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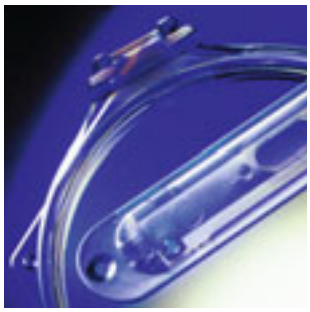
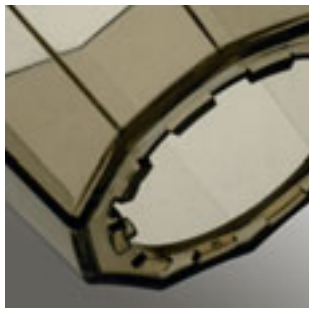
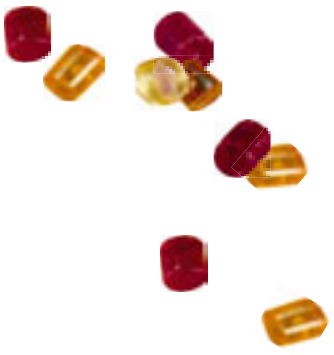
TROGAMID®

Transparent polyamides with
an outstanding combination
of properties



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



Directory

TROGAMID CX

1 Introduction

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

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

Table 1: 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.

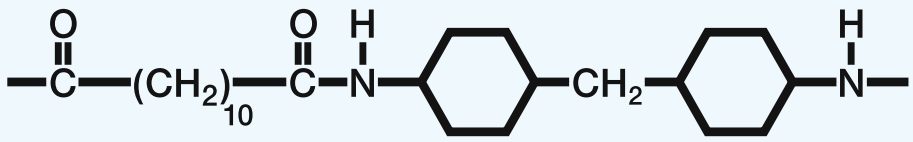


Figure 1: Molecular base of TROGAMID CX7323

Properties
Products already established on the market are partially aromatic units that impart rigidity and high heat resistance. Our TROGAMID T5000 is a typical representative of this group. Replacing aromatic constituents with aliphatic monomers improves the UV stability of amorphous polyamides. TROGAMID CX7323 is an example of this type of polyamide.

By selecting specific monomers, one can achieve a crystallizable and permanently transparent polyamide: TROGAMID CX. The crystallites are so small that they do not scatter visible light, and the material appears transparent to the human eye—a property known as microcrystallinity. Because of its crystallinity, the microcrystalline structure retains important properties such as stress cracking resistance—without clouding. The degree of crystallinity is so negligible, however, that it has no adverse effect on the shrinkage behavior of molded parts. Like other amorphous materials, TROGAMID CX undergoes isotropic shrinkage.

TROGAMID CX combines the chemical resistance of semi-crystalline molding materials with the advantages of amorphous, UV-resistant materials. The outstanding properties of TROGAMID CX are:

- crystal-clear, permanent transparency; high transmission
- superior chemical and stress cracking resistance
- high level of UV resistance
- low water absorption compared with many other polyamides, which leaves the mechanical properties virtually unaffected
- high dimensional stability
- very balanced mechanical property profile
- high impact resistance, even at low temperatures
- high level of dynamic strength (e.g., for internally pressurized parts)
- abrasion and scratch resistance
- high glass transition temperature
- very low isotropic shrinkage
- easy processing

The combination of good UV resistance, high mechanical strength, permanent transparency, high transmission and superior chemical resistance opens a wide range of applications for TROGAMID CX. Typical areas of application are in the automotive industry, machinery and engineering, medical technology, the sports and recreation industry, the glasses production, the cosmetics industry and in water treatment and filter technology.

Introduction

Product overview
The product range of TROGAMID CX currently comprises the following products:

TROGAMID CX7323:
Medium-viscous, permanently transparent polyamide for injection molding and extrusion

TROGAMID CX9701:
Highly viscous, permanently transparent polyamide for extrusion, with an external mold release agent

TROGAMID CX9703:
Medium-viscous, permanently transparent polyamide for injection molding and extrusion, with UV absorber

TROGAMID CX9704:
Low-viscous, permanently transparent polyamide for injection molding

TROGAMID CX9710:
Medium-viscous, permanently transparent polyamide for injection molding and extrusion, with an internal mold release agent

Further products, e.g., transparent laser-markable and colored grades, or products for medical applications on request.

Delivery and coloring
Like all other products of Degussa´s Business Unit High Performance Poymers, the TROGAMID CX range is manufactured, tested and delivered to our customers in accordance with the quality management system established by ISO 9001:2000. TROGAMID CX compounds are normally supplied in their natural color as cylindrical granules in moisture-proof packaging, ready for processing. Special colors can be supplied when specific minimum quantities are ordered. Shelf life at room temperature is at least two years. We can also deliver TROGAMID CX compounds in larger units upon request.

In general, TROGAMID CX compounds can be colored without problem. The best choice is a coloring agent concentrate based on TROGAMID CX. 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 the stated contacts.

2 Mechanical Properties

Property	Test method	Unit	TROGAMID			
			CX7323	CX9701	CX9704	CX9710
Tensile test 23 °C 50 mm/min	ISO 527-1/2					
Stress at yield		MPa	60	60	60	60
Strain at yield		%	8	8	8	8
Nominal strain at break		%	> 50	> 50	> 50	> 50
Tensile test 80 °C 50 mm/min	ISO 527-1/2					
Stress at yield		MPa	60	n. d.	n. d.	n. d.
Strain at yield		%	8	n. d.	n. d.	n. d.
Nominal strain at break		%	> 50	n. d.	n. d.	n. d.
Tensile modulus 23 °C	ISO 527-1/2	MPa	1400	1500	1400	1400
80 °C		MPa	1270	n. d.	n. d.	n. d.
Tensile creep modulus	ISO 899-1					
1 h		MPa	1300	1400	n. d.	n. d.
1000 h		MPa	700	700	n. d.	n. d.
Flexural test 5 mm/min	ISO 178					
Flexural strength		MPa	90	90	90	90
Flexural strength at 3.5 % strain		MPa	50	50	50	50
Outer fiber strain at maximum stress		%	9	9	> 10	9
Outer fiber strain at break		%	n. r.	n. r.	n. r.	n. r.
Flexural modulus	ISO 178	MPa	1700	1700	1520	1650
CHARPY impact strength	ISO 179/1eU					
23 °C		kJ/m^2	N	N	N	N
0 °C		kJ/m^2	N	N	N	N
-30 °C		kJ/m^2	N	N	N	N
CHARPY notched impact strength	ISO 179/1eA					
23 °C		kJ/m^2	16 C	18 C	11 C	14 C
0 °C		kJ/m^2	15 C	17 C	11 C	14 C
-30 °C		kJ/m^2	14 C	16 C	10 C	13 C
Shore hardness D	ISO 868		81	81	81	80
Ball indentation hardness H30	ISO 2039-1	N/mm^2	108	108	111	110
Burst pressure	Degussa	bar	110	n. d.	n. d.	n. d.
Dynamical behaivor under load (Filter cup / 0–38 bar / 160 min^{-1})	Degussa	Cycles	> 10^6	n. d.	n. d.	n. d.

N = no break, C = complete break; n. r. = not reached, n. d. = not determined

Properties

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). In this area in particular, TROGAMID CX 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 CX exceptionally suitable in this field of application.

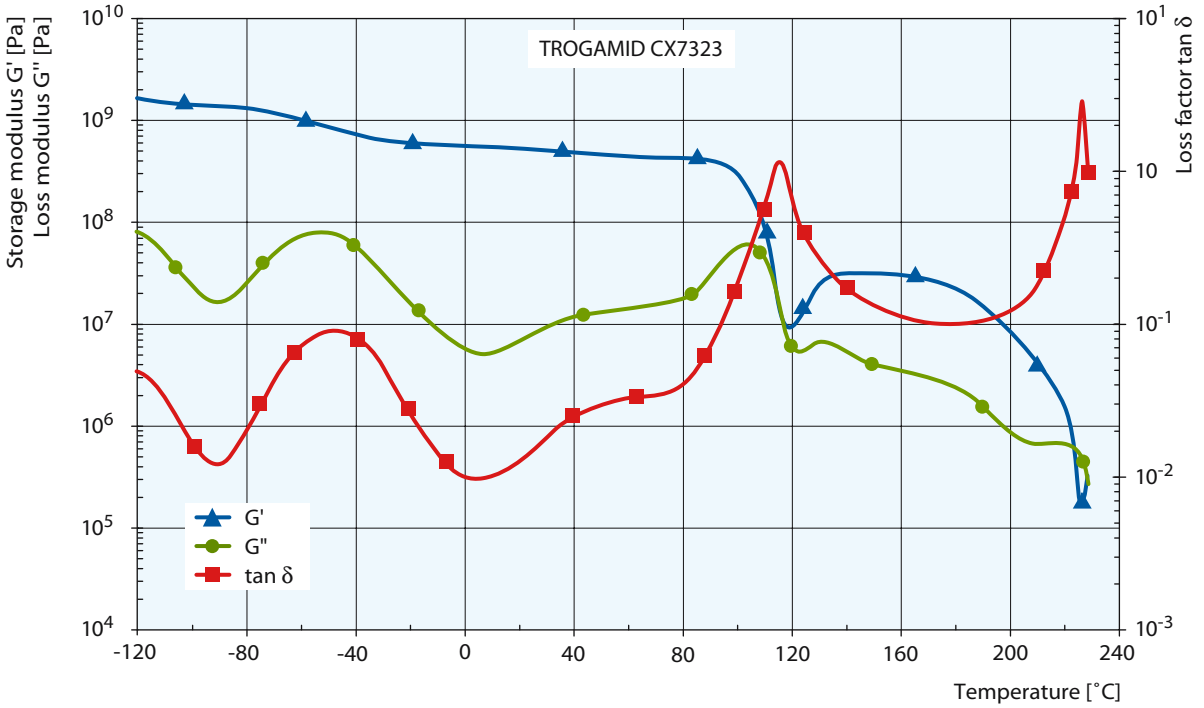


Figure 2: Torsional oscillation analysis of TROGAMID CX7323

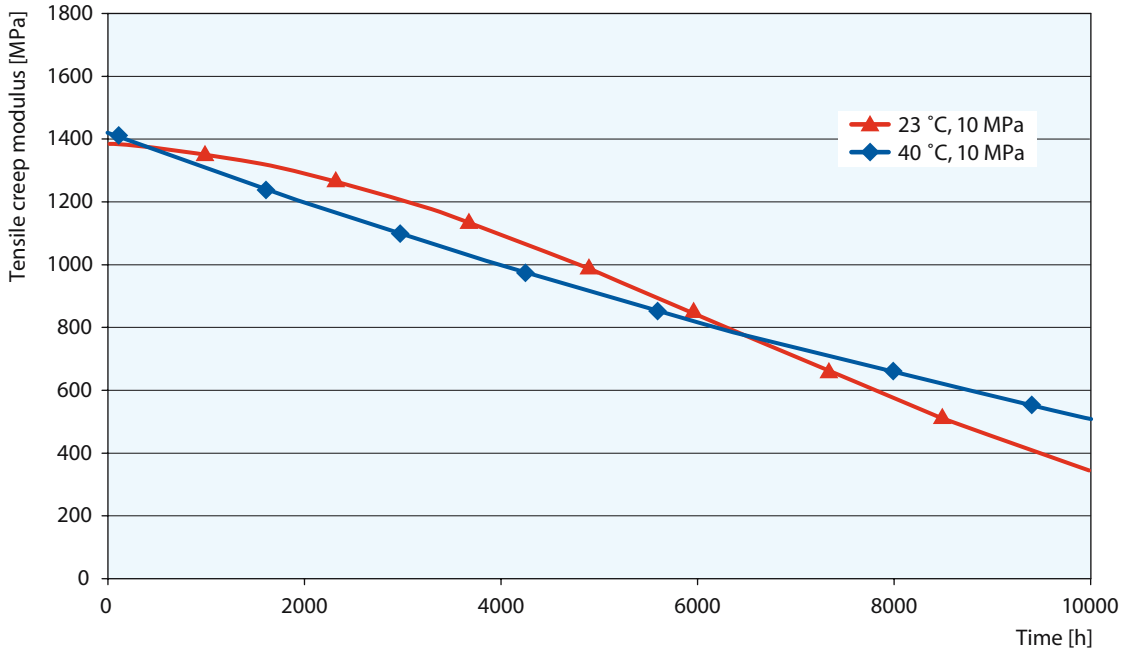


Figure 3: Tensile creep modulus of TROGAMID CX7323 at 23 °C and 40 °C (results of tensile creep test, load 10 MPa)

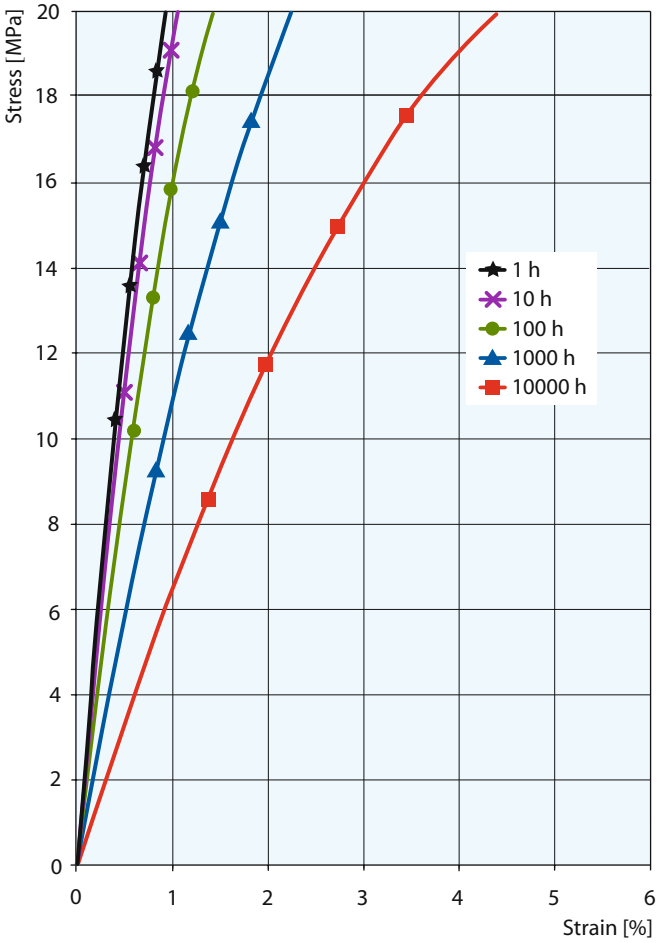


Figure 4: Isochronous stress/strain plots of TROGAMID CX7323 at 23 °C

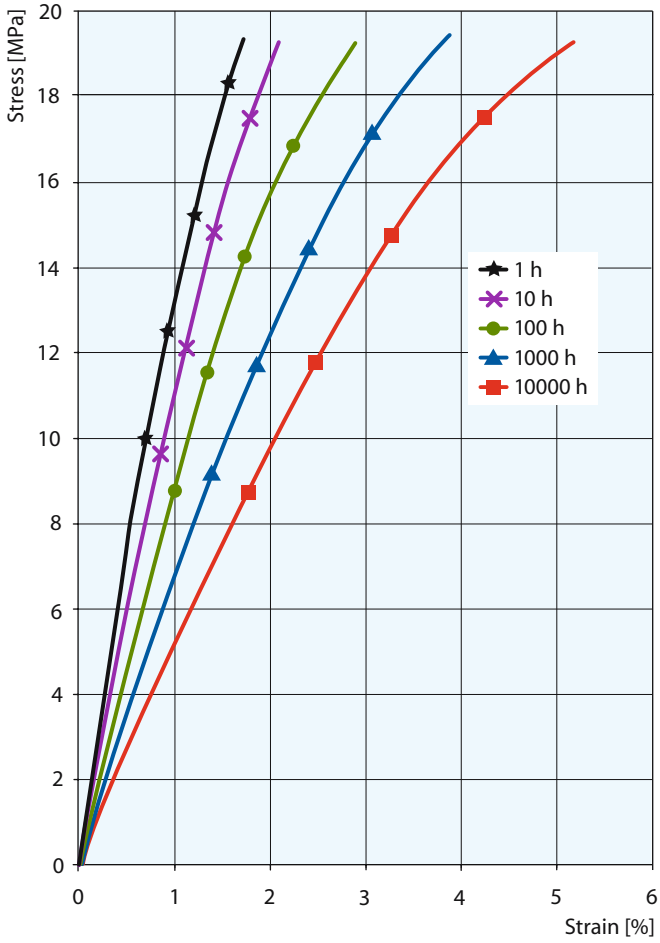


Figure 5: Isochronous stress/strain plots of TROGAMID CX7323 at 40 °C

3 Physical, Thermal and Electrical Properties

Property	Test method	Unit	TROGAMID			
			CX7323	CX9701	CX9704	CX9710
Density 23 °C	ISO 1183	g/cm³	1.02	1.02	1.02	1.02
Viscosity number*	ISO 307	cm³/g	160 ± 10	190 ± 10	n. d.	> 150
Vicat softening temperature	ISO 306					
Method A 10 N		°C	138	136	132	135
Method B 50 N		°C	130	129	125	130
Temperature of deflection under load	ISO 75-1/2					
Method A 1.8 MPa		°C	105	110	102	108
Method B 0.45 MPa		°C	122	126	120	123
Linear thermal expansion 23 °C - 80 °C	ISO 11359					
longitudinal		10^{-4} K^{-1}	0.9	0.9	0.9	0.9
transverse		10^{-4} K^{-1}	0.9	0.9	n. d.	0.9
Temperature index (Criterion: stress at yield)	IEC 216	°C	100	100	n. d.	100
Glass transition temperature Tg 10 K/min	ISO 11357	°C	140	140	132	140
Melt temperature DSC, 2nd heating		°C	250	250	n. d.	250
Relative permittivity 23 °C	IEC 60250					
100 Hz	DIN VDE		3.6	3.6	3.4	3.6
1 MHz	0303-Part 4		3.2	3.2	3.3	3.2
Dissipation factor 23 °C	IEC 60250					
100 Hz	DIN VDE	10^{-4}	115	115	130	120
1 MHz	0303-Part 4	10^{-4}	325	325	215	325
Electric strength K20/P50	IEC 60243-1	kV/mm	27	27	n. d.	n. d.
Comparative tracking index	IEC 60112					
Test solution A CTI			600	600	600	600
100 drops value			575	575	575	575
Glow wire test Test thickness = 1 mm	IEC 60695-2-1/0-3	°C	850	850	n. d.	850
Volume resistivity	IEC 60093	Ohm m	> 10^{14}	> 10^{14}	10^{13}	> 10^{14}
Surface resistance R_{OA}	IEC 60093	Ohm	> 10^{13}	> 10^{13}	10^{14}	> 10^{13}
Flammability acc. UL 94	IEC 60695					
0.8 mm			HB	HB	HB	HB
1.6 mm			HB	HB	HB	HB

* further viscosities upon request

n.d. = not determined

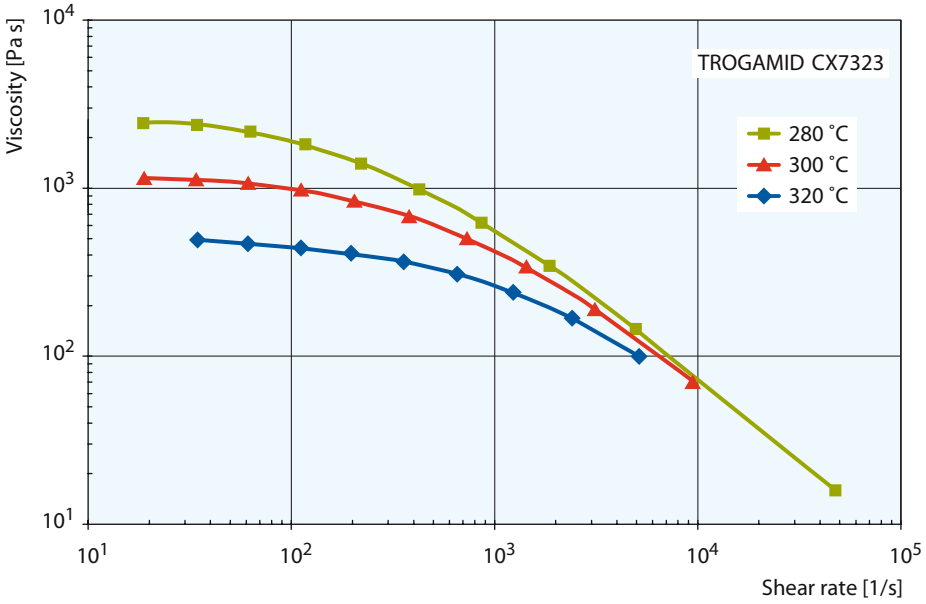


Figure 6: Melt viscosity of TROGAMID CX7323; results of high pressure capillary rheometer testing at different temperatures

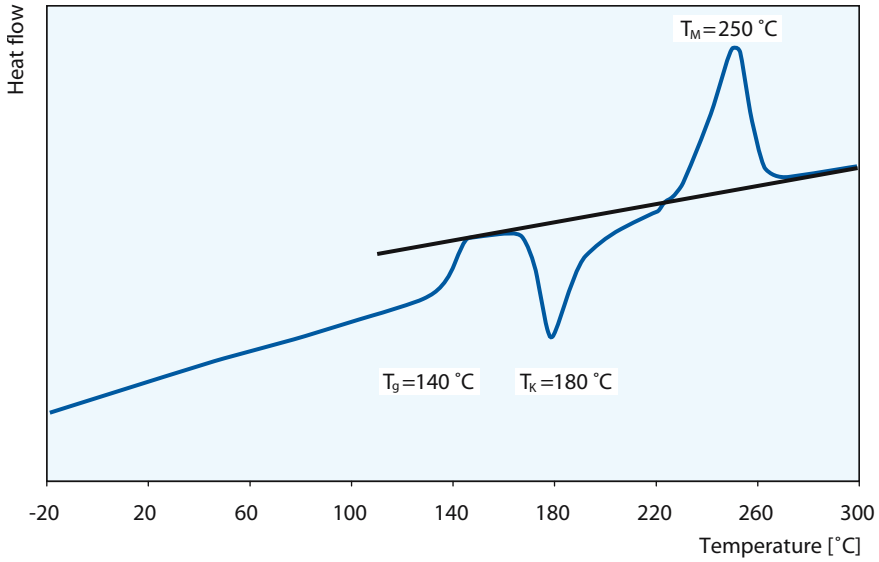


Figure 7: DSC plot of TROGAMID CX7323

T_g = glass transition temperature
T_K = peak maximum of recrystallization temperature
T_M = peak maximum of melt temperature

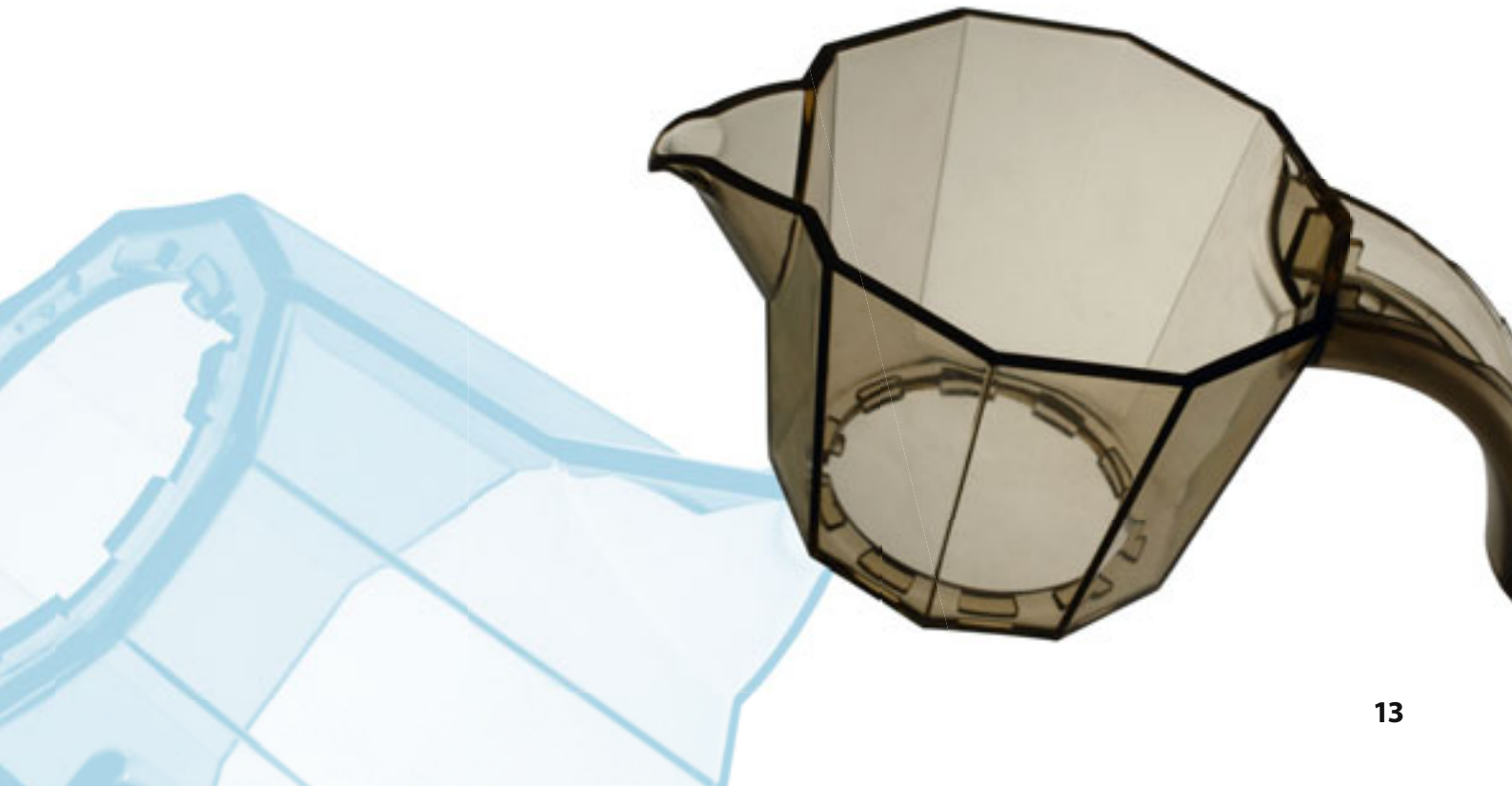
4 Behavior against Outside Influences

Water absorption and hydrolysis resistance

Depending on the temperature and the relative humidity, TROGAMID CX compounds, like all other polyamides, absorb water. The rate of absorption depends on the temperature and the humidity of the ambient air. Compared to other polyamides, though, water absorption of microcrystalline TROGAMID CX in a saturated state is very low, equaling of 3.5 % wt.-% (see figures 8 - 11). Molded part dimension changes to a maximum of 0.55 % (test specimen 130x12x3mm). The mechanical properties are virtually uneffected by water absorption; indeed, impact strength increases. To determine hydrolysis resistance, the molding material was immersed in boiling water. The relative solution viscosity (η rel) was measured in various intervals, since it permits a direct correlation with the degree of polymerization. After the material was immersed in boiling water for a period of one year, a reduction in solution viscosity of only 6 % was observed. (η rel = 1.63 when t = 0; η rel = 1.53 when t = 360 d).

Permeability/water vapor permeability

Property	Test conditions	Unit	TROGAMID CX7323
Water vapor permeability	23 °C / 85 % rel. humidity, d = 0.108 mm	g / (m^2 24 h)	8.3
Gas permeability	20 °C, d = 0.05 mm	cm^3 / (m^2 24 h bar)	
carbon dioxide CO_2			2540
oxygen O_2			740
nitrogen N_2			85
Permeation coefficient	20 °C, d = 0.05 mm	cm^3 / (cm s bar)	
carbon dioxide CO_2			$14.2 * 10^{-9}$
oxygen O_2			$4.3 * 10^{-9}$
nitrogen N_2			$0.5 * 10^{-9}$



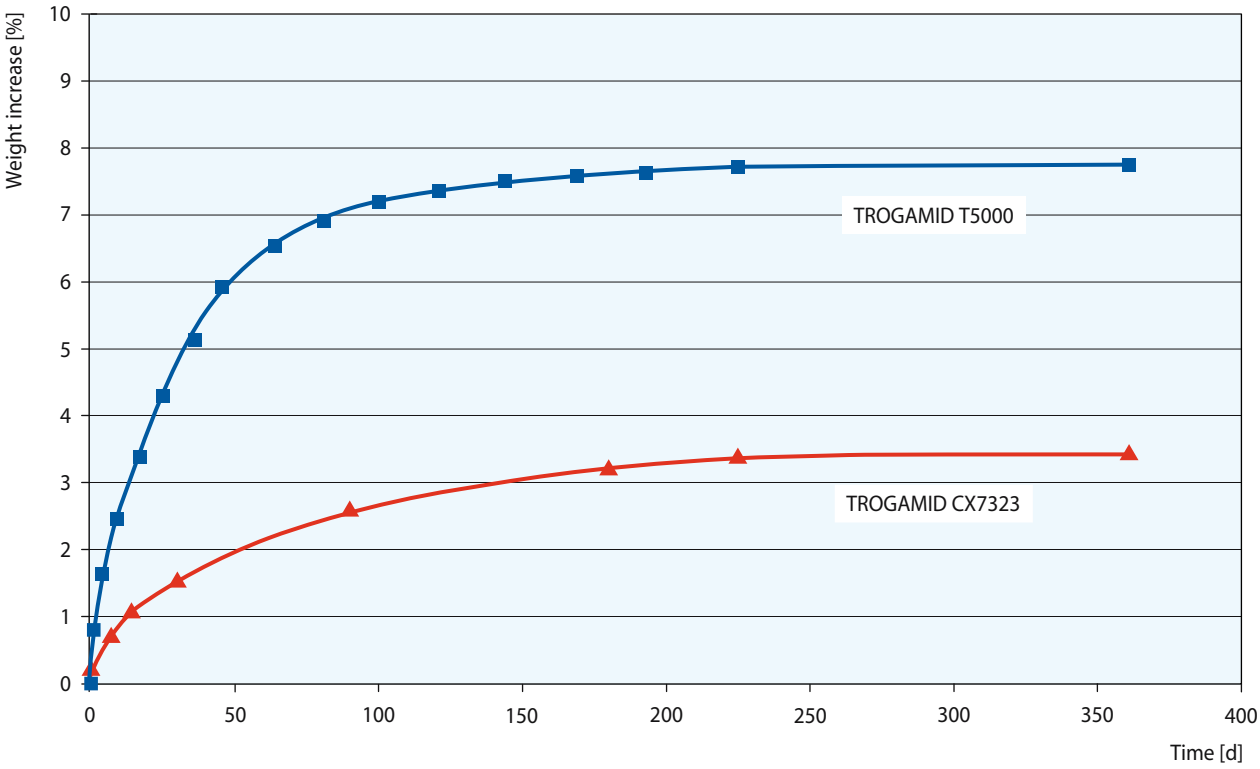


Figure 8: TROGAMID CX7323 water absorption (full immersion at 23 °C, according to ISO 62)

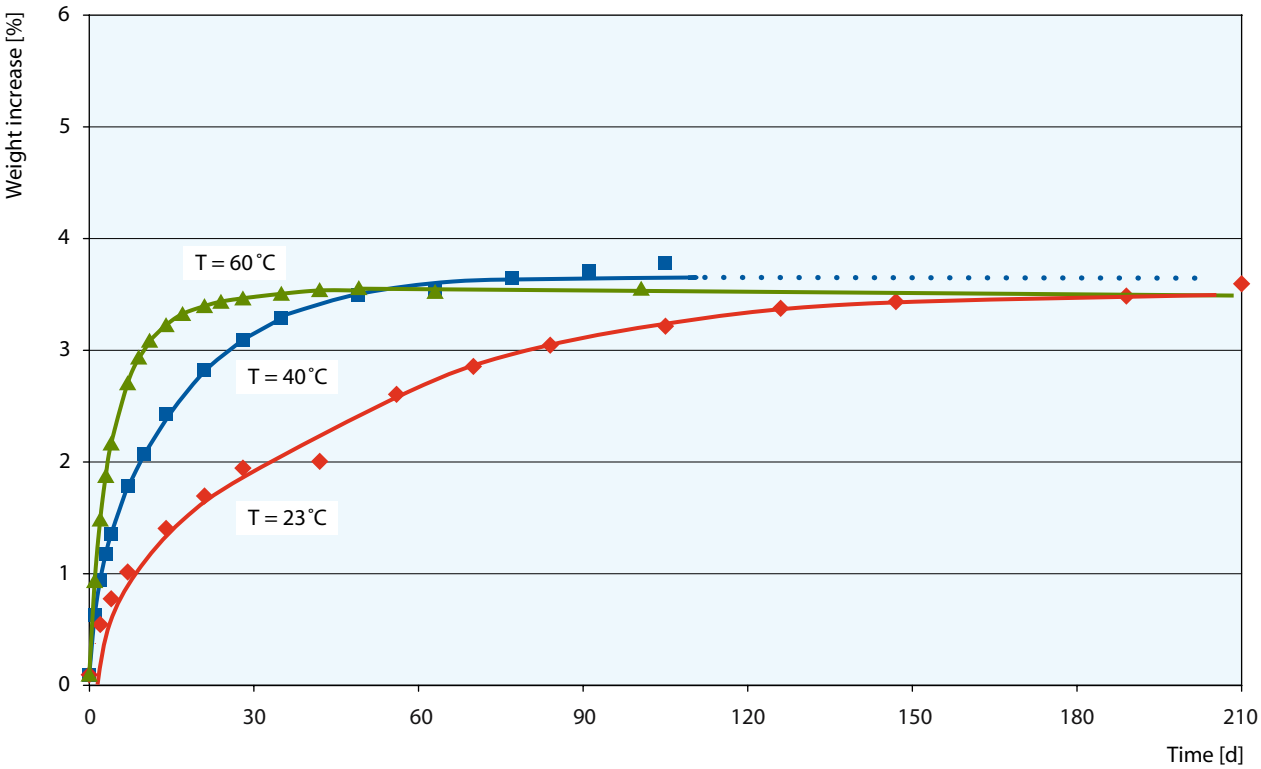


Figure 9: TROGAMID CX7323 water absorption depending on temperature and time (full immersion)

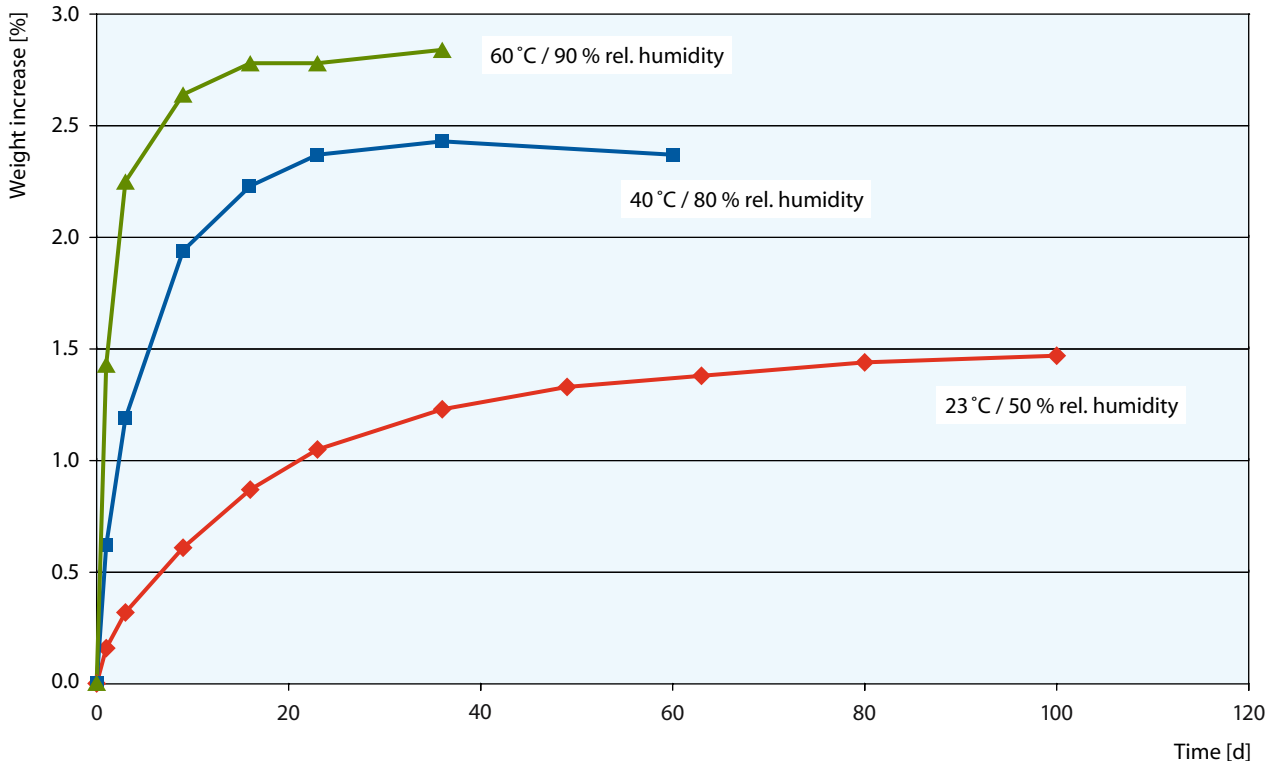


Figure 10: Moisture absorption of TROGAMID CX7323 depending on temperature and relative humidity, test specimen 50x50x3 mm

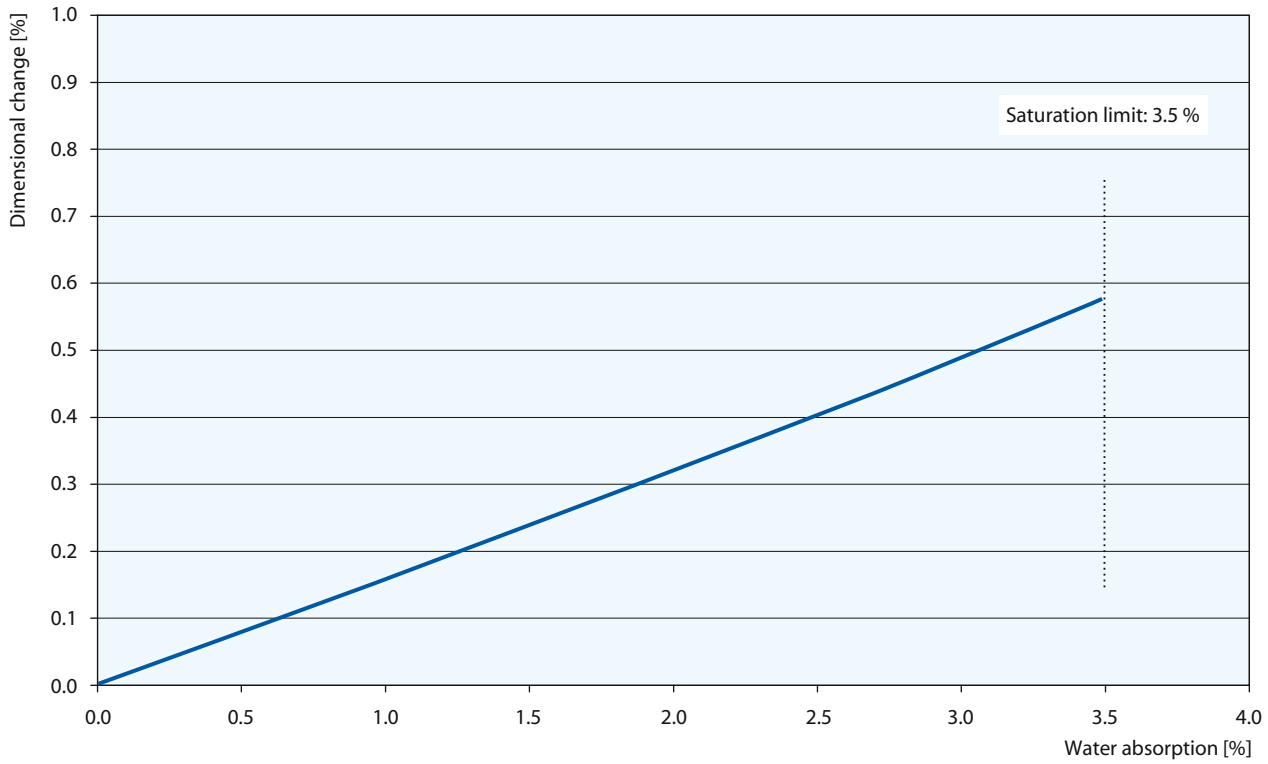


Figure 11: Dimensional stability of moldings from TROGAMID CX7323 (test specimen 130x12x3mm)

Resistance against ionizing radiation/ sterilization

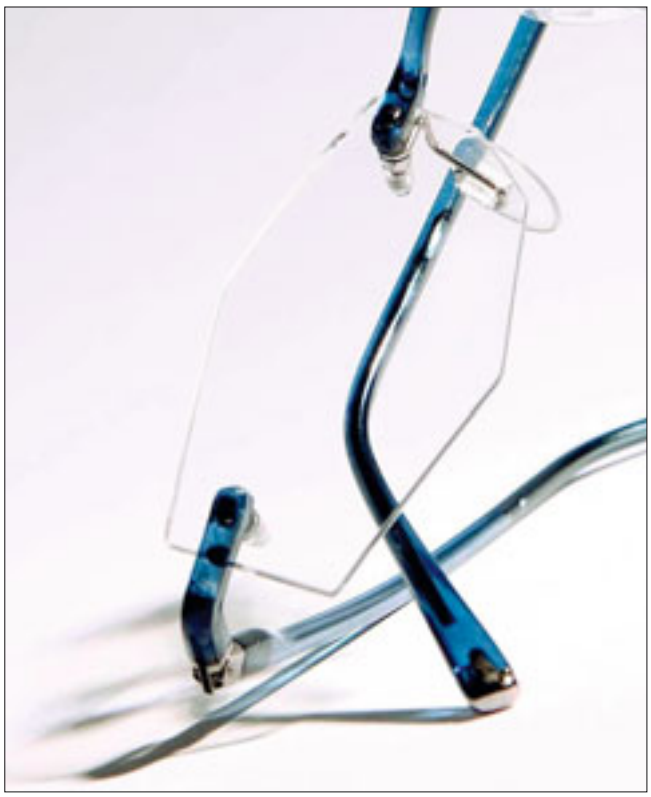
Moldings or semi-finished parts made of TROGAMID CX are sterilizable in the usual way by gamma radiation or with ethylene oxide. The sterilization with gamma radiation up to 56 kGy does not affect the molecular weight significantly; therefore no change in the overall physical properties is expected.

The sterilization of TROGAMID CX with water vapor is limited due to the water absorption effect.

Abrasion and scratch resistance

Since transparent materials like TROGAMID CX are often used as covers (e.g., for keyboards or machinery parts) the demand on abrasion and scratch resistance is, as expected, very high. With a value of 18 mg per 100 revs (DIN 53754), TROGAMID CX thus outperforms even standard grades of polycarbonate (PC) or polymethyl methacrylate (PMMA). The values given in the following table have been determined using the Taber Abrasion method (according to DIN 53754).

Property	Test method	Unit	TROGAMID CX7323	TROGAMID T5000	PC	PMMA
Abrasion resistance	DIN 53754	mg/100 rev.	18	23	27	66
Scratch resistance	DIN 52347	% turbidity increase	32	28	40	30



UV radiation and weathering

If any plastic is exposed to short-wave light of wavelengths less than 300 nm, molecular mass diminishes at an increasing rate, leaving moldings or semifinished products brittle. Due to its all aliphatic monomers TROGAMID CX exhibits a high stability against UV light and weathering. This is also true for its mechanical properties and color (yellowing). The addition of light stabilizers is usually not necessary. As shown in Figure 12, the color change of TROGAMID CX is comparable to values for PMMA.

Natural-colored TROGAMID CX showed no change in CHARPY impact strength after 2000 hours of radiation (Xenotest Alpha S120). The use of pigments and colorants may have an effect on UV and weathering stability. At any rate, suitability should be tested in each case.

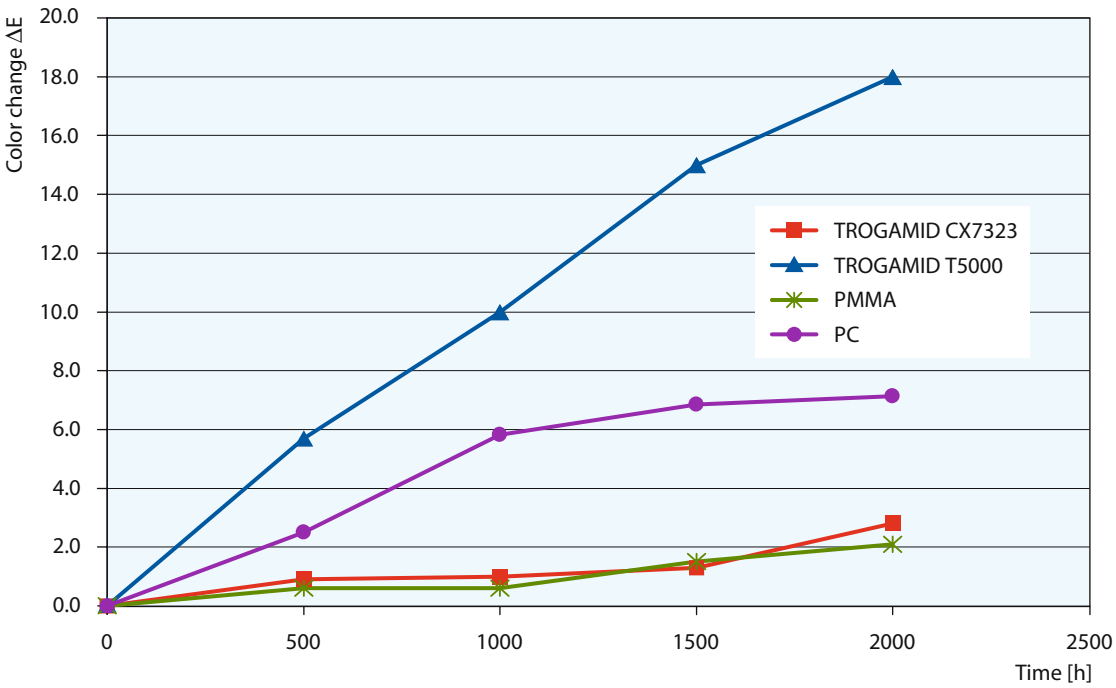


Figure 12: TROGAMID CX7323 color change ΔE (artificial weathering, Xenotest Alpha 150 S)

5 Optical Properties

TROGAMID CX features excellent, permanent, crystal-clear transparency and outstanding optical properties—in spite of it's microcrystallinity. The light transmission in the range of visible light (λ = 400-960 nm) even at a wall thickness of 4 mm is > 85 %. The refractive index n_D^{20} is 1.516, the average Abbe value 45.

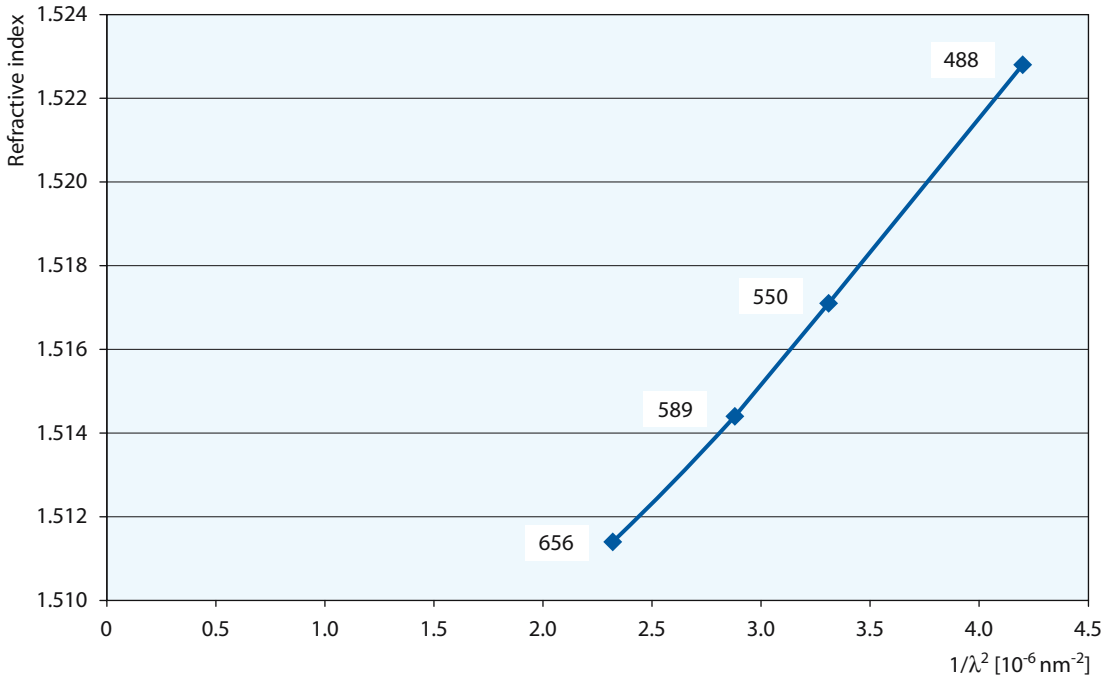


Figure 13: Refractive index of TROGAMID CX7323 (T = 20 °C)

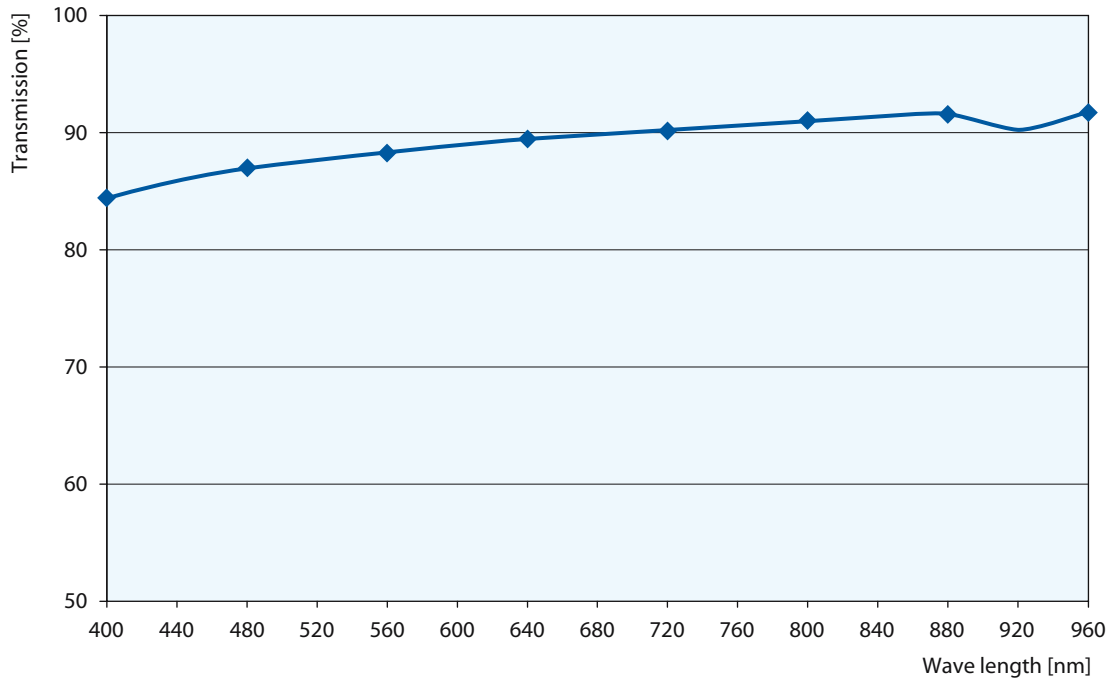
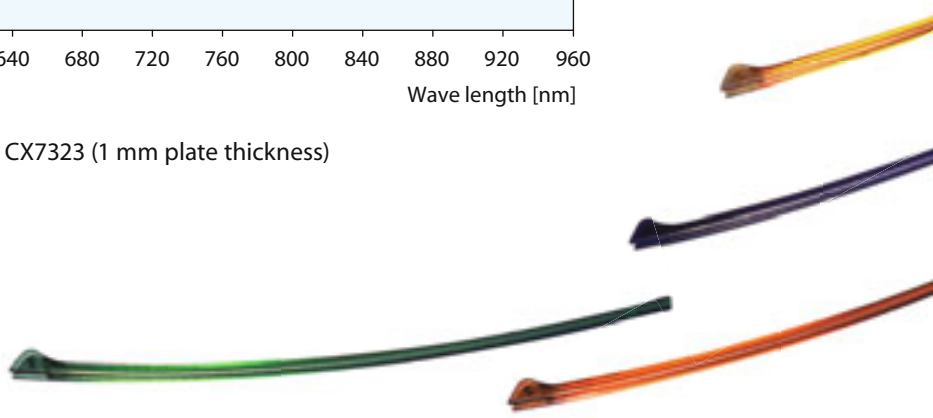


Figure 14: Transmission of TROGAMID CX7323 (1 mm plate thickness)



6 Chemical Resistance

General remarks
If there is an interaction between polymers and chemicals one can generally distinguish between the following cases in terms of stress cracking resistance:

- **The chemical will be absorbed to a certain amount, leading more or less to the swelling of the plastic article.** Swelling is normally a reversible process; i.e., if the medium is removed the resin or molding regains its original form, providing that the chemical extracts nonsoluble additives.

- **The chemical frequently acts as a solvent only at higher temperatures** while at lower temperatures it is only a powerful swelling agent.

- **The chemical causes the polymer to degrade**, the speed of which is highly related to temperature. In this case a reduction in the molar mass represents a decrease in impact strength and elongation at break; the material is irreversibly damaged.

When most transparent molded parts made of such materials as polystyrene or polymethacrylate fail, so-called stress cracks are often observed. In a model representation, it is assumed that the intermolecular interactive forces are weakened. Thus, when stress is relieved, we notice macroscopically visible expansion cracks.

To assess the chemical stress cracking resistance of a material, the operating temperature range and the stress level of the molded parts play just as important a role as the chemical/solvent itself. Less important is whether the failure of a molded part is caused by the outer mechanical load or by internal stress (caused by processing conditions). However, both types of stress—internal or external—add up. The internal stress level of any molded part can be seen in polarized light, as long as it is transparent, of course. In general, the more colored the interference pattern, the higher is the level of internal stress. External (mechanical) load is built up when molded parts are assembled, for example, through bending, clicking, squeezing, stretching or screwing. In such cases, wetting the media with chemicals that could cause stress cracking should be avoided. Constructions that undergo flexural tensile stress after assembly should also be avoided if they could come into contact with an aggressive solvent. In addition, mechanical load also results from pressure applied to filter cups, for example. Regardless of whether the pressure is statically or dynamicly applied, contact with aggressive solvents should be avoided, since the filter cup will often burst, sometimes into splinters, as a result.

To a lesser or greater extend, internal stress always become more pronounced during the processing of articles. For detailed information please refer to our brochure "TROGAMID Handling and Processing".

Effects of various media
The chemical resistance of molded parts made of TROGAMID CX depends on the internal and external stress levels, the orientation of the part, and changes in the swelling behavior in relation to temperature.

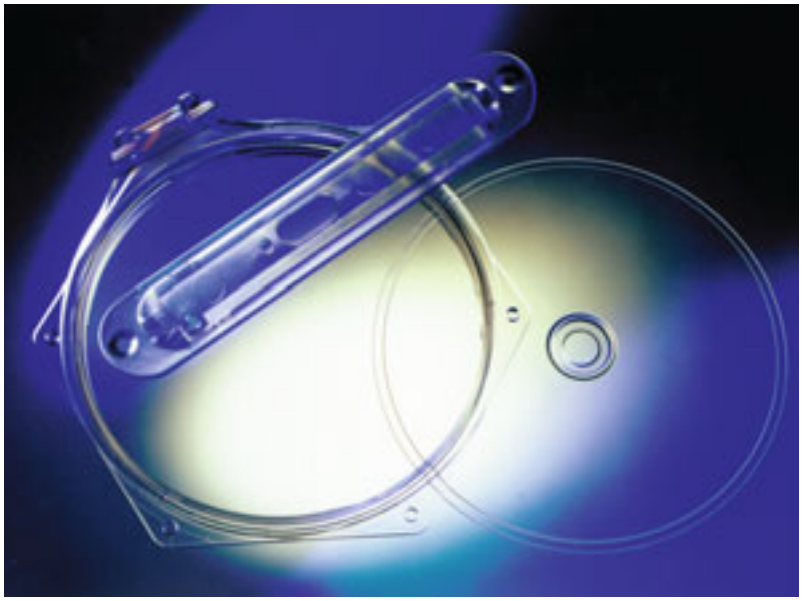
To test the chemical resistance of TROGAMID CX, we have therefore carried out strip bending tests according to ISO 4599 (DIN 53449/3, bent strip test) in the respective medium. To test strip bending, tensile bars are inserted into a template with radii of different flexural stresses (equivalent to different levels of outer fiber strain). An outer fiber strain of 0 % equals a stress-free stored tensile bar. The test specimen is immersed in the respective medium completely. The use of tensile bars enables tensile tests as well as visual assessment. Unless indicated otherwise, test specimens are stored for 22 hours at 20 °C in the respective medium.

TROGAMID CX is resistant to such common influences as moisture, perspiration, ink, lipstick, alkalis or weak acids. Because of the short-term contact of the medium with parts made of TROGAMID CX, its mechanical properties are typically left unaffected. The high level of chemical resistance makes it possible to use TROGAMID CX in areas where other transparent materials cannot be used.

In general, it is possible to make the following statements about TROGAMID CX and its resistance to the different classes of solvents/media:

Hydrocarbons (e.g., benzene, xylene)
Resistance to aliphatic hydrocarbons and aromatic hydrocarbons is generally very good. Apart from outer fiber strain, neither stress cracking nor swelling can be observed. Thus, contact with this type of media does not cause any problems.

Stencil for strip bending test acc. ISO 4599



Halogenated hydrocarbons (e.g., chloroform, carbon tetrachloride, 1,1,1-trichloroethane)
Depending on time and temperature halogenated hydrocarbons affect TROGAMID CX to a lesser or greater extent. It is difficult to make a general statement, so suitability should therefore be tested in each case.

Alcohols/phenols (methanol, ethanol, isopropanol, cresol, 1,2-propane diol)
Alcohols often cause stress cracking. Especially monovalent alcohols like methanol and ethanol are highly likely to cause stress cracking.
The resistance of TROGAMID CX to these type of chemicals is outstanding. Even to the most aggressive alcohol of all, methanol, the chemical resistance of TROGAMID CX is superior compared to all other transparent materials. Transparent polyamides are generally limited in their use with polyvalent alcohols like propane diol or cresol; the suitability should therefore be tested in each case.

Oils, greases (lubricant oil, hydraulic oil)
The resistance of TROGAMID CX to oils and greases is generally good. Lubricant oils are less aggressive than hydraulic oils. Due to the large number of oils and greases commonly used in the market, an overall statement is difficult, so suitability should therefore be tested in each case.

Lipids
In medical applications, stress cracks can cause serious complications. Such cracks can be caused by medicinal drugs, disinfectants, fat emulsions or lipids. This is where TROGAMID CX is far superior to polycarbonate, for example (Table 2). A practical examination of the molded part is absolutely necessary.

Table 2: Stress-crack formation, caused by media used in medical technology, in TROGAMID CX (CX) and polycarbonate (PC)

	Number of parts (%)											
	no cracks		few cracks		many cracks		internal cracks		penetrating cracks		destructive cracks	
	CX	PC	CX	PC	CX	PC	CX	PC	CX	PC	CX	PC
Cyclosporin	100	18	0	20	0	14	0	34	0	8	0	6
Lipids	100	22	0	64	0	14	0	0	0	0	0	0
Phenytoin Sodium	100	52	0	12	0	8	0	20	0	2	0	6
Propofol 1 %	100	34	0	32	0	14	0	20	0	0	0	0

Solvents for TROGAMID CX

Due to the outstanding chemical resistance of TROGAMID CX, only a few solvents are known to be usable. M-cresol, sulfuric acid (98 %) and mixtures of phenol/o-dichlorobenzene are among the very few solvents of TROGAMID CX. In addition, only hexafluoroisopropanol, hexamethylene phosphoric acid triamide, and trifluoroethanol are able to dissolve TROGAMID CX. We would like to emphasize that the later chemicals are either strong acids or toxic, and thus safety should be practiced at all times.

Accelerated testing

For accelerated testing, some granules or a molded part should be dipped into the solvent/chemical in question and kept submerged over night. After the material is dried, a visual inspection is the only way to reach a definite assessment.

In practice, the behavior of molded parts has a marked effect on the resistance of TROGAMID CX. The data given in the following table should be understood as a reference: how molded parts of TROGAMID CX will react under practical conditions. Compatibility should therefore be tested in each case before TROGAMID CX is used. It can best be achieved under circumstances as close to the later conditions of use as possible.

Not all substances that we have tested so far have been included in the following table; if you need more information on the resistance of TROGAMID CX to other media, please contact our Technical Marketing department.

Medium	Test temperature/time	Outer fiber strain			
		0 %	1.10 %	1.89 %	2.61 %
Acetone	20 °C / 22 h	+	+	+	-
Benzene	20 °C / 22 h	+	+	+	+
Break Free (lubricating oil)	20 °C / 22 h	+	+	+	+
Carbon tetrachloride	20 °C / 22 h	+	-	-	-
Chloroform	20 °C / 22 h	(1)	(1)	(1)	(1)
Cresol	20 °C / 22 h	(2)	(2)	(2)	(2)
	70 °C / 22 h	(2)	(2)	(2)	(2)
Dichloromethane	20 °C / 22 h	(1)	(1)	(1)	(1)
Diesel fuel	20 °C / 22 h	+	+	+	+
Econa PG32 (Hydraulic fluid)	20 °C / 22 h	+	+	-	-
Ethanol	20 °C / 22 h	+	+	+	(3)
Ethyl acetate	20 °C / 22 h	+	+	+	-
Eucalyptus oil	20 °C / 22 h	+	+	+	+
Formaldehyde solution/formalin (37 w/w-%)	20 °C / 22 h	+	+	+	+
Glycerine (DAB 6)	20 °C / 22 h	+	+	+	+
Heating oil	20 °C / 22 h	+	+	+	+
Isopropanol	20 °C / 22 h	+	+	+	+
Methanol	20 °C / 22 h	+	+	+	(3)
	50 °C / 30 min.	+	+	+	+
Mountain pine oil	20 °C / 22 h	+	+	+	+
Petroleum ether	20 °C / 22 h	+	+	+	+
Potassium hydroxide (25 w/w-%)	20 °C / 22 h	+	+	+	+
	70 °C / 22 h	+	+	+	+
Potassium hydroxide (50 w/w-%)	20 °C / 22 h	+	+	+	+
	70 °C / 22 h	+	+	+	+
Premium gasoline	20 °C / 22 h	+	+	+	+
1,2-propane diol	20 °C / 22 h	+	+	-	-
Regular gas	20 °C / 22 h	+	+	+	+
Sulfuric acid (98 w/w-%)	20 °C / 22 h	(2)	(2)	(2)	(2)
	70 °C / 22 h	(2)	(2)	(2)	(2)
Test fuel (M15)	20 °C / 22 h	+	+	+	+
Toluene	20 °C / 22 h	+	+	+	+
1,1,1-trichloroethane	20 °C / 22 h	+	-	-	-
Xylene	20 °C / 22 h	+	+	+	+

Supplementary data for the listed chemicals:

+ = Resistant, no stress cracks detected
– = Not resistant, stress cracks detected

(1) = Swells, softens
(2) = Dissolves
(3) = Surface turns cloudy

7 Registrations and Listings

The Environment, Health, Safety & Quality department, whose domain includes the High Performance Polymers Business Unit, provides general information on the toxicological properties of TROGAMID CX 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 CX. Please direct all questions on the subject to the indicated contacts.

Food Contact - EU-Status
Uniform regulations for plastics that come into contact with foodstuffs exist at the European level. The consolidated EU Directive 2002/72/EC and its amendments apply. The grades
TROGAMID CX7323,
TROGAMID CX9704 and
TROGAMID CX9710
are approved for direct food contact in the European Union because they are based on monomers that are listed favorably in this directive. It is necessary to observe restrictive migration limits on the finished article.

Plastic additives permitted for food-contact are listed favorably in the "incomplete list" of the EU Plastics Directive. This means that the additives in the EU list and the additives approved by national regulations (in Germany, these are the recommendations of the Federal Institute for Risk Assessment, BfR) may be used. The "incomplete list" of approved substances is scheduled to become a "complete list" by the end of 2006 so that, starting in 2007, only additives appearing in EU list may be used. Because of these continuous revisions, we are currently unable to make any general binding statements about the status of our TROGAMID CX resins.

Drinking Water Contact
Substances that come into contact with drinking water must satisfy the various national regulations that govern both the finished product and to some extent the material from which it was made. In Germany, the applicable regulations are the KTW recommendations and the guidelines of the Federal Environmental Agency (Umweltbundesamt). Since the above grades
TROGAMID CX7323,
TROGAMID CX9704 and
TROGAMID CX9710
are approved under EU food regulations, they may be recommended as materials for drinking-water contact. They satisfy the requirements of the plastics-drinking water (KTW) tests, although these tests have in general not been performed on our raw materials but on the finished products. The KTW test certificate is an important component of the DVGW certificate (German Association for Gas and Water, DVGW), because it covers the health requirement. Only DVGW-certified components may be installed into the drinking water distribution system.

Medical Applications
TROGAMID CX7323 and
TROGAMID CX9710
are certified according to USP Class VI, the highest classification of the United States Pharmacopeia (requirements in conformity with DIN EN ISO 10993). They are therefore suitable for the manufacture of medical products.

8 Ecology and Safety

TROGAMID resins are non-hazardous substances that are not governed by any particular safety regulations. TROGAMID CX resins 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 CX material safety data sheets 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 the indicated contacts.

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

TROGAMID resins 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 CX resins will burn. At melt temperatures between 360 °C 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.

9 CAE Data, Campus® Material Database

Our philosophy is to sell high performance polymers 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 performence 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 CX7323	TROGAMID CX9710
Density of melt	g/cm^3	0.90	0.90
Specific heat capacity	$J\ kg^{-1}\ K^{-1}$	2490	2500
Heat conductivity in the melt	$W\ m^{-1}\ K^{-1}$	0.25	0.28
Carreau-WLF values			
K1		559.3	250.6
K2		0.001870	0.005889
K3		0.7486	0.9137
K4		300	295
K5		176.3	150.5
Transition temperature	°C	132	193
Ejection temperature	°C	120	120

Campus® Material Database
Plastic suppliers and processors have been acquainted with our Campus database for a long time. It contains important information on plastic raw materials available from Degussa AG. From a given specific profile it is possible to pre-select materials suitable to your application from a multitude of grades. The properties of the thermoplastic raw material are based on ISO-Standard (International Organization of Standardization) and, therefore are interchangeable.

You can download Campus from the web at: www.degussa-hpp.com.

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