VESTODUR®

Technical Information

VESTODUR® polybutylene terephthalate compounds

Customized portfolio

Evonik manufactures a range of polybutylene terephthalate (PBT) compounds and supplies it under the registered trademark VESTODUR®. Material properties characterizing VESTODUR® compounds are:

- high thermostability
- high stiffness
- low water absorption resulting in high dimensional stability
- high hardness
- good strength
- good sliding friction behavior, low abrasion
- good creep behavior
- good electrical properties
- good chemical resistance
- good weathering resistance
- good processability
- no tendency to form stress cracks

By adding various additives into virgin PBT, its properties can be adjusted to meet the requirements of different applications:

- Stabilizers prevent damage during further processing and increase durability upon exposure to UV, heat, and moisture.
- Processing aids facilitate demolding.
- Polymer modifications improve flexibility and impact strength and reduce post shrinkage.
- Flame-retardant additives permit the production of self-extinguishing resins.
- Fillers and reinforcing agents increase stiffness and dimensional stability upon exposure to heat. Chopped strands have proven most effective in this regard. Minerals and micro glass beads counteract the tendency to warp.
- Special properties, such as laser markability, metallizability, and different electrical conductivities can be adjusted through special additives.

Long-term properties of PBT under load

At elevated temperatures, thermoplastics begin to flow or creep under the influence of stresses, especially when they are unreinforced. PBT has a relatively low tendency to creep. However, the designer must still take creep resistance into consideration because it declines under continuous load in comparison with short-time stability. On the other hand, this also means that the initial stress will drop when the strain is held constant. Ten thousand hours worth of readings have been made for many VESTODUR® compounds. Details and data can be obtained from your contacts.

Resistance to heat, radiation, and chemicals

To give thermoplastics the resistance needed for long-term use in harsh environmental conditions (UV radiation, hot air, etc.) one must incorporate the proper stabilizers.

Heat aging

Heat stabilizers greatly improve the aging behavior of polybutylene terephthalate, enabling it to be used longer at high temperatures. With the exception of a few specialty base products, all VESTODUR® resins come with an optimized stabilizer system. For data concerning heat aging please ask your contacts.

A range of VESTODUR® compounds has also been classified according to UL standard 746B for the relative temperature index RTI. In this case, RTI characterizes the creep resistance for approximately 60,000 hours. Details can be found in the special product brochure "Underwriters Laboratories (UL) Certifications for High Performance Polymers from Evonik Industries AG".

Hydrolysis resistance

PBT is a polycondensate, a class of polymers that only have limited resistance to moist air at higher temperatures. The most important application of PBT is fiber optic jacketing. Since more and more cables are being installed in environments that feature high temperatures and high humidity, it became necessary to develop PBT compounds with improved hydrolytic stability, resulting in the resins VESTODUR® 3010, 3013 und 3030.

UV resistance

When a polymer is exposed to light of short wavelengths below 400 nm its molar mass declines rapidly. Moldings and semi-finished products become brittle. Light stability agents, UV absorbers and radical interceptors can greatly reduce the damage caused by weathering. Suitable types of carbon black offer the best protection of all provided, that the resulting black coloring is considered acceptable. Although light stability agents and UV stabilizers substantially improve weathering resistance, they are not as effective as carbon black.

The addition of pigments can serve to stabilize as well as sensitize. Nevertheless, pigments or blacks may also affect a polymer's mechanical properties.

Chemical resistance

PBT is extremely resistant to stress cracks induced by chemicals. For details please ask your contacts obtain them from the next page's list.

Abrasion and frictional behavior

Polybutylene terephthalate is distinguished by very high abrasion resistance. This can be determined according to DIN 53754 (Taber) or DIN 53516. The test consists of abrasion from emery grinding. Harder resins have a higher abrasion than softer resins. The abrasion only increases again for very soft resins.

For bearings or sliding parts, the coefficient of sliding friction is more important than abrasion. This coefficient is a function of pressure per surface area of bearing, friction velocity, surface structure and surface hardness of the friction partner, and temperature. It is low for PBT. The addition of reinforcing agents or fillers (glass fibers, graphite) doesn't affect sliding friction or abrasion provided that the surface skin of the molding hasn't been damaged. The influence of the additives is only evident (in the case of glass fibers) from the increased abrasion of the sliding partners, which only occurs after the additives have come to the surface.

Lubricants influence the abrasion and frictional behavior. The lubrication greatly reduces the coefficient of friction and almost stops abrasion completely. PBT's high chemical resistance permits the use of nearly any lubricant.

Physiological and toxicological analysis of VESTODUR® resins

Please direct all questions on the toxicological properties of VESTODUR® compounds and relevant analysis pertaining their contact with foodstuffs to the indicated contact address. Here you will also receive the up-to-date safety data sheets of VESTODUR®.

Applications

VESTODUR® compounds can be used for a wide range of applications, for example, for thin-walled injection-molded parts in electrical engineering applications, for especially dimensionally stable components of high surface quality in the automotive industry, as a barrier layer in multilayer fuel lines, for laser-markable components, and in the cable industry. High-molecular extrudable VESTODUR® specialty products have come to occupy a leading position as materials for secondary fiber optic jacketing, because they fulfil the requirements perfectly.

Chemical resistance of PBT compounds

Chemicals	VESTODUR® unreinforced			VESTODUR® reinforced/fllled		
	23°C	60°C	80°C	23°C	60°C	80°C
Acetic acid 5%/10%/100%	+/+/~	~/~/~	-/-/-	+/+/~	~/~/~	-/-/-
Acetone	+	-		~	-	
Ammonium hydroxide 10%	~	-	-	~	-	-
Brake fluid	+	+	~	+	+	~
Calcium chloride 10%	+	+	-	+	~	-
Chloroform	-	-		-	-	
Diesel oil	+	+	+	+	+	+
Dioxane	+	-		+	-	
Ethanol	+	~	-	+	~	-
Glycol	+	~	-	+	~	-
Hydraulic oil	+	+		+	+	
Hydrochloric acid 10%/37%	+/-	~/-	-/-	+/-	~/-	-/-
Hydrofluoric acid 5%	+	~	-	-	-	-
Isopropanol	+	~		+	~	
Motor oils	+	+	~	+	+	~
Octane	+	+	+	+	+	+
Paraffin oil	+	+	+	+	+	+
Petrol, super	+	+	~	+	+	~
Petroleum	+	+	+	+	+	+
Petroleum jelly	+	+	+	+	+	+
Potassium chloride 10%	+	+	-	+	~	-
Sea water	+	+	-	+	+	-
Silicone oils	+	+	+	+	+	+
Soap solution	+	+	-	+	-	-
Sodium chloride 10%	+	+	-	+	~	-
Sodium hydroxide 1%	+	~	-	-	-	-
Transformer oil	+	+	+	+	+	+
Turpentine	+			+		
Vegetable oils	+	+	+	+	+	+

+ = resistant, no or only slight weight change ~ = resistant within limitations, short-term contact with the agent possible
- = unstable, weight change over 5%, marked decline in mechanical properties

Mechanical and thermal properties of VESTODUR® compounds and fire behavior

Properties	Test method	Unit	VESTODUR®			VESTODUR®	
			1000	2000	3000 series*	HI19	X4877
Density 23 °C	ISO 1183	g/cm³	1.31	1.31	1.31	1.26	1.49
Melting range DSC	ISO 11357	°C	221 –226	221 –226	221 –226	200 –205	200 –205
Melt volume flow rate[1] 250 °C/2.16 kg	ISO 1133	cm³/10 min	45	14	9	12	20
Heat deflection temperature under load							
Method A 1.8 MPa	ISO 75	°C	55	55	55	50	175
Method B 0.45 MPa		°C	150	150	150	110	195
Vicat softening temperature	ISO 306						
Method A 10 N		°C	220	220	220	190	190
Method B 50 N		°C	180	180	180	125	165
Coefficient of linear expansion 23–55°C	ISO 11359						
in flow direction		10^{-4} K^{-1}	1.1	1.1	1.1	1.5	0.5
in transverse direction		10^{-4} K^{-1}	1.1	1.1	1.1	1.5	
Oxygen index	ISO4589	%	23	23	23		
Flammability acc. UL94	IEC 60695						
0.4 mm			HB	HB	HB	HB	HB
0.8 mm			HB	HB	HB	HB	HB
1.6 mm							
Glow wire test wall thickness 2mm	ISO 60695-2-12/-13						
GWFI		°C	800	800	800	750	750
GWIT		°C	800	800	800	750	750
Water absorption 23 °C, saturation	ISO 62	%	0.45	0.45	0.45	0.35	0.25
Mold shrinkage[2]	ISO 294-4						
in flow direction		%	1.5	1.6	1.7	1.4	0.3
in transverse direction		%	1.5	1.6	1.7	1.4	1.0
Tensile test 50 mm/min	ISO 527-1/-2						
Stress at yield		MPa	55	55	55	27	105
Strain at yield		%	4	7	9	23	5
Strain at break		%	>50	>50	>50	>50	5.5
Tensile test 5 mm/min	ISO 527-1/-2						
Tensile strength		MPa					
Strain at break		%					
Tensile modulus	ISO 527-1/-2	MPa	2600	2600	2600	550	5200
Ball indentation hardness H 30	ISO 2039-1	N/mm²	160	150	150	50	105
Shore hardness D	ISO 868		79	77	77	65	79
CHARPY impact strength 23 °C	ISO 179/1eU	kJ/m²	200 C	N	N	N	80 C
–30 °C		kJ/m²	185 C	300 C	300 C	N	70 C
CHARPY notched impact strength 23 °C	ISO 179/1eA	kJ/m²	5.0 C	7.0 C	7.0 C	30 C	18 C
–30 °C		kJ/m²	4.5 C	6.0 C	6.0 C	8.0 C	13 C

N = no break, C = complete break

* Series consists of VESTODUR® 3000, 3001, 3010, 3013, 3030

[1] Moisture content < 0.05 %

[2] Pigmentation can change mold shrinkage.

** ISO 1874-2 ≙ PA molding compounds for the S6 and extr. preparation of test specimens

/1 = 1mm thick

	VESTODUR®					VESTODUR®				
	GF10	GF20	GF30	X7095	2002-FR3	GF12-FR3	GF20-FR3	GF30-FR3	X7212	X9426
	1.38	1.47	1.53	1.53	1.50	1.58	1.65	1.72	1.84	1.31
	221 -226	221 -226	221 -226				221 -226	221 -226	221 -226	
	23	16	13	12	20	20	20	12	6	45
	190 215	195 220	210 223	195 220	75 180	212 223	215 223	216 223	217 223	60 140
	220 205	220 210	220 213		215 190	218 210	218 212	220 213	220 215	190 130
	0.7 1.1	0.6 0.7	0.5 0.6		1.0 1.0	0.6	0.5	0.4	0.2 0.4	
	19	20	20		32	34	34	34	37	
	HB HB	HB HB	HB HB	HB HB	V-0 V-0 V-0	V-0 V-0 V-0	V-0 V-0 V-0	V-0 V-0 V-0	V-0 V-0 V-0	V-2 V-2
	750 750	750 800	750 800		960/1 825/1		960 750	960 750	960 775	960/1 775/1
	0.45	0.45	0.45	0.5	0.4	0.4	0.4	0.4	0.3	
	0.4 1.65	0.3 1.5	0.2 1.5	0.5 1.8	1.8 - 2.0 1.8 - 2.0	0.4 - 0.6 1.7 - 1.9	0.3 1.7	0.2 1.5	0.15 1.4	
	100 3.7 4.2									30 17 40
		140 3.5	160 3.0	105 4.0		95 3.0	120 3.0	140 2.2	150 1.3	
	4700	7200	9500	7000	3100	6000	8000	11000	15500	750
	170	190	200					220		
	81	82	83		81	82	83	84	86	
	30 C 30 C	60 C 65 C	75 C 80 C	30 C 30 C	100 C 90 C	30 C 30 C	35 C 35 C	55 C 55 C	45 C 45 C	N
	6.0 C 5.5 C	9.0 C 8.5 C	12 C 12 C	5.5 C 4.5 C	4.0 C 4.0 C	6.5 C 6.5 C	8.0 C 8.0 C	10 C 10 C	12 C 12 C	5 C

Electrical properties of VESTODUR® compounds

Properties		Test method	Unit	VESTODUR®			VESTODUR®	
				1000	2000	3000 series*	HI19	X4877
Comparative tracking index Test solution A	CTI 100 drops value	IEC 60112		600 575	600 575	600 575	600 575	600 575
Volume resistivity	23°C	IEC 60093	Ω cm	10^{15}	10^{15}	10^{15}	10^{15}	10^{14}
Surface resistance	23°C	IEC 60093	Ω	10^{13}	10^{13}	10^{13}	10^{13}	10^{13}
Relative permittivity	23°C, 100 Hz 23°C, 1 MHz	IEC 60250		3.3 3.5	3.3 3.5	3.3 3.5	4 3.6	4.7 4.5
Dissipation factor	23°C, 100 Hz 23°C, 1 MHz	IEC 60250		0.002 0.023	0.002 0.023	0.002 0.023	0.022 0.033	0.02 0.03
Electrolytic corrosion		IEC 60426	step	A1	A1	A1	A1	A1
Electric strength[1)]	K 20/P 50	IEC 60243-1	KV/mm	27	27	27	27	27

*Pigmentation may change electrical values.

[1)] Determined in transformer oil ($\epsilon r \approx 2.2$) at 1mm injection molded sheets.

	VESTODUR®					VESTODUR®				
	GF10	GF20	GF30	X7095	2002-FR3	GF12-FR3	GF20-FR3	GF30-FR3	X7212	X9426
	325 330	300 275	450 425		225 200	225 225	175 150	250 225	275 250	
	10^{15}	10^{15}	10^{15}		10^{14}	10^{14}	10^{15}	10^{15}	10^{14}	10^{14}
	10^{13}	10^{13}	10^{13}		10^{13}	10^{13}	10^{13}	10^{13}	10^{13}	10^{14}
	3.6 3.9	3.8 4.2	4 4.4		3.4 3.4	3,7 4,1	3.9 4.2	4.1 4.4	4.4 4.6	4.2 3.8
	0.002 0.019	0.003 0.018	0.003 0.017		0.002 0.020	0.002 0.018	0.003 0.016	0.003 0.015	0.004 0.013	0.022 0.033
	A1	A1	A1		A1	A1	A1	A1	A1	
	27	27	27		29	30	27	27	27	

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