10,500 / 10,500
150* / 140*	155* / 135*	140* / 130*
3* / –	2.5* / 2.2*	2.2* / 2.2*
–	11,000 / 11,000	10,500 / 10,500
–	245 / 215	220 / 210
75 / –	65 / 50	60 / 50
–	60 / –	60 / –
13 / –	6.5 / 6.5	7 / 7
–	6.5 / –	–
295	290	300
–	25, 325 (5)	30, 325 (5)
310 - 330	310 - 330	310 - 340
80 - 120	80 - 120	100 - 160
0.4, 320 (100)	0.3, 320 (100)	–
0.55 (1.00)	0.30 (0.80)	0.35 (0.95)

A glass fibre reinforced, flame retardant, partially aromatic polyamide for injection molding. Good mechanical properties, low water absorption, high melting point (295 °C). High tracking resistance, low tendency to form deposits on electrical contacts, very resistant to electrolytic corrosion, resistant to soldering temperatures, can be electroplated.

Partially aromatic polyamid, halogen-free flame-retardant, light colorable, outstanding flame retardance, resistant to soldering temperatures

Partially aromatic polyphthalamide, halogen-free flame retardant, glass fiber reinforced with strong electrical and mechanical properties at elevated temperatures and excellent chemical resistance. Very low water absorption and outstanding dimensional stability. Perfectly suited for soldering due to high melting point. Easy processing due to excellent flowability and melt stability.

Ultradur® (PBT)

Unreinforced Types

Values at 23 °C ¹⁾	Unit	Test method
Features		
Polymer abbreviation	–	–
Density	kg/m³	ISO 1183
Water absorption, saturation in water at 23 °C	%	similar to ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen Index	%	ISO 4589-1/-2
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥1 mm ⁵⁾	–	ISO 3795, FMVSS 302
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2
Electrical properties		
Relative permittivity at 1 MHz	–	IEC 62631-2-1
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1
Volume resistivity	Ω·m	IEC 62631-3-1
Surface resistivity	Ω	IEC 62631-3-2
CTI, solution A	–	IEC 60112
Thermal properties		
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Max. service temperature, up to a few hours ²⁾	°C	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B
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)	E-6/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress (v=50mm/min), (Stress at break (v=5mm/min)*	MPa	ISO 527-1/-2
Yield strain (v=50mm/min), (Strain at break (v=5mm/min)*	%	ISO 527-1/-2
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU
Charpy unnotched impact strength, -30 °C ³⁾	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		
Melting temperature, DSC	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133
Melt temperature injection moulding	°C	–
Mould temperature injection moulding	°C	–
Molding shrinkage, test box, d= 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultradur® B 4520	Ultradur® B 4406	Ultradur® B 4440
PBT	PBT FR(17)	PBT-I FR(40)
1,300	1,450	1,310
0.5	0.4	0.4
0.25	0.25	0.25
HB (0.75)	V-0 (0.4)	V-0 (0.4)
3	0.4	0.4
850 (≤1.5)	960 (1)	960 (1)
775 (≤1.5)	–	–
20	29	42,9
+	+	+
3.3	3.3	–
200	170	–
1E14	1E14	–
1E13	1E13	–
550	250	600
55	60	–
165	170	–
200	200	–
120 (140)	110 (135)	–
130	120	–
0,27	0,27	–
1,250	1,200	–
130 - 160/–	50/–	–
2,500	3,000	2,000
55	65	28
3.7	3.9	4.5
2,400	–	–
85	–	–
N	50	55
180	*	35
5	4	3,5
3	4	–
223	223	223
21, 250 (2.16)	30, 275 (2.16)	20, 275 (2.16)
250 - 275	245 - 270	250 - 275
40 - 70	40 - 70	60 - 100
1.2 - 1.5, 260 (60)	1.3 - 1.5, 260 (60)	–
1.50 (1.70)	1.80 (1.90)	2.40 (2.00)

Standard injection molding grade for the production of various functional parts.
Abbreviated designation according to ISO 1043-1: PBT

Injection molding grade with migration-free flame retardant; for parts requiring enhanced fire resistance (eg plug-and-socket connectors, housings).
Abbreviated designation according to ISO 1043-1: PBT FR(17)

Impact modified grade for extrusion and injection molding; flame retardant halogen and antimony free; light colorable; for parts requiring enhanced fire resistance and toughness (eg connectors and loose tubes).
Abbreviated designation according to ISO 1043-1: PBT-I FR(40)

Ultradur® (PBT)

Reinforced Types

Values at 23 °C ¹⁾	Unit	Test method
Features		
Polymer abbreviation	–	–
Density	kg/m³	ISO 1183
Water absorption, saturation in water at 23 °C	%	similar to ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen Index	%	ISO 4589-1/-2
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥1 mm ⁵⁾	–	ISO 3795, FMVSS 302
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2
Electrical properties		
Relative permittivity at 1 MHz	–	IEC 62631-2-1
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1
Volume resistivity	Ω·m	IEC 62631-3-1
Surface resistivity	Ω	IEC 62631-3-2
CTI, solution A	–	IEC 60112
Thermal properties		
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Max. service temperature, up to a few hours ²⁾	°C	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B
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)	E-6/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress (v=50mm/min), (Stress at break (v=5mm/min))*	MPa	ISO 527-1/-2
Yield strain (v=50mm/min), (Strain at break (v=5mm/min))*	%	ISO 527-1/-2
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU
Charpy unnotched impact strength, -30 °C ³⁾	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		
Melting temperature, DSC	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133
Melt temperature injection moulding	°C	–
Mould temperature injection moulding	°C	–
Molding shrinkage, test box, d= 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultradur® B 4406 G2	Ultradur® B 4406 G4	Ultradur® B 4406 G6	Ultradur® B 4406 G6 HSP
PBT-GF10 FR(17)	PBT-GF20 FR(17)	PBT-GF30 FR(17)	PBT-GF30 FR(17)
1,520	1,600	1,650	1,700
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 (1.5)
	sw, 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	-
1E14	1E14	1E14	> 1E15
1E13	1E13	1E13	> 1E15
225	200	200	175
190	200	205	205
215	220	220	220
210	210	210	-
120 (130)	120 (130)	125 (150)	-
140	140	140	140
-	-	0,32	-
1,100	1,000	900	900
50/-	28 - 34/-	20 - 30/-	20 - 20 (80 - 135)
5,500	8,200	11,300	11,700
95*	125*	145*	140*
3.3*	2.6*	2.3*	1.9*
-	-	-	11,300
-	-	-	200
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)	0.5 - 0.6, 260 (80)
-	0.50 (1.30)	0.30 (1.10)	0.30 (1.10)
Injection molding grade with 10 % glass fibers for parts requiring enhanced fire resistance (eg relay housings, coil formers, switches, lighting components, plug-and-socket connectors).	Injection molding grade with 20 % glass fibers for parts requiring enhanced fire resistance (eg relay housings, plug-and-socket connectors, switches, lighting components).	Injection molding grade with 30 % glass fibers for parts requiring enhanced fire resistance (eg potentiometer parts, plug-and-socket connectors, switches).	Easy flowing Injection molding grade with 30 % glass fibers for parts requiring enhanced fire resistance (eg relay housings, plug-in connector, switch and lamp parts)
Abbreviated designation according to ISO 1043-1: PBT FR (17)	Abbreviated designation according to ISO 1043-1: PBT FR(17)	Abbreviated designation according to ISO 1043-1: PBT FR(17)	Abbreviated designation according to ISO 1043-1: PBT FR(17)

Ultradur® (PBT)

Reinforced Types

Values at 23 °C ¹⁾	Unit	Test method
Features		
Polymer abbreviation	–	–
Density	kg/m³	ISO 1183
Water absorption, saturation in water at 23 °C	%	similar to ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen Index	%	ISO 4589-1/-2
Testing of materials for automobile interior, Burning rate ≤100mm/min, d ≥1 mm ⁵⁾	–	ISO 3795, FMVSS 302
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2
Electrical properties		
Relative permittivity at 1 MHz	–	IEC 62631-2-1
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1
Volume resistivity	Ω·m	IEC 62631-3-1
Surface resistivity	Ω	IEC 62631-3-2
CTI, solution A	–	IEC 60112
Thermal properties		
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Max. service temperature, up to a few hours ²⁾	°C	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B
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)	E-6/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress (v=50mm/min), (Stress at break (v=5mm/min))*	MPa	ISO 527-1/-2
Yield strain (v=50mm/min), (Strain at break (v=5mm/min))*	%	ISO 527-1/-2
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU
Charpy unnotched impact strength, -30 °C ³⁾	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		
Melting temperature, DSC	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133
Melt temperature injection moulding	°C	–
Mould temperature injection moulding	°C	–
Molding shrinkage, test box, d= 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = Passed

Ultradur® B 4441 G5	Ultradur® B 4450 G5	Ultradur® B 4450 G5 HR
PBT-GF25 FR(40)	PBT-GF25 FR(5x)	PBT-GF25 FR(5x)
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	0.4	0.4
960 (1)	960 (1)	960 (1.5)
775 (1)	675 (1)	–
38	29	–
+	+	
	HL2 (0.8 - 6 mm)	
3.6	3.8	3.9
137	140	150
1E14	1E14	1E14
> 1E16	> 1E16	1E15
525	600	600
210	210	210
220	220	220
210	–	210
–	–	–
140	140	140
–	–	–
1,000	1,000	1,000
20 - 30 (110 - 120)	30 - 40 (120 - 130)	2.5 - 3 (13 - 18)
9,800	10,000	8,700
100*	110*	120*
2.3*	2.2*	2.6*
10,000	9,700	8,700
180	180	210
45	45	50
47	45	40
7	6	6
*	*	*
223	223	223
15, 275 (2.16)	17, 275 (2.16)	10, 275 (2.16)
260 - 280	250 - 280	250 - 270
60 - 100	60 - 100	60 - 100
0.5, 260 (80)	0.7, 260 (80)	0.7, 260 (80)
0.44 (1.24)	0.50 (1.30)	0.50 (1.30)

Injection molding grade with 25 % glass fibers optimized for the glow wire requirements acc. to IEC 60335; for parts requiring enhanced fire resistance (eg components for household appliances, connectors, power switches), halogen and antimony free.

Abbreviated designation according to ISO 1043-1: PBT FR(40)

Injection molding grade with 25 % glass fibers for parts requiring enhanced fire resistance as well as increased tracking resistance (eg lamp sockets, connectors, power switches, coil formers, housings for control units), halogen and antimony free.

Abbreviated designation according to ISO 1043-1: PBT FR(5x)

Injection-molding grade with 25 % glass fibers, halogen- and antimony-free for parts requiring enhanced fire resistance, especially optimized for good hydrolytical stability and increased tracking resistance.

Abbreviated designation according to ISO 1043-1: PBT FR(5x)

Ultrason® (PESU, PSU, PPSU)

Unreinforced Types

Values at 23 °C ¹⁾	Unit	Test method
Features		
Polymer abbreviation	–	–
Density	kg/m³	ISO 1183
Water absorption, saturation in water at 23 °C	%	similar to ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen Index	%	ISO 4589-1/-2
Testing of materials for automobile interior, Burning rate ≤100mm/min, d≥1 mm ⁵⁾	–	ISO 3795, FMVSS 302
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2
Electrical properties		
Relative permittivity at 1 MHz	–	IEC 62631-2-1
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1
Volume resistivity	Ω*m	IEC 62631-3-1
Surface resistivity	Ω	IEC 62631-3-2
CTI, solution A	–	IEC 60112
Thermal properties		
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Max. service temperature, up to a few hours ²⁾	°C	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B
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)	E-6/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress (v=50mm/min), (Stress at break (v=5mm/min))*	MPa	ISO 527-1/-2
Yield strain (v=50mm/min), (Strain at break (v=5mm/min))*	%	ISO 527-1/-2
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU
Charpy unnotched impact strength, -30 °C ³⁾	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		
Melting temperature, DSC	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133
Melt temperature injection moulding	°C	–
Mould temperature injection moulding	°C	–
Molding shrinkage, test box, d= 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = 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	42.5	43.4
+	+	
3.8	3.8	3.7
140	140	89
> 1E13	> 1E13	> 1E13
> 1E15	> 1E15	> 1E15
125	125	150
205	207	198
218	218	212
220	220	–
180 (–)	180 (–)	–
180	180	–
0.19	0.18	–
980	1,000	1,010
52/–	52/–	55/–
2,650	2,650	2,250
85	85	74
6.9	6.9	7.8
–	–	2,400
–	–	–
N	N	N
N	N	N
7	8	75
7.5	8	25
*	*	–
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)	–
0.82 (0.86)	0.85 (0.90)	0.90 (1.00)

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

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

Unreinforced, higher viscosity injection moulding grade, flameretardant and with improved chemical resistance.
Abbreviated designation according to ISO 1043-1: PPSU

Ultrason® (PESU, PSU, PPSU)

Reinforced Types

Values at 23 °C ¹⁾	Unit	Test method
Features		
Polymer abbreviation	–	–
Density	kg/m³	ISO 1183
Water absorption, saturation in water at 23 °C	%	similar to ISO 62
Moisture absorption, equilibrium in standard cond. atmo. 23 °C/50 % r.h.	%	similar to ISO 62
Flammability		
Flammability acc. to UL 94 (thickness)	class (mm)	UL-94, IEC 60695
UL (f1) proven for outdoor use: color code, min. thickness	color, mm	UL 746C
UL 746C Fire/ignition performance (UL94 + HAI + HWI), min. thickness	mm	UL 746C
GWFI (thickness)	°C (mm)	IEC 60695-2-12
GWIT (thickness)	°C (mm)	IEC 60695-2-13
Oxygen Index	%	ISO 4589-1/-2
Testing of materials for automobile interior, Burning rate ≤100mm/min, d≥1 mm ⁵⁾	–	ISO 3795, FMVSS 302
Railway: Hazard level acc. to requ. sets R22 and R23	class	EN 45545-2
Electrical properties		
Relative permittivity at 1 MHz	–	IEC 62631-2-1
Dissipation factor at 1 MHz	E-4	IEC 62631-2-1
Volume resistivity	Ω*m	IEC 62631-3-1
Surface resistivity	Ω	IEC 62631-3-2
CTI, solution A	–	IEC 60112
Thermal properties		
Deflection temperature HDT A (1.80 MPa)	°C	ISO 75-1/-2
Deflection temperature HDT B (0.45 MPa)	°C	ISO 75-1/-2
Max. service temperature, up to a few hours ²⁾	°C	–
Temperature index for 50 % loss of tensile strength after 20,000h/5,000h	°C	IEC 60216
RTI “dielectric strength” at 1.5mm thickness	°C	UL 746B
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)	E-6/K	ISO 11359-1/-2
Mechanical properties		
Tensile modulus of elasticity	MPa	ISO 527-1/-2
Yield stress (v=50mm/min), (Stress at break (v=5mm/min)*	MPa	ISO 527-1/-2
Yield strain (v=50mm/min), (Strain at break (v=5mm/min)*	%	ISO 527-1/-2
Flexural modulus	MPa	ISO 178
Flexural stress at max. force	MPa	ISO 178
Charpy unnotched impact strength, 23 °C ³⁾	kJ/m²	ISO 179/1eU
Charpy unnotched impact strength, -30 °C ³⁾	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		
Melting temperature, DSC	°C	ISO 11357-1/-3
Melt volume-flow rate MVR, test temperature (load)	cm³/10 min, °C (kg)	ISO 1133
Melt temperature injection moulding	°C	–
Mould temperature injection moulding	°C	–
Molding shrinkage, test box, d= 1.5 mm, T _M (T _w) ⁴⁾	%, °C (°C)	–
Molding shrinkage parallel (perpendicular)	%	ISO 294-4

Footnote

¹⁾ For undyed product, unless otherwise indicated in the product designation.

²⁾ Empirical values for parts repeatedly exposed to this temperature for several hours at a time over a period of years, provided that shaping and processing were in accord with the material.

³⁾ N = not broken

⁴⁾ Test box with central gating, base dimensions (107 x 47 x 1.5) mm.

⁵⁾ + = 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	47.3	37.4
+	+	+
4.2	4.3	3.7
100	100	60
> 1E13	> 1E13	> 1E13
> 1E15	> 1E15	> 1E15
125	125	125
222	223	185
224	224	187
220	220	180
180 (–)	190 (–)	160 (–)
180	180	160
0.19	0.23	0.22
–	913	970
20 (51)	15 (45)	20/–
6,900	9,800	8,900
130*	150*	125*
3.2*	2.3*	2.2*
–	–	–
–	–	–
60	55	40
65	60	45
8	10	8.5
8	9.5	8.5
*	*	*
29, 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 moulding grade with high rigidity and strength, 20 % glass fiber reinforced. Abbreviated designation according to ISO 1043-1: PESU-GF	Medium viscosity injection moulding grade with high rigidity and strength, 30 % glass fiber reinforced. Abbreviated designation according to ISO 1043-1: PESU-GF	Medium viscosity injection moulding grade with high rigidity and strength, 30 % glass fiber reinforced 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 302¹
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® 1192 A11 FHF ²
–	–	–	–
1,140	1,230	1,250	1,250
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	29-29.6
–	627	–	–
–	0.36	–	–
+	+	+	+
6.5	5.5	–	–
–	960	–	–
10 ⁹	10 ⁹	–	–
10 ¹⁴	10 ¹⁴	–	–
600	600	–	–
–	–	–	–
–	–	–	–
–	0.32	–	–
–	1,500	–	–
75 (A)	89 (A)	90 (A)	91 (A)
–	–	–	–
40	35	25	–
700	600	550	550
N	N	–	–
N	N	–	–
N	N	N	–
N	120	46	–
40, 190/10	35, 200/21.6	35, 200/21.6	38, 200/21.6
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. Improved fire-retardant properties.

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 302¹
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® 1154 D10 FHF	Elastollan® 1185 A10 HFFR ²	Elastollan® 1195 A10/1195 A15
–	–	–
1,270	1,420	1,150
1.4	–	–
0.4	–	–
V2 (0.76 - 1.5) V0 (3)		HB (0.5; 0.75; 3.0)
960 (2)	–	750 (2)
875 (2)	–	775 (2)
–	32	–
–	181 (1.6mm)	–
–	0.11	–
+	+	–
4.5	6.2	7.5
640	1,108	400
10 ¹⁰	10 ⁷	10 ¹²
10 ¹⁴	10 ¹²	10 ¹⁵
600	600	600
–	–	–
–	–	–
0.37	–	–
–	–	–
58 (D)	86 (A)	96 (A)
160	–	–
30	23	55
400	580	500
–	N	–
–	N	–
50	N	N
3	77	N
50, 230/2.16	10, 180/5	–
225 - 235	215 - 225	–
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.

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.

Thermoplastic polyether-polyurethane with excellent strength and low-temperature flexibility, hydrolytic resistance 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.), 25kW/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 302¹
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® 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.

Engineering plastics for the E & E industry – Publications

- Engineering plastics for the E & E industry – Standards and ratings
- Engineering plastics for the E & E industry – Products, applications, typical values
- Engineering plastics for automotive electrics – Products, applications, typical values
- Elastollan® – Thermoplastic polyurethane elastomers (TPU)
- Elastollan® – Thermoplastic polyurethane elastomers (TPU) – Product Range
- Elastollan® – Thermoplastic polyurethane elastomers (TPU) – Processing Recommendations

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. (September 2019)

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