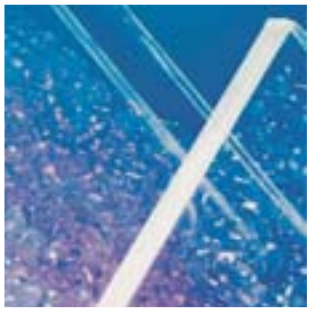
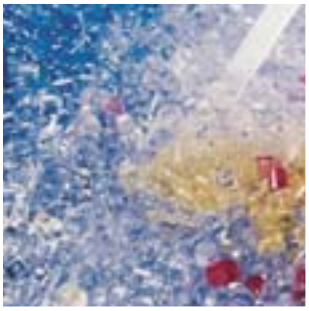
degussa.

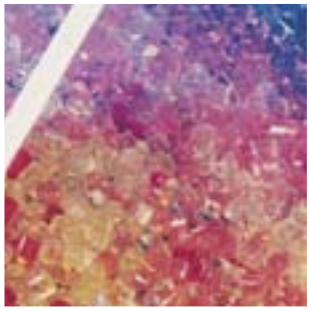
High Performance Polymers

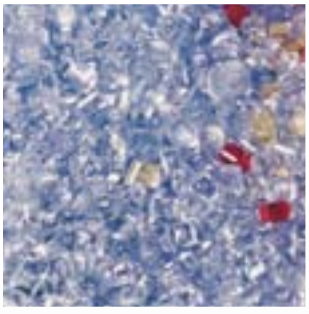
TROGAMID®

Transparent polyamides with an outstanding combination of properties









- **TROGAMID T Grades**
- TROGAMID CX Grades
- TROGAMID Handling and Processing

Directory

TROGAMID T

1 Introduction

1.1 Nomenclature

The TROGAMID product range of Degussa AG's High Performance Polymers Business Unit consists of basic products and compounds that are distinguished by their permanent transparency and high chemical resistance. T grades comprise products based on polyamide 6-3-T (PA 6-3-T) only, while BX grades cover PA 6-3-T blends containing other semi-crystalline or amorphous polyamides. New, specially designed polyamides are designated as CX grades and are followed by a four-digit number.

This four-digit number has now specific meaning, e.g., viscosity number or composition. The table below provides further information about the nomenclature of the TROGAMID range according to the commonly used DIN/ISO standards.

T grades: PA 6-3-T-based polymers and compounds made of trimethyl hexamethylene diamine and terephthalic acid, e.g., TROGAMID T5000 or TROGAMID T-GF35.

BX grades: PA 6-3-T and semi-crystalline polyamide blends, reinforced and unreinforced, e.g., TROGAMID BX7304 or TROGAMID BX9724.

CX grades: Special polyamide grades made of other monomers, e.g., TROGAMID CX7323 or TROGAMID CX9701.

Nomenclature of semi-aromatic/aliphatic amorphous polyamides according DIN 16773 and ISO 1874

TROGAMID	DIN 16773 nomenclature *)	ISO 1874 nomenclature	Monomers
T grades	PA 6-3-T	PA NDT/INDT	trimethyl hexamethylene diamine terephthalic acid
BX grades	PA 6-3-T/XX	not applicable	trimethyl hexamethylene diamine terephthalic acid
CX grades	not applicable	PA PACM 12	cycloaliphatic diamine dodecanedioic acid

*) DIN 16773 affords a further differentiation, e.g., the viscosity number; further information can be provided upon request.

This brochure covers the TROGAMID T and BX grades. Two other brochures contain information about the CX grades and about handling and processing TROGAMID products.

TROGAMID T
TROGAMID T and BX consist of terephthalic acid and 2,2,4- /2,4,4-trimethyl hexamethylene diamine, a chemical composition that is responsible for their amorphous structure. This makes them transparent in contrast to the semi-crystalline high performance plastics of High Performance Polymers, the VESTAMID® L, D, and E grades (polyamide 12 and 612, polyamide 12 elastomers) and VESTODUR® (polybutylene terephthalate). The amorphous structure also results in low mold shrinkage and low tendency to warp.

In addition to the basic products, a range of specially equipped compounds is also available. The product line fits a wide range of applications and satisfies many requirement profiles.

TROGAMID T compounds are distinguished by the following properties:

- crystal-clear, optical transparency
- high mechanical stability
- high thermostability
- high viscosity
- good chemical resistance compared to other plastics
- good electrical properties
- low mold shrinkage

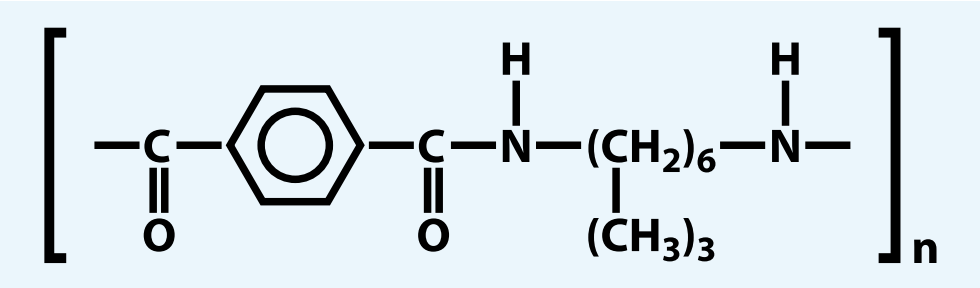


Figure 1: Molecular base of TROGAMID T

The special properties of TROGAMID T have made it useful in many branches of industry:

Electrical industry
- high-voltage switch casings
- cable glands
- battery seals
- keys and push buttons
- terminal strips
- casings for switches, relays, and counters
- gearwheels and gear racks

Water resource management and filter technology
- filter cups for pneumatic systems
- filter cups for water treatment
- fuel filter cups
- pump casings
- metering devices
- inspection glasses

Machine and apparatus construction
- flowmeters
- liquid-level indicators
- valve blocks and common control blocks for dispensing and metering equipment
- guide rails

1.2 Product overview

The product line of the TROGAMID T grades consists of the following products:

Basic product
TROGAMID T5000
Permanently transparent polyamide for injection molding, extrusion, and blow molding; no additives

Compounds
TROGAMID T5002
Permanently transparent polyamide with internal mold release agent for injection molding, extrusion, and blow molding

TROGAMID T5004
Permanently transparent polyamide with UV stabilizer and improved outdoor weathering behavior for injection molding, extrusion, and blow molding

TROGAMID TX7389
Permanently transparent polyamide with internal mold release agent and further improved flow and demolding behavior for injection molding, extrusion, and blow molding

Blends
TROGAMID BX7304
Permanently transparent polymer blend consisting of an amorphous and semi-crystalline polyamide for injection molding; improved stress-cracking resistance, low water absorption

Reinforced compounds
TROGAMID T-GF35
Amorphous polyamide, 35% glass fiber reinforced, for the injection molding of stiff, low-warpage moldings; can be mixed with TROGAMID T5000 to form compounds with a low glass fiber content whose general properties can be adjusted to fit a particular application.

TROGAMID BX9724
Polymer blend consisting of amorphous and semi-crystalline polyamides, 40% glass fiber reinforced, with high tensile modulus for injection molding, dimensionally stable even while absorbing water; appropriate for substituting cast metal parts with plastic. Moldings exhibit outstanding surface qualities in spite of their high glass fiber content.

1.3 Delivery and coloring

Like all products from High Performance Polymers, TROGAMID products are manufactured, tested, and delivered to our customers in accordance with the ISO 9001 and QS 9000 quality management system. TROGAMID compounds are commonly supplied in their natural color as cylindrical granules in moisture-proof packaging with a net weight of 25 kg. We can also deliver TROGAMID in larger units upon request. Special colors can be supplied when specific minimum quantities are ordered. Shelf life at room temperature is virtually unlimited, unless the packaging is damaged.

In general, TROGAMID compounds can be colored without problem. The best choice is a coloring agent concentrate based on TROGAMID. Dry coloring with finely dispersed coloring is also possible, but precludes pneumatic extraction. We do not recommend a "neutral" pigment paste, since it can result in incompatibility. The paste has an adverse effect on the mechanical or optical properties (e.g., a decline of the weld line strength or the loss of transparency because of streaking or clouding). Nonetheless, suitability for use should therefore be tested in each case.

More information about our TROGAMID products and how they may be modified can be obtained from our Technical Marketing Department.

2 Mechanical Properties

Property	Test method	Unit	TROGAMID						
			T5000	T5002	T5004	TX7389	BX7304	BX9724	T-GF35
Tensile test 23 °C 50 mm/min	ISO 527-1/2								
Stress at yield σ_S		MPa	90	90	90	88	82		
Strain at yield ε_S		%	8	8	8	8	6		
Nominal strain at break ε_B		%	> 50	> 50	> 50	> 50	> 50		
Tensile test 23 °C 5 mm/min	ISO 527-1/2								
Tensile strength σ_B		MPa						220	140
Nominal strain at break ε_B		%						3.2	2.1
Tensile modulus 23 °C	ISO 527-1/2	MPa	2800	2800	2800	2700	2200	11000	10000
Tensile creep modulus	ISO 899-1								
1 h		MPa	2300	2500	2500	2200	2200	9600	10000
1000 h		MPa	1100	1300	1300	1600	800	5200	8300
Flexural test 5 mm/min	ISO 178								
Flexural strength σ_{bB}		MPa	152	152	152	147	118	342	190
Flexural strength at 3.5% strain $\sigma_{b3.5}$		MPa	104	104	104	84	80	302	
Outer fiber strain at maximum stress ε_{bB}		%	9	8.5	8.5	9	8		3
Outer fiber strain at break ε_{bR}		%	n. r.	n. r.	n. r.	n.r.	n.r.	4.3	2.7
Flexural modulus	ISO 178	MPa	3000	3000	3000	3000	2700	12000	12000
CHARPY impact strength	ISO 179/1eU								
23 °C		kJ/m²	N	N	N	N	N	96 C	77 C
0 °C		kJ/m²	N	N	N	N	N	87 C	70 C
-30 °C		kJ/m²	N	N	N	N	N	80 C	59 C
CHARPY notched impact strength	ISO 179/1eA								
23 °C		kJ/m²	12 C	11 C	11 C	10 C	9 C	14 C	9 C
0 °C		kJ/m²	10 C	9 C	9 C	9 C		11 C	8 C
-30 °C		kJ/m²	7 C	6 C	6 C	6 C	8 C	10 C	7 C
Shore hardness D	ISO 868		87	86	86	86	84	90	89
Ball indentation hardness H30	ISO 2039-1	N/mm²	155	155	150	150	130	262	200

N = no break C = complete break n. r. = not reached

Since the mechanical properties of plastics change as a function of stress level, stress duration, and temperature, it is advisable to use tensile creep strength to calculate and dimension moldings intended for permanent use.

The following figures show the isochronous stress-strain plots of TROGAMID T5000 at 20 °C and 80 °C, respectively, for various stress durations.

Due to multiaxial stress, long-term values obtained from internal pressure creep tests must be used for internally stressed parts, such as filter cups, that are utilized in pneumatic systems, water treatment, and the automotive industry.

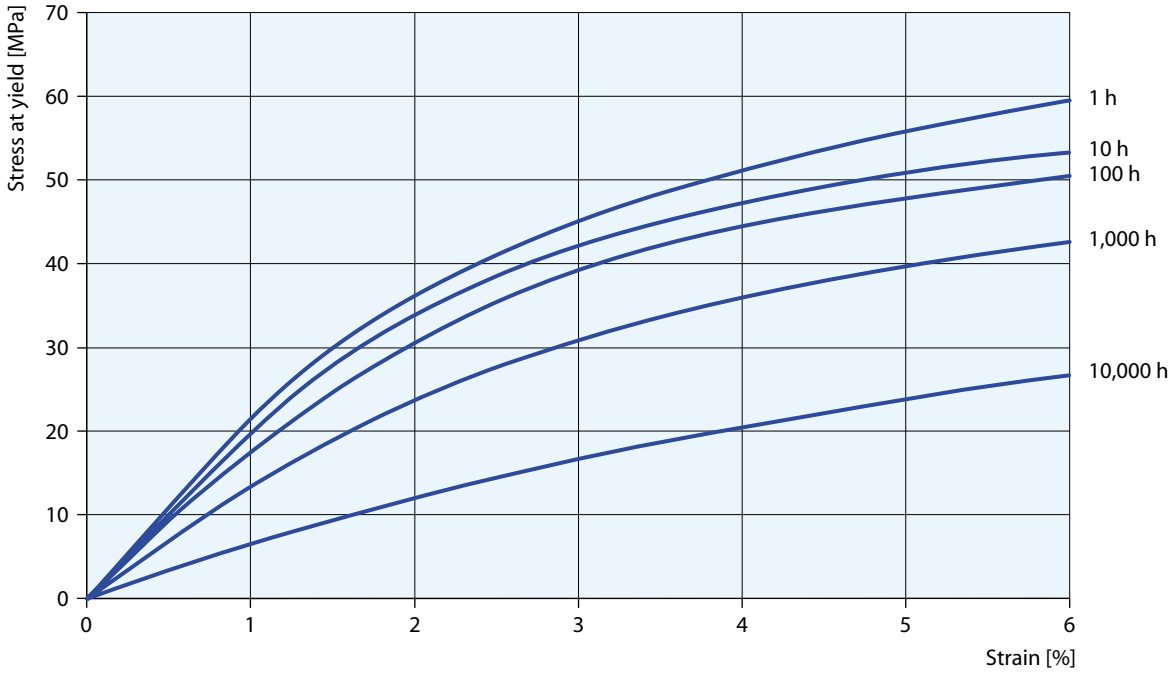


Figure 2: Isochronous stress-strain plots of TROGAMID T5000 at 20 °C according to ISO 899

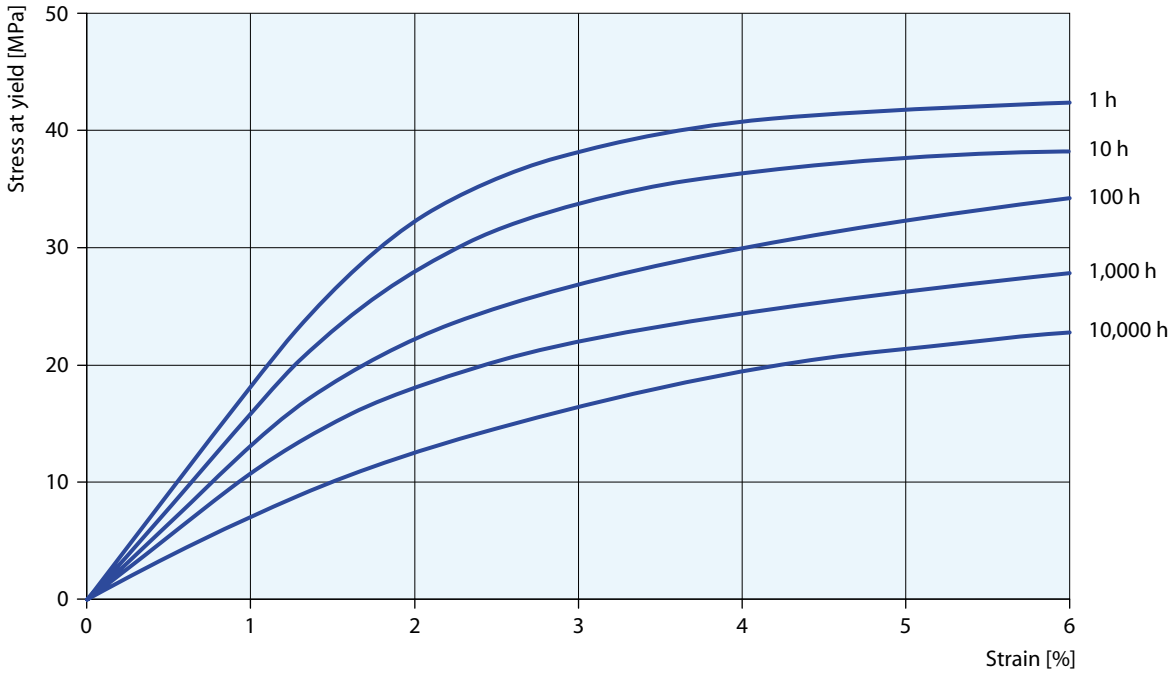


Figure 3: Isochronous stress-strain plots of TROGAMID T5000 at 80 °C according to ISO 899

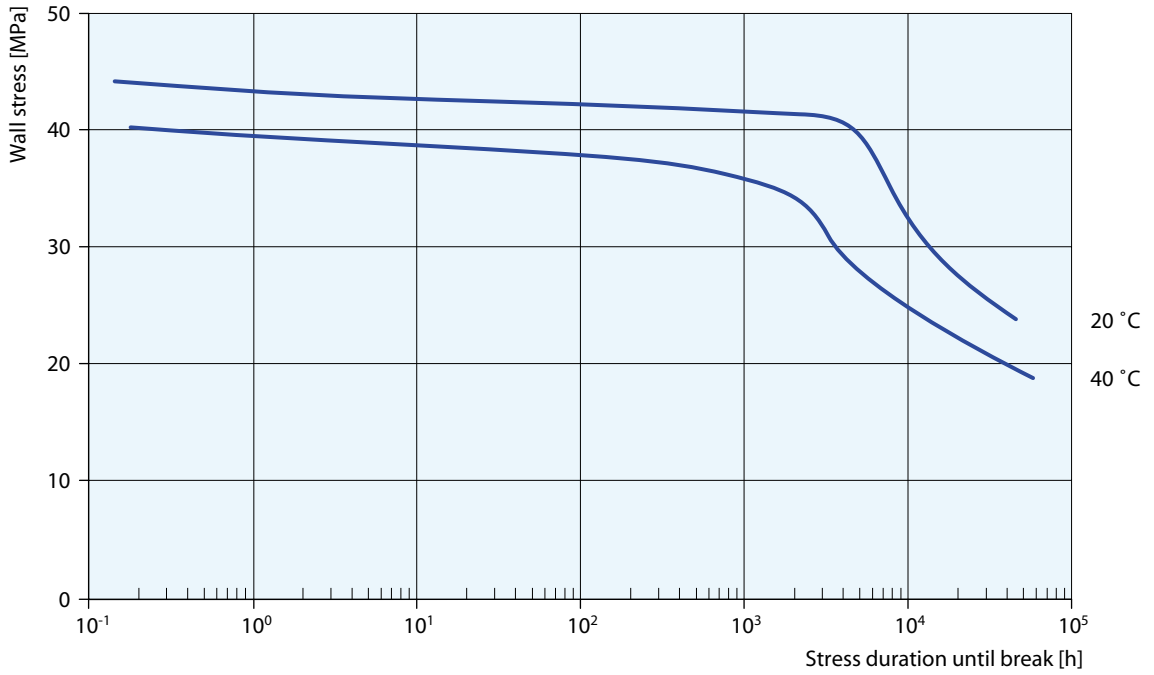


Figure 4: Internal pressure-creep behavior of filter cups consisting of TROGAMID T5000 (3.5 mm wall thickness)

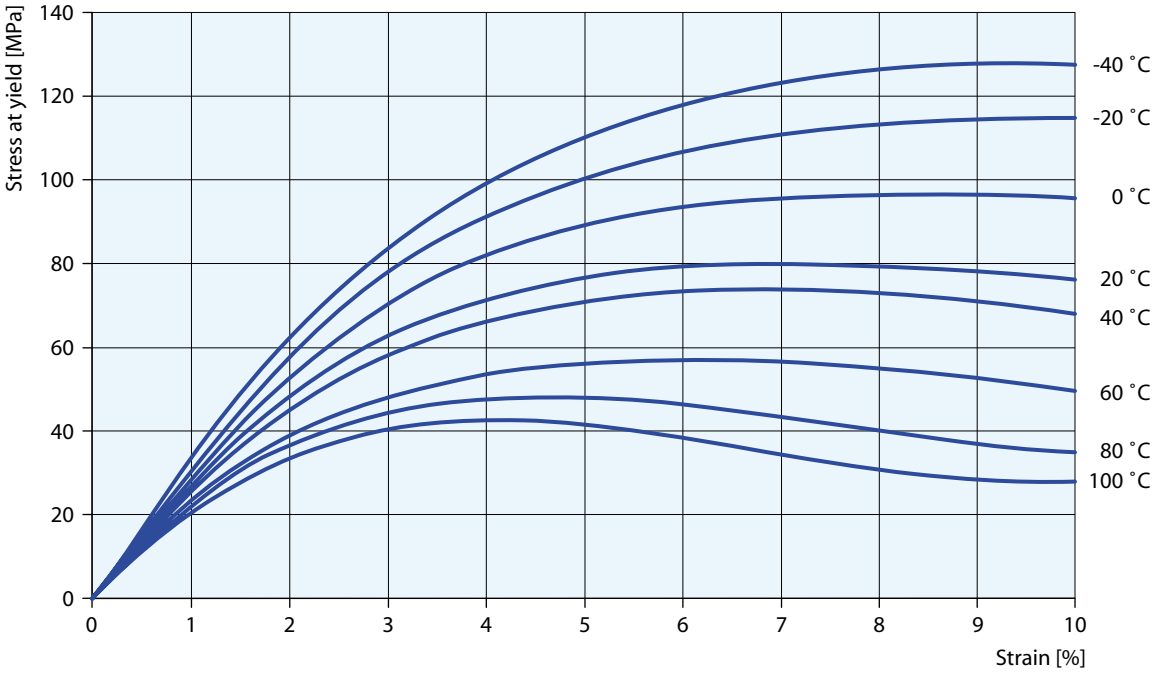


Figure 5: Stress-strain plots from the tensile creep test, according to ISO 899

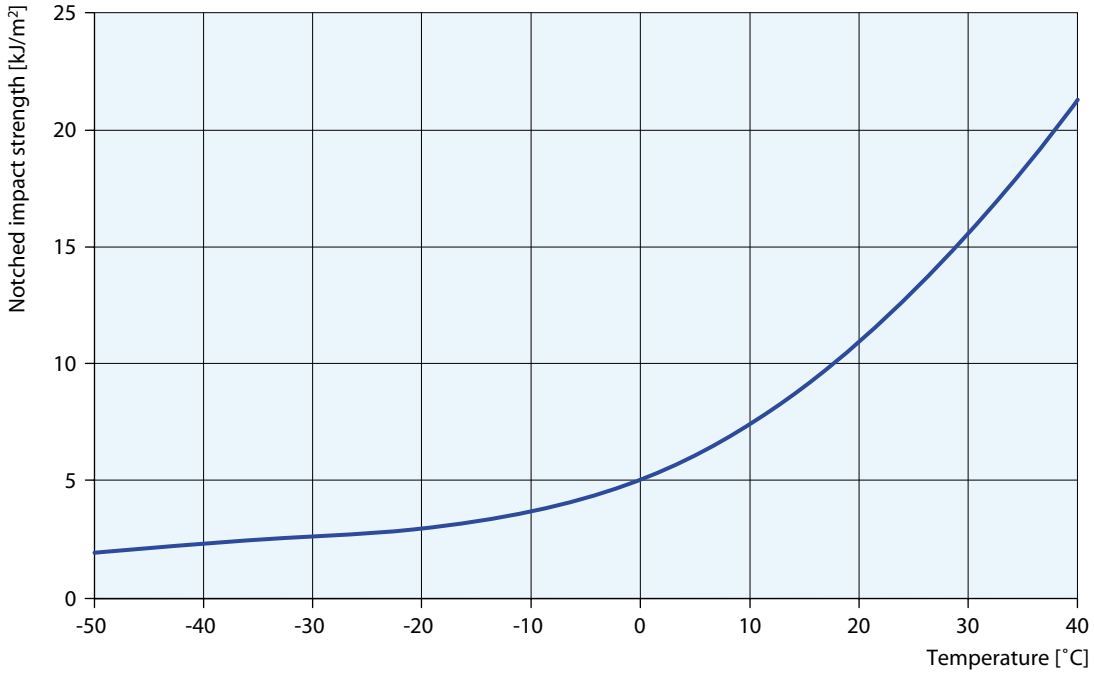


Figure 6: Notched impact strength of TROGAMID T5000 (depending on temperature) according to ISO 179/1eA

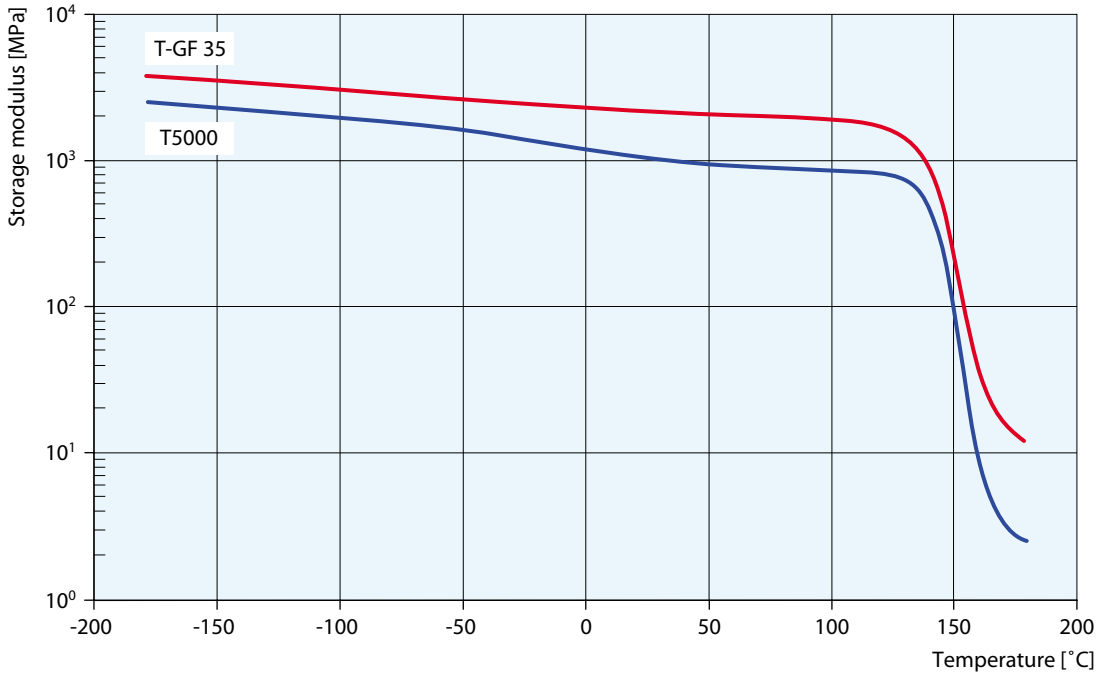
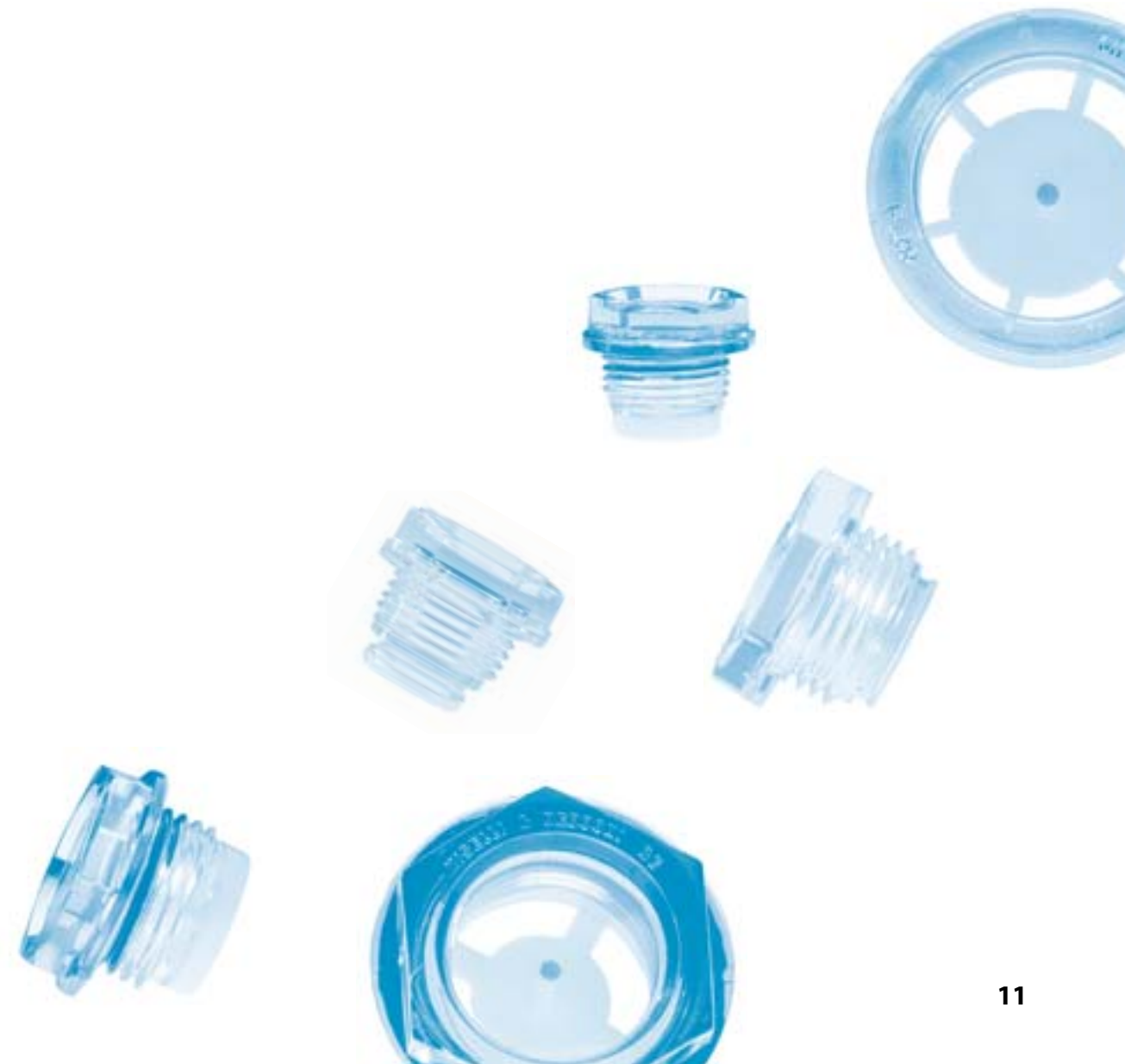


Figure 7: Torsional vibration analysis according to ISO 6721-2

3 Physical and Thermal Properties

Property	Test method	Unit	TROGAMID						
			T5000	T5002	T5004	TX7389	BX7304	BX9724	T-GF35
Density at 23 °C	ISO 1183	g/cm³	1.12	1.12	1.12	1.12	1.08	1.48	1.4
Viscosity number	ISO 307	cm³/g	132	125	125	115	160	130	100
Vicat softening temperature	ISO 306								
Method A 10 N		°C	148	148	148				158
Method B 50 N		°C	150	142	142	140	99	230	151
Temperature of deflection under load	ISO 75-1/2								
Method A 1.8 MPa		°C	120	120	120	120	75		140
Method B 0.45 MPa		°C	140	140	140	140	85	230	150
Linear thermal expansion 23°C–80 °C	ISO 11359								
longitudinal $\alpha_{\parallel}$		10^{-4} K^{-1}	0.54	0.53	0.53	0.6	0.7	0.22	0.32
transverse $\alpha_{\perp}$		10^{-4} K^{-1}	0.53	0.54	0.57	0.6	0.7	0.38	0.3
Glass transition temperature Tg 10 K/min		°C	153	150	150	149	93	93	150
Melt temperature (DSC) 10 K/min		°C						260	



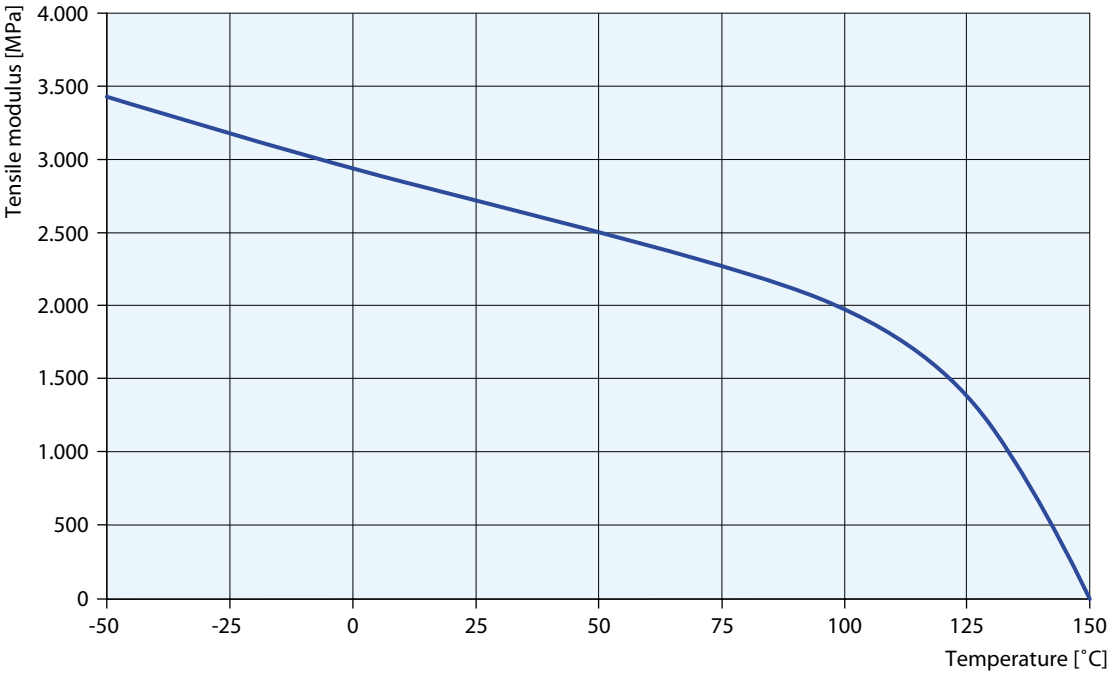


Figure 8: TROGAMID T5000 tensile modulus (depending on temperature) according to ISO 525-1/2

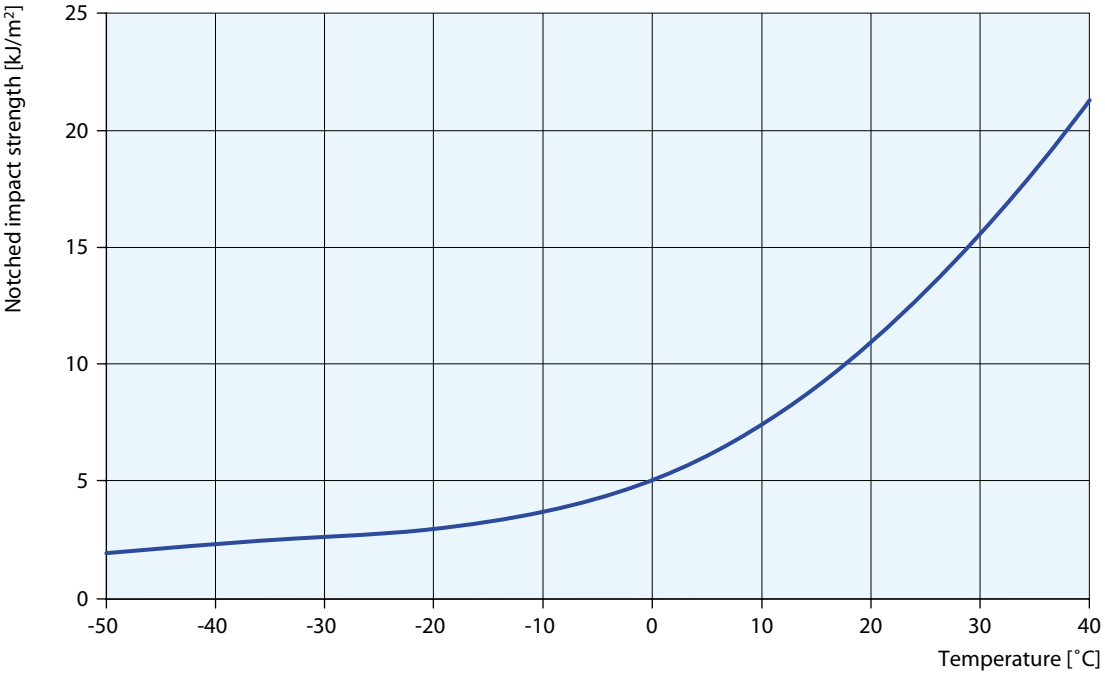


Figure 9: TROGAMID T5000 notched impact strength (depending on temperature) according to ISO 179/1eA

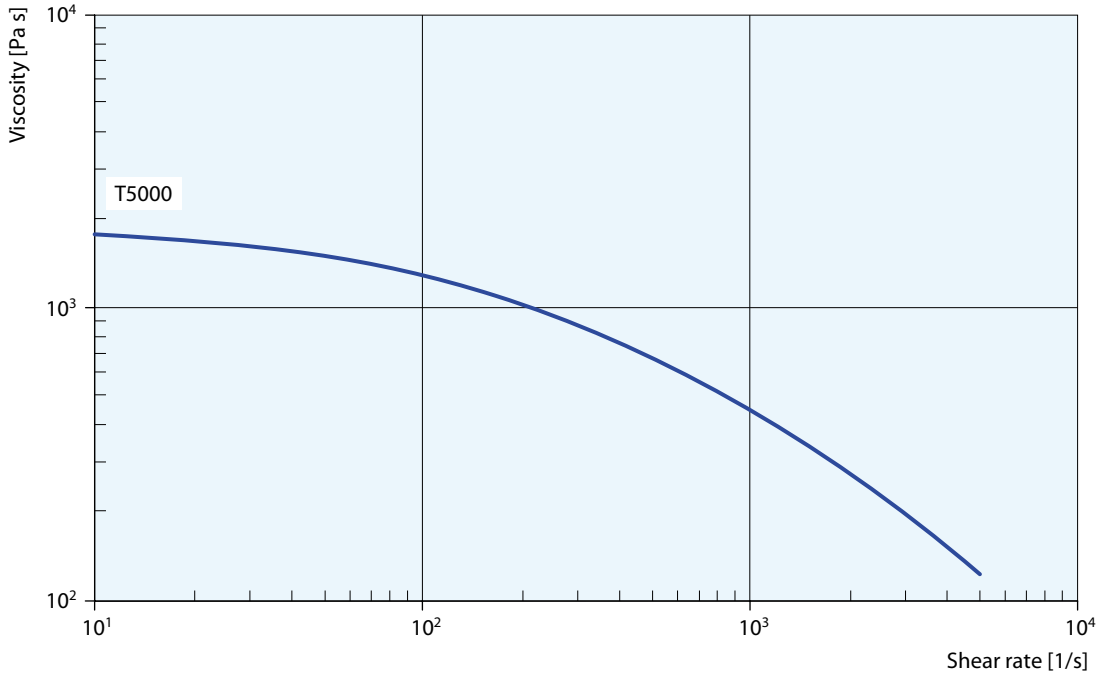


Figure 10: Melt viscosity of TROGAMID T5000. Results of high pressure capillary viscosimeter (L/D–60/2 mm nozzle geometry)

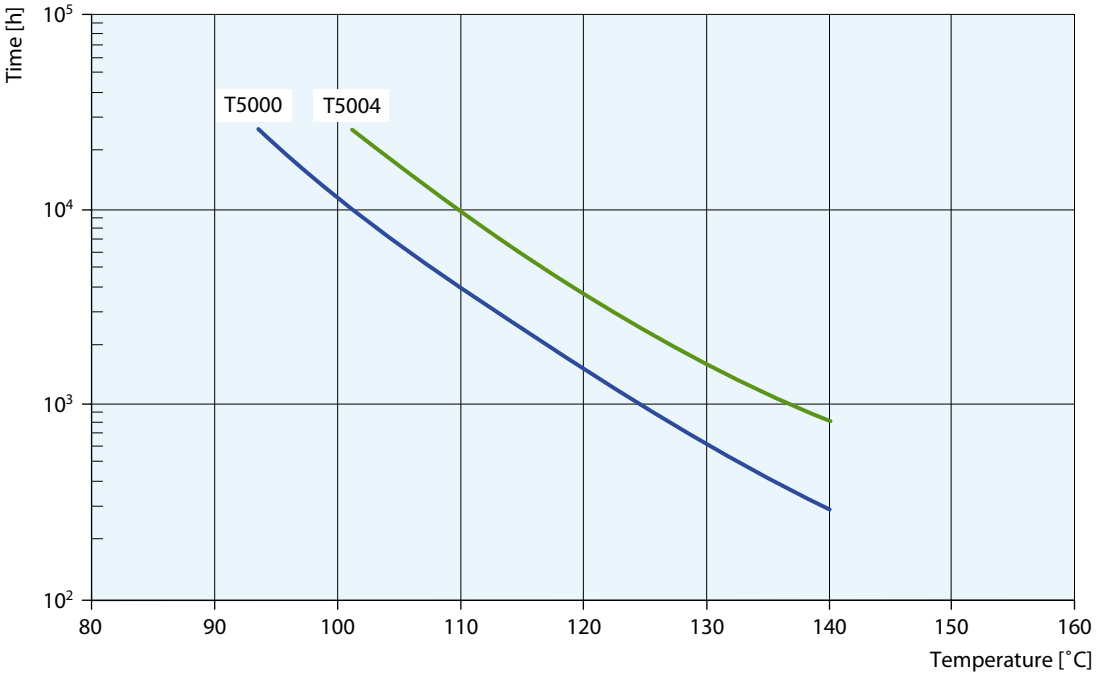


Figure 11: Thermal stability of TROGAMID T compounds according to IEC 216

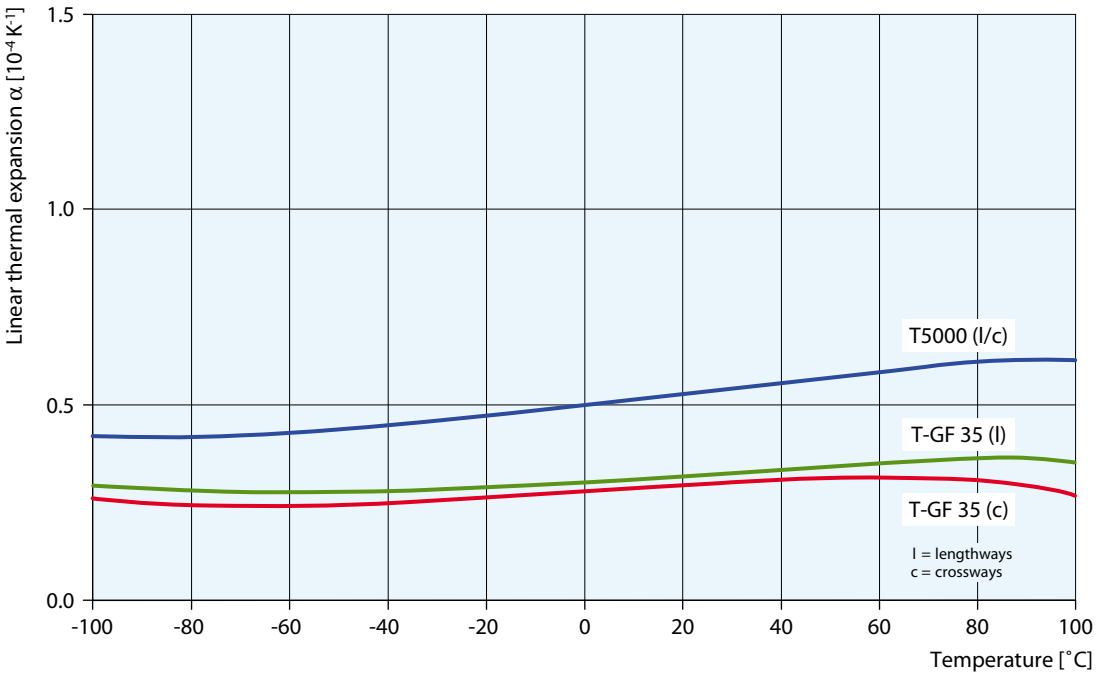


Figure 12: Linear thermal expansion according to ISO 11359 (2 K/min heating rate)

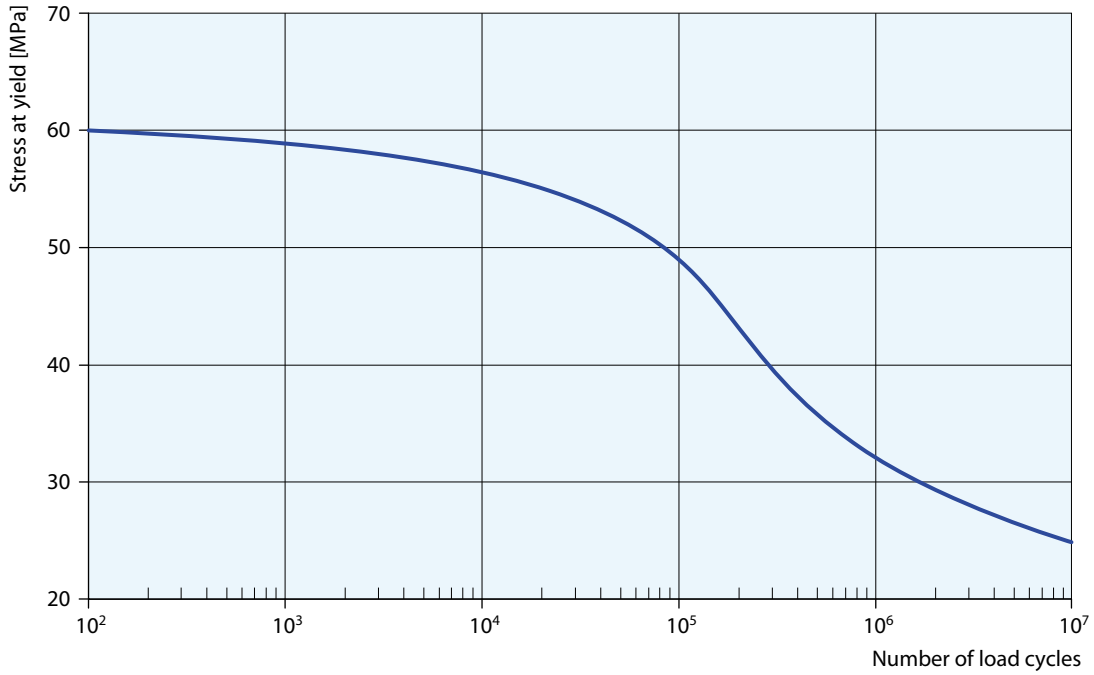


Figure 13: TROGAMID T5000 tensile fatigue limit (5 Hz frequency)

4 Electrical Properties

Property		Test method	Unit	TROGAMID						
				T5000	T5002	T5004	TX7389	BX7304	BX9724	T-GF35
Relative permittivity ε_r	50 Hz	IEC 60250		4.2	4	4.2				4.5
23 °C	100 Hz			4.6	4.3	4.6				5
	1 MHz			3.4	3.7	3.3	3.8		6.2	3.8
Dissipation factor tan δ	50 Hz	IEC 60250		0.021	0.018	0.017				0.016
23 °C	100 Hz			0.025		0.024				0.018
	1 MHz			0.028	0.026	0.028	0.028	0.0425	0.025	0.024
Electric strength E_d	K20/P50	IEC 60243-1	kV/mm	25	26	24	23	19	27	35
Comperative tracking index		IEC 60112								
Test solution A	CTI			> 600	> 600	> 600	600	600	600	575
	100-drops value									
Glow wire test test thickness = 1 mm		IEC 60695-2-1/0-3	°C	960						
Volume resistivity ρ_d		IEC 60093	Ohm m	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}
Spec. surface resistance ρ_s		IEC 60093	Ohm	> 10^{15}	> 10^{15}	> 10^{15}	> 10^{15}	> 10^{15}	> 10^{15}	> 10^{15}
Surface resistance R_{OA}		IEC 60093	Ohm	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}

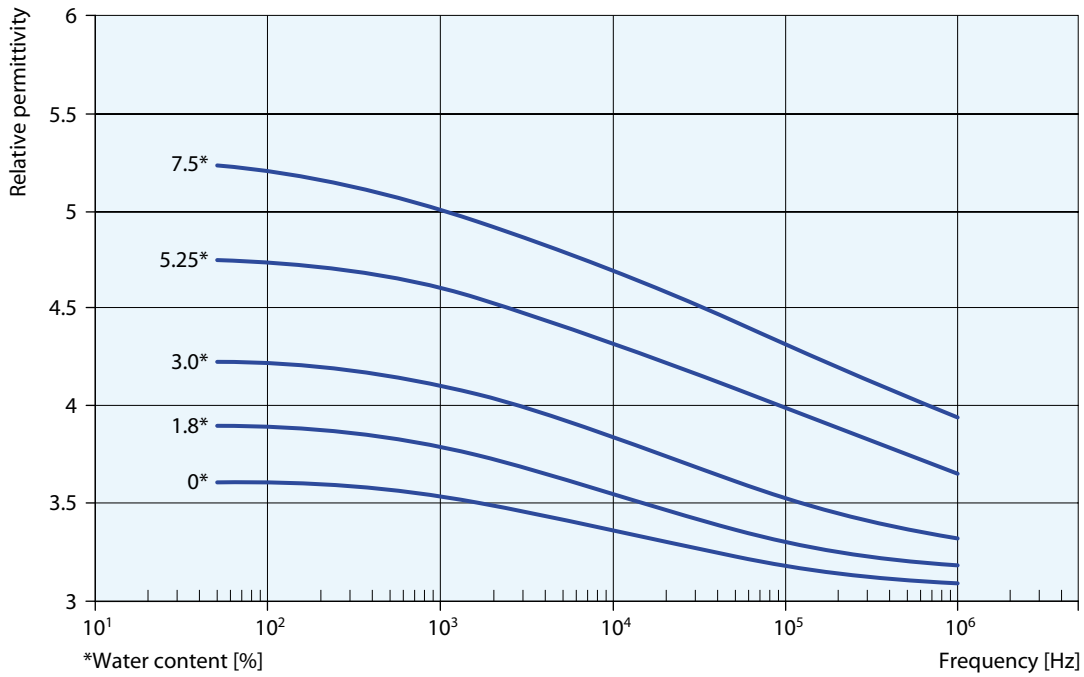


Figure 14: TROGAMID T5000 relative permittivity (depending on frequency and water content) according to IEC 60250

5 Behavior Against Outside Influences

Water absorption/hydrolysis resistance
TROGAMID T compounds, like all other polyamides, absorb water at a rate that depends on the temperature and relative humidity. The water absorption of TROGAMID T5000 in a saturated state is about 7.5 wt.-%. In contrast to semi-crystalline polyamides PA 6 and PA 66, however, it should be noted that TROGAMID is not plasticized when it absorbs water. The following figure indicates the effect of the water that is absorbed.

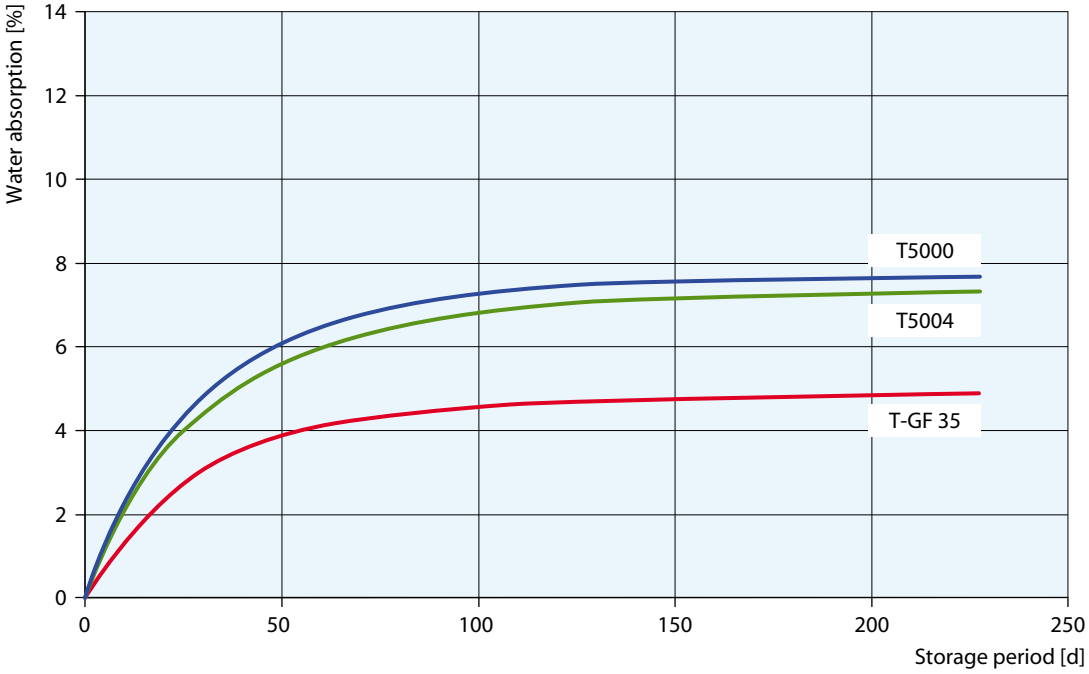


Figure 15: Water absorption of TROGAMID T compounds (stored in water at 23 °C) according to ISO 62

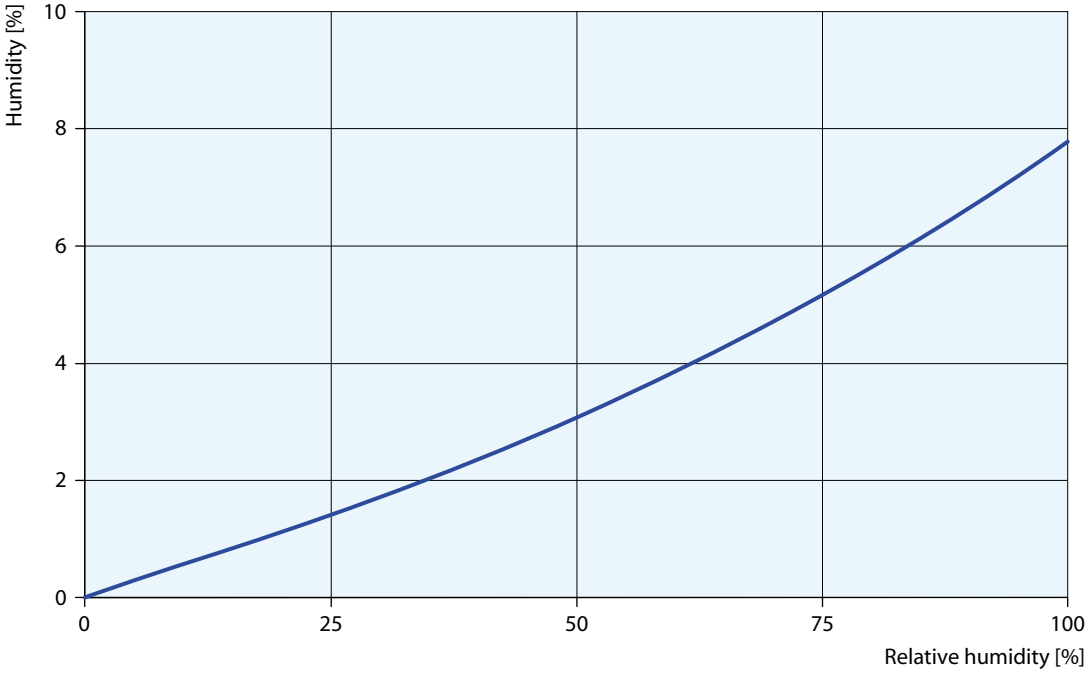


Figure 16: TROGAMID T5000 moisture absorption as function of atmospheric humidity

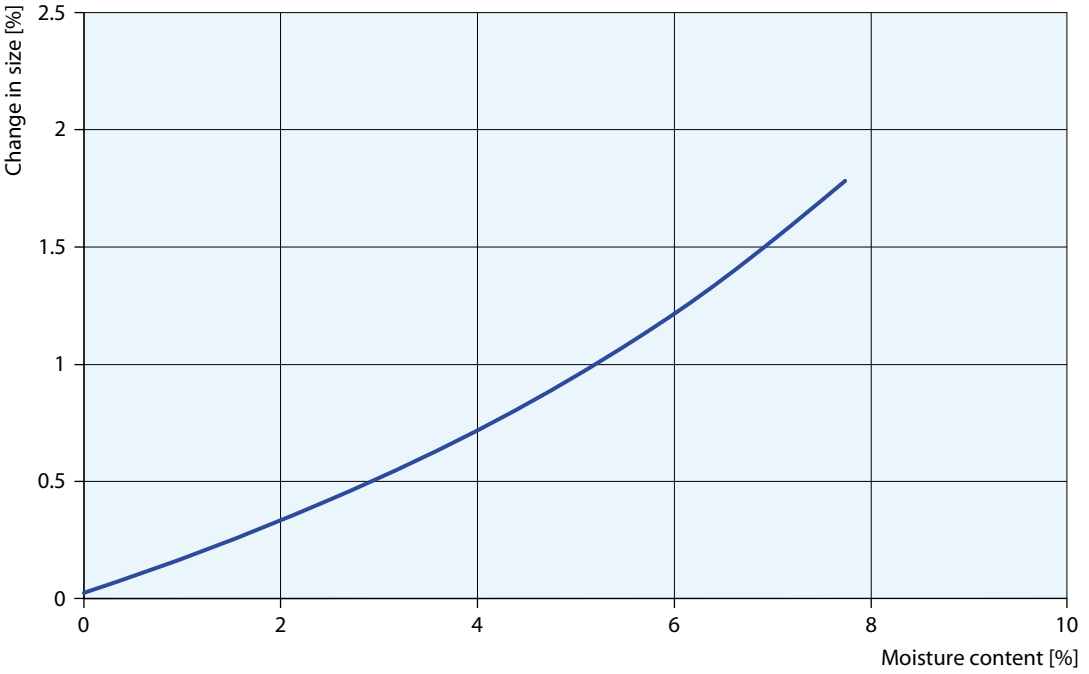


Figure 17: Dimensional stability of TROGAMID T5000 moldings (test specimen 50x50x4 mm^3)

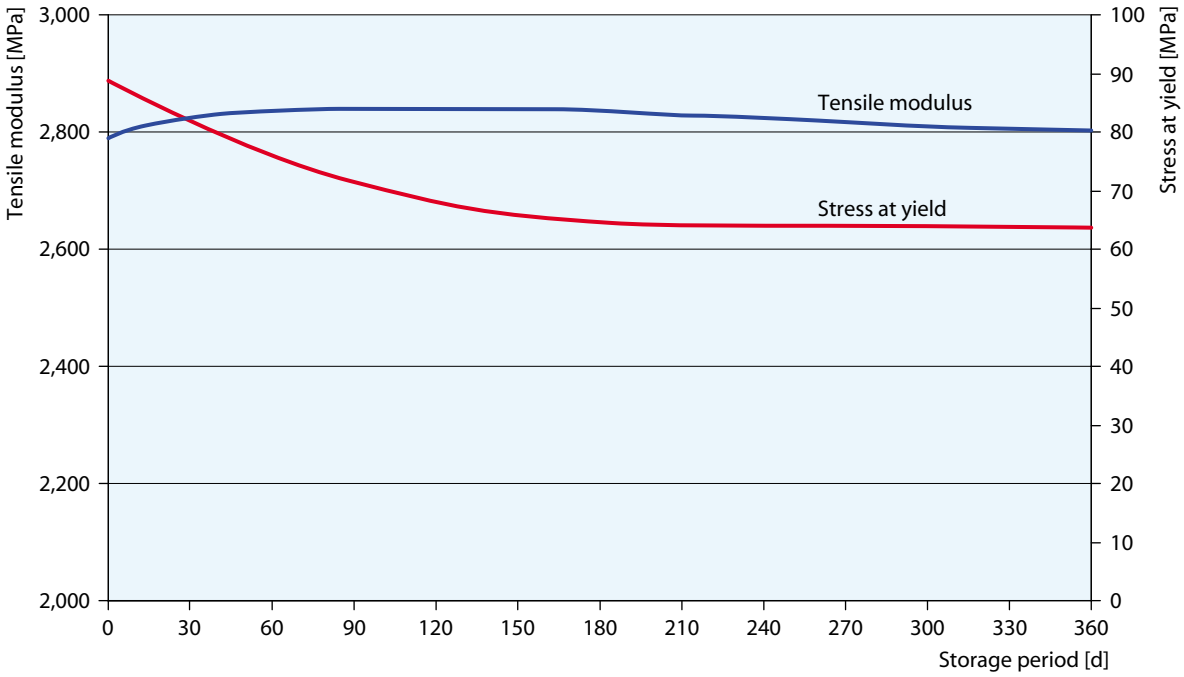


Figure 18: Tensile modulus and stress at yield of TROGAMID T5000 as a function of storage period in water at 23 °C

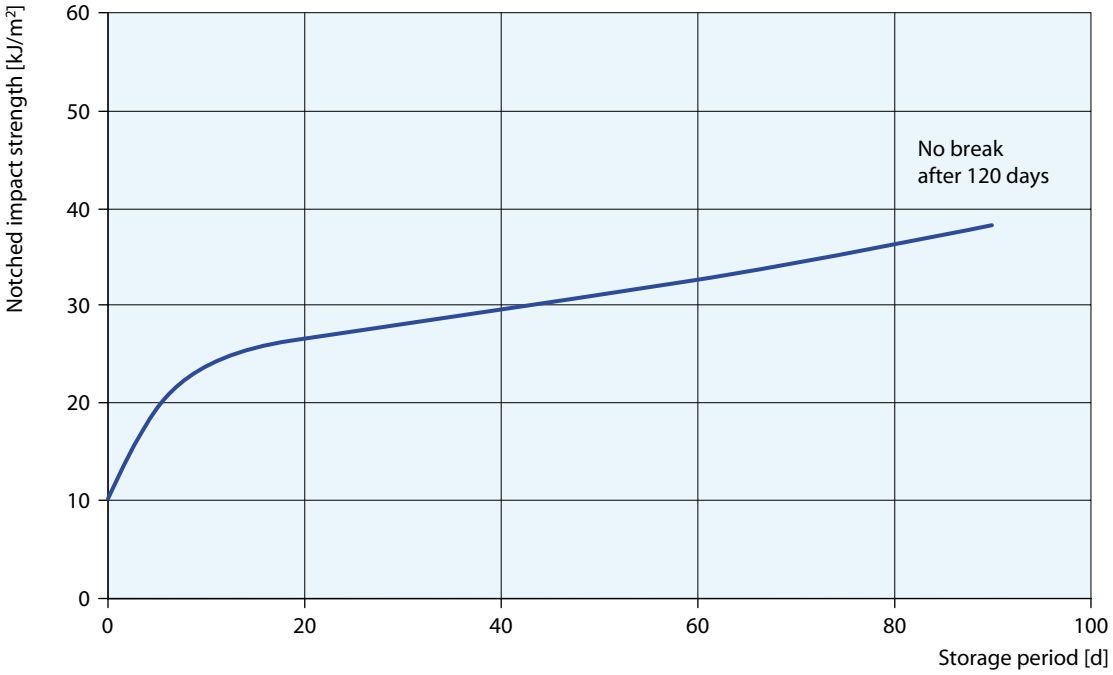


Figure 19: Notched impact strength of TROGAMID T5000 as a function of storage period in water at 23 °C according to ISO 179/1eA

Resistance to internal pressure / dynamic load

Resistance to internal pressure and a high dynamic load are demands typically made by water treatment and filter technology. To conform with common safety regulations, the material must withstand internal pressure at least three times the operation pressure. Furthermore, one distinguishes between short-time stress (burst pressure) and dynamic load (number of load cycles).

The special advantages of TROGAMID can be seen in the field of water filter cups, as follows. Water filter units prevent corrosion phenomena by restraining the build-up of residue in pipes, especially in building plumbing. Water filters are often used in combination with pressure reducers. Such a control system produces a water pressure that is constant and thus gentle on fittings and pipe systems.

Property	Test method	Unit	TROGAMID T5000	TROGAMID BX9724
Burst pressure	Degussa	bar	150	180
Dynamic behavior under load (Filter cup/0–38 bar / 160 min^{-1})	Degussa	cycles	> 10^6	> 10^6

High requirements are placed on the mechanical and dynamic properties of the materials used in filter units to ensure that the units will not break and cause water damage. In this area in particular, TROGAMID T5000 is the ideal material since it fulfils all the requirements, in short-time stress as well as in the field of dynamic load. In addition, its transparency and its high level of chemical resistance to most oils and greases make TROGAMID T5000 exceptionally suitable in this field of application.

In addition to the physical properties, it is also essential that TROGAMID compounds coming into contact with drinking water and food are toxicologically harmless.

Fittings and the top parts of filter cups are not only subject to high internal pressure, but are also exposed to enormous mechanical stresses during both assembly and operation. In many cases, these molded parts are still produced out of metal alloys in the casting process, because thermoplastic constructional materials that possess constant high strengths and good tenacity for the manufacture of dimensionally accurate parts were never previously available. With TROGAMID BX9724, there now exists a glass-fiber reinforced material that can be used as an alternative to metal. Compared to purely semi-crystalline polyamides, its fundamental mechanical properties hardly change when it comes into contact with water.

Extensive testing of finished parts has confirmed that these compounds can be used very successfully for fittings and flanges.

TROGAMID compounds are subject to inspection of the testing agency Deutsche Vereinigung des Gas- und Wasserfaches – Technologiezentrum Wasser [German Association of Gas and Water—Water Technology Center] (DVGW—TZW) in Karlsruhe and to the KTW Recommendation (German Drinking Water Standard) of the German Federal Health Office.

Flammability / thermal properties

TROGAMID compounds satisfy many of the regulations and directives regarding higher fire safety and lower fire risk without using any flame retardants, halogenated or non-halogenated.

Underwriters Laboratories Inc. has classified the fire behavior and maximum continuous working temperature of various TROGAMID compounds discussed in this brochure in accordance with UL standard 94 (fire behavior) and UL standard 746B (Relative Temperature Index, RTI). The certification listed below relates to the compound. Moldings and equipment need separate certification.

Flammability / thermal properties

Property		Test method	Unit	TROGAMID						
				T5000	T5002	T5004	TX7389	BX7304	BX9724	T-GF35
Flammability acc. to UL 94		IEC 60695								
	0.8 mm			V-2	V-2	V-2	V-2	HB	HB	HB
	1.6 mm			V-2	V-2	V-2	V-2	HB	HB	HB
Glow wire test	1 mm	IEC 60695-2-1/0-3	°C	850	850		850			

Property		Test method	Unit	TROGAMID		
				T5000	T5002	TX7389
RTI acc. to UL without impact test		UL746 B				
	0.8 mm		°C	85	85	65
	1.6 mm		°C			65
RTI acc. to UL with impact test		UL746 B				
	0.8 mm		°C	80	80	65
	1.6 mm		°C			65

6 Optical Properties

Light transmission

TROGAMID T is amorphous and therefore permanently transparent. It maintains its transparency even at considerable thicknesses. The light transmission in the range of visible light is 90%. The refraction index n_D^{20} is 1.566.

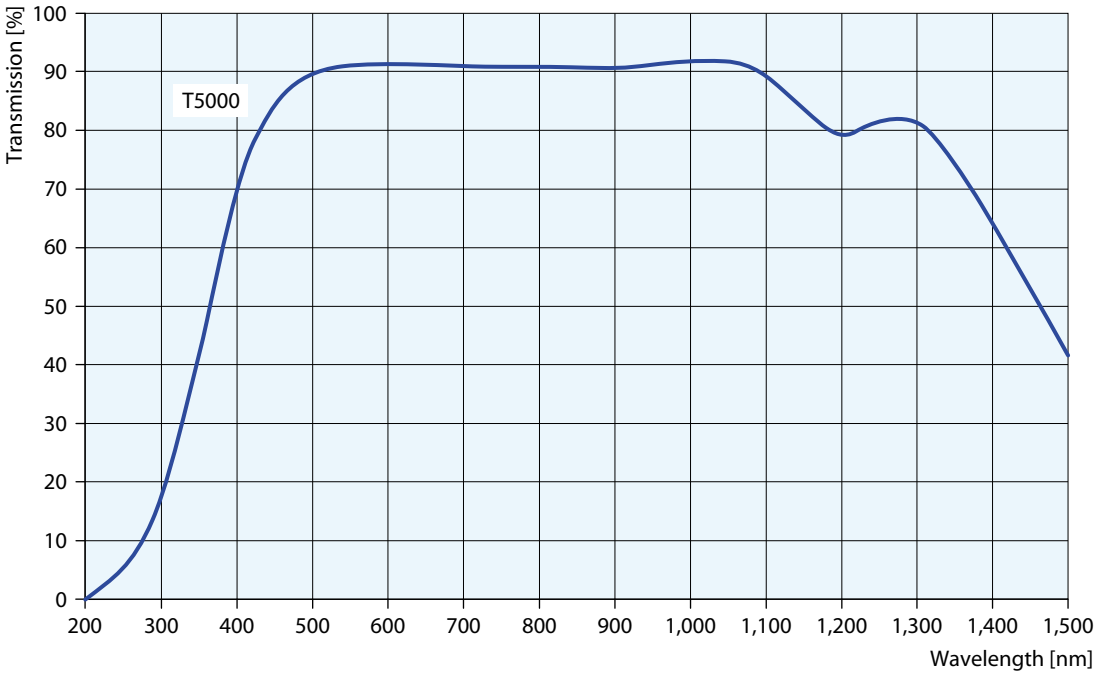


Figure 20: Spectral light transmission of TROGAMID T5000 (3.5 mm wall thickness)

7 Chemical Resistance

General remarks

The chemical resistance of TROGAMID T was measured by storing test specimens in the media to be analyzed for six months at 23 °C. At higher temperatures, both the dissolving capacity and tendency toward stress-crack formation increase. If you are considering applying TROGAMID at a higher temperature, it is important to first check whether TROGAMID would be suitable at the planned operating temperature. Testing consists of storing test specimens so that they are strain-free and completely surrounded by the test medium. Internal stresses, which always occur in finished products to a more or less strong extent in practice, have a marked effect on the resistance of TROGAMID T. Suitability for use should therefore be tested in each case. More information about the durability of TROGAMID T products in different media can be obtained from our Technical Marketing department.

Chemical and solvent resistance of TROGAMID T5000

Medium (23 °C):	Evaluation	
A		
Acetone	●	
Acrylonitrile	□	(1)
Adipinic acid, sat.	■	
Allyl alcohol	□	(2)
Aluminum sulfate, sat.	■	
Ammonium acetate, sat.	■	
Ammonium carbonate, sat.	■	
Ammonium iron(II) sulfate, sat.	■	
Ammonium iron(III) sulfate, sat.	■	
Ammonium nitrate, sat.	■	
Ammonium phosphate, sat.	■	
Ammonium sulfide, 40%	●	(3)
Amyl acetate	■	
Amyl alcohol	□	(2)
Aniline	□	(2)
Anisole	■	
B		
Barium hydroxide, 10%	■	
Benzaldehyde	□	(1)
Benzene	■	
Benzoic acid, sat.	●	(3)
Bromine, liquid	□	(2)
1,3-butanediol	□	(1)
1,4-butanediol	□	(1)
2,3-butanediol	□	(1)
Butyl acetate	■	

Medium (23 °C):	Evaluation	
n-butyl alcohol	□	(2)
t-butyl alcohol	□	(1)
Butylene glycol	□	
t-butyl methyl ether	■	
C		
Carbon disulfide	■	
Carbon tetrachloride	■	
Chloroform	□	(1)
Chlorosulfuric acid	□	(2)
Crotonaldehyde	□	(2)
Cyclohexane	●	
D		
Dibutylphthalate	■	
1,2-dichlorobenzene	■	
1,2-dichloroethane	●	
1,2-dichloroethylene	□	(1)
Difluorodichloromethane	■	
Difluoromonochloromethane	●	
Diisobutylketone	■	
Diisopropyl ether	■	
Dimethylformamide	□	(2)
1,4-dioxane	●	(3)
E		
Ethyl acetate	■	
Ethyl alcohol	□	(1)
Ethylamine, 33%	●	(3)
Ethylbenzene	■	

Medium (23 °C):	Evaluation	
Ethylene diamine	□	(2)
Ethylene glycol	□	(3)
Ethyl ether	■	
F		
Fluorodichloromethane	□	
Formaldehyde solution	■	
Formic acid, conc.	□	(2)
Furfuralcohol	□	(2)
G		
Gasoline (5% methanol)	□	(2)
Gasoline	■	
Glacial acetic acid	□	(2)
H		
n-heptane	■	
n-hexane	■	
Hexanetriol	■	
Hydrazine hydrate, 80%	●	(3)
Hydrochloric acid, 2%	■	
Hydrochloric acid, 10%	■	
Hydrochloric acid, conc.	□	(1)
Hydroxylamine, 30%	■	
I		
Iron (II) sulfate, sat.	■	
Iron (III) sulfate, sat.	■	
Isoamyl alcohol	□	(2)
Isooctane	■	
Isopropanol	□	(1)
K		
Kerosene	■	
M		
Methylene chloride	□	
Methyl ethyl ketone	□	(1)
Monofluorotrichloromethane	■	

Medium (23 °C):	Evaluation	
N		
Nitric acid, 2%	●	
Nitric acid, 10%	●	
Nitric acid, 30%	□	
Nitrobenzene	■	
P		
Paraffin oil	■	
Potassium chlorate, sat.	●	
Potassium chloride, sat.	■	
Potassium dichromate, sat.	■	
Potassium hydroxide solution, 50%	■	
Potassium iodide, sat.	■	
Potassium nitrate, sat.	■	
Potassium perchlorate, 10%	■	
n-propanol	□	(2)
Propylene glycol	□	(1)
S		
Sodium hydroxide solution, 5%	■	
Sodium hydroxide solution, 10%	■	
Sodium hydroxide solution, 50%	■	
Sulfuric acid, 10%	■	
Sulfuric acid, 40%	■	
Sulfuric acid, conc.	□	(1)
T		
Tartaric acid, sat.	●	(1)
1,1,2,2-tetrafluorodichloroethane	■	
Toluene	■	
Trichloroethylene	■	
1,2,2-trifluorotrichloroethane	■	
Trioctyl phosphate	■	
X		
Xylene	■	

■ = resistant
● = conditionally resistant
□ = not resistant

Supplementary abbreviations
for the chemicals listed:
sat. = saturated solution in water at 23 °C
conc. = concentrated

Supplementary numbers for
"conditionally resistant" and "not resistant":
(1) = stress-crack formation, (2) = dissolving
(3) = discoloration, impairment of transparency

8 Registrations and Listings

The Environment, Health, and Safety department, which answers to the High Performance Polymers Business Unit, provides general information on the toxicological properties of TROGAMID compounds and all evaluations dealing with the compound's contact with foodstuffs. This department is also responsible for providing information on product safety and for compiling EC Safety Data Sheets for TROGAMID. Please direct all questions on the subject to our Technical Marketing department.

To date, TROGAMID has received approval by third-party institutions and has been registered with European authorities, as the following shows:

- Approval in accordance with the EU's Directive 90/128/EEC relating to plastic materials and articles intended to come into contact with foodstuffs; the relevant migrations values must be heeded.
- BGVV Listing (German Institute for Consumer Health Protection and Veterinary Medicine)
- KTW Recommendation (German Drinking Water Standard)
- UL Listing
- FDA approval (CFR Title 21, Part 177, Section 177.1500 Nylon Compounds)

9 Ecology and Safety

TROGAMID compounds are non-hazardous substances that are not governed by any particular safety regulations. TROGAMID compounds are classified under Water Hazard Class 0. They can be disposed of in landfills or incinerated as normal household waste in accordance with local ordinances. Further information can be obtained from the TROGAMID material safety data sheet that we send upon request. Recycling is, however, preferred and advisable for economic reasons. How reclaimed materials affect the functional properties of a molded part has to be judged in each individual case. Further information about the use of regrind can be obtained from our Technical Marketing Department.

No dangerous by-products are formed if TROGAMID is processed correctly. Care should be taken, however, to ventilate the working area properly.

TROGAMID compounds contain no halogenated flame retardants, e.g., brominated biphenyls or diphenylethers. No pigments or additives containing cadmium are used.

If the melt is discolored or black specks appear, this is a sign that the material has degraded during processing. Degraded material should be removed quickly from the machine and cooled under water to minimize any offensive odors or fumes. At higher temperatures, most TROGAMID compounds will burn. At melt temperatures between 360 and 370 °C, flammable gases are released. Combustion with a sufficient supply of air produces carbon monoxide, carbon dioxide, water, and nitrogen containing compounds as end products. Since the crack and combustion spectrum depends to a great extend on the combustion conditions, it is not possible to make any general statement here.

10 CAE Data of TROGAMID T5000, Campus® Material Database

The philosophy of Degussa AG's High Performance Polymers Business Unit is to sell high performance plastics and solutions that satisfy the requirements of our customers. The use of CAE methods significantly reduces development risks. Changes at an early stage of development are a fraction of what the costs could be at later stages or during series production. Take advantage of our overall application advice, which includes CAE methods for each type of high-performance polymers. Please contact our Technical Marketing Department if you are considering building a new component or tool, or are having difficulties with existing tools.

Property	Unit	TROGAMID T5000
Density of melt	g/cm³	0.90
Spec. heat capacity	J kg^{-1} K^{-1}	22000
Heat conductivity	W m^{-1} K^{-1}	0.21
Carreau-WLF values		
K1		1975.9
K2		0.0034126
K3		0.94013
K4		290
K5		205.03
No-flow temperature	°C	180
Ejection temperature	°C	130

Campus® material database
Other properties of TROGAMID compounds and material information on the other products of the High Performance Polymers Business Unit are contained in the plastics database Campus, which is updated regularly. The properties of the material are based on ISO-Standard (International Organization of Standardization) and, therefore are interchangeable.

You will find Campus on the Internet at **www.degussa-hpp.com**

Campus® is a registered trademark of CWF GmbH/Frankfurt (Main).

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® = registered trademark

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