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Product Description

PLEXIGLAS® XT
Basic grades 20070 and 29070

General remarks

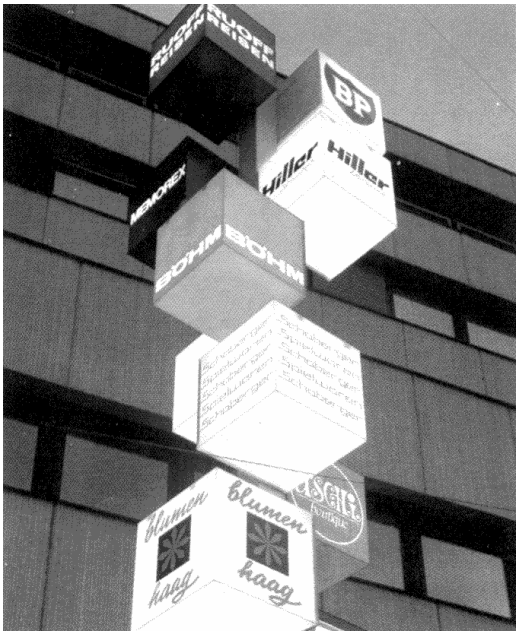
PLEXIGLAS® XT is an extruded acrylic by the chemical name of polymethyl methacrylate (PMMA). PLEXIGLAS® XT 20070 and 29070 are our clear-transparent basic grades, which differ only in their UV-transmission. They are manufactured in the form of 1.5 to 25 mm thick sheets as well as tubes, round rods, corrugated sheets and multi-skin sheets, the dimensions of which can be taken from our current Sales Range Brochure. The surfaces are either smooth, glossy, matt (AR, C) or textured.

Our "Product Description PLEXIGLAS® GS, PLEXIGLAS® XT, Ref. No. 211-1" informs you about other grades of PLEXIGLAS XT and their most important characteristics.
Separate documents are available for each type of semifinished product.

Applications

PLEXIGLAS® XT has found ever new applications in recent years. It is above all used for glazing in buildings (light domes, continuous rooflights, saw-tooth roofs, etc.), greenhouses, residential buildings (canopies, patio roofs, conservatories), for dairy pipes, displays, optical discs, etc. Its main characteristics are high light transmission, excellent weather resistance and easy machinability at adequate strength.

PLEXIGLAS® XT: Illuminated advertising signs



PLEXIGLAS® SDP 16: Patio roof

Physical properties

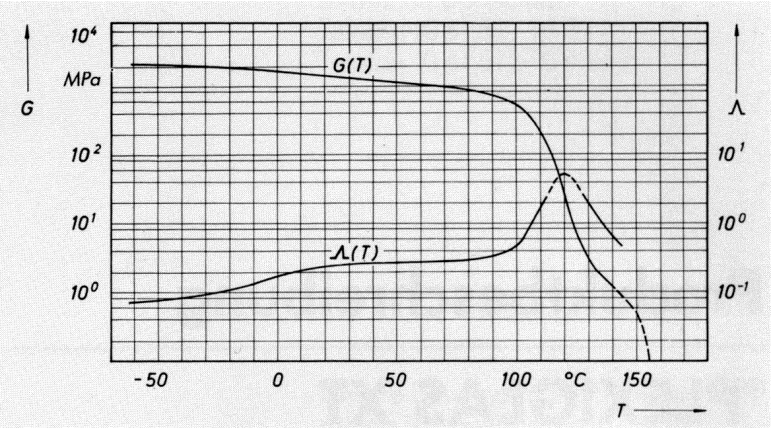
The Table of typical values gives an overview of the physical properties of PLEXIGLAS®. As with all other materials, however - and plastics in particular - most of the properties listed there are influenced by time and temperature. The time and temperature functions of a few more important properties are shown and discussed below.

The temperature functions of the dynamic modulus in shear G and the mechanical damping decrement Λ characterize PLEXIGLAS® XT as a homogeneous material with its main softening range between 80 and 140 °C. Below this range PLEXIGLAS® XT is hard-elastic, between 130 °C and 150 °C it is rubbery-elastic, and beyond 150 °C it becomes soft and formable.
Figures illustrate the influence of temperature on stress-strain behaviour and flexural strength as well as on impact and notched impact strength. It is evident that the mechanical properties first change noticeably above 50 °C.
The influence of time and temperature on tensile strength and creep elongation of

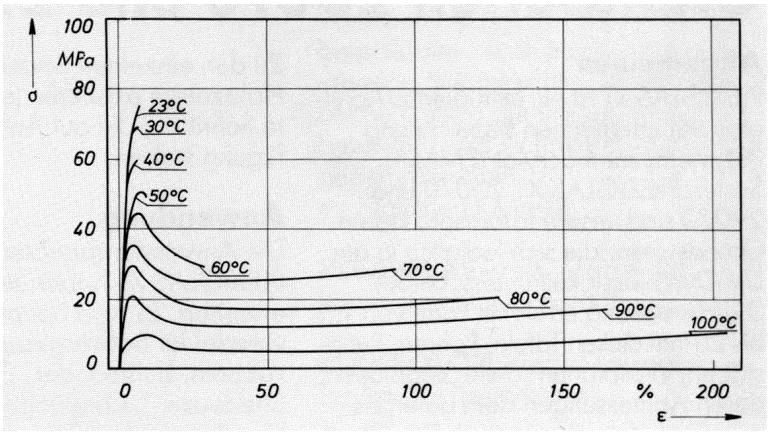
PLEXIGLAS® XT is illustrated in long term mechanical behaviour graphs. For construction purposes, the reducing influence of elevated temperatures and notches must be borne in mind.

The influence of the temperature on the long-term behaviour is shown in a graph. Permanent exposure to aggressive media may also reduce the strength of PLEXIGLAS® XT.
Other figures illustrate the influence of water at different temperatures. Much more pronounced is the influence of corrosive agents like ethanol or plasticizers such as dibutyl phthalate and dioctyl phthalate.
The **chemical behaviour** of PLEXIGLAS® XT in general is described in our documents "Chemical behaviour, Ref. No. 211-2" and "Resistance to crazing and chemicals, Ref. No. 211-4."
If a structural unit of PLEXIGLAS® XT is installed under stress, this stress relaxes as time goes by .Within one year it reduces to about half the original value.
The light transmission of clear PLEXIGLAS® XT in the visible range (λ = 380 to 780 nm) is about 92%, irrespective of the wavelength. 8% of incident light is reflected at the surfaces (4% each). The absorption is negligibly small, even at increased thicknesses. Only at a sheet thickness around 3 m (!) is the absorption about 50%.
Light transmission in the ultraviolet region depends on the basic grade used. In the infrared range up to about 25 µm, the transmission is negligible throughout.
The refractive index of PLEXIGLAS® XT depends on the wavelength of light. It decreases with increasing wavelength λ.

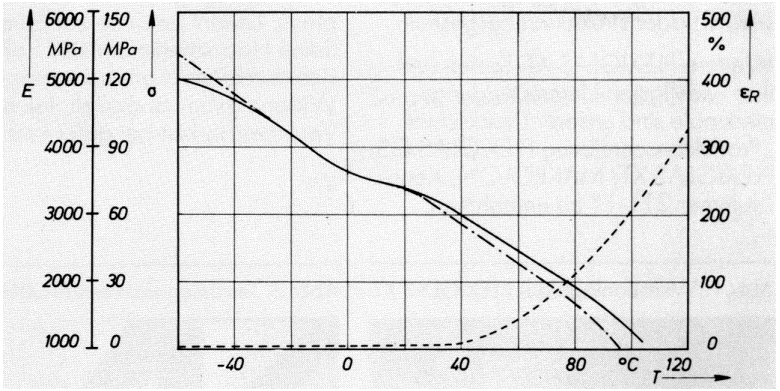
PLEXIGLAS® XT: Dynamic modulus in shear G and mechanical damping Λas a function of temperature T



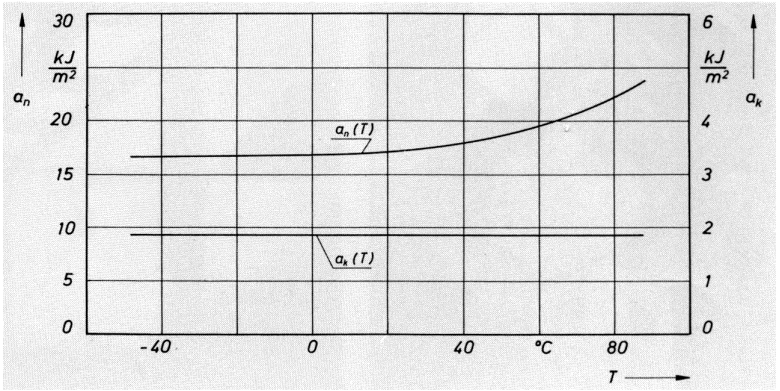
PLEXIGLAS® XT: σ-ε diagram at different temperatures



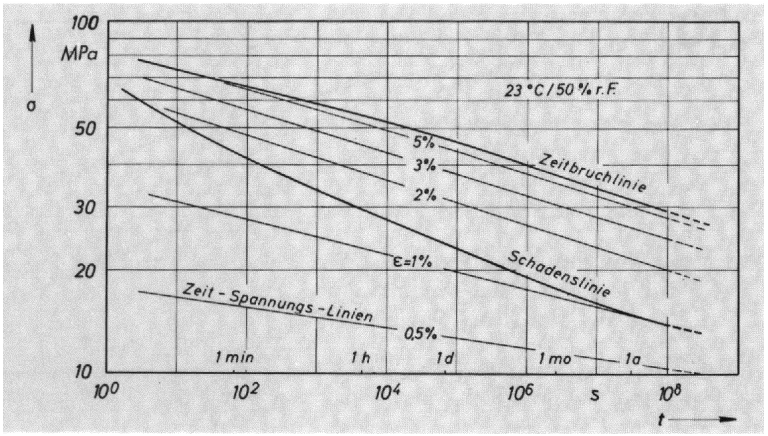
PLEXIGLAS® XT: Tensile strength σ (_____) elongation at break ε_R (-----) and elastic modulus E (- - - - -) as a function of temperature T



PLEXIGLAS® XT: Charpy impact strength a_n and Izod impact strength a_k as a function of temperature T

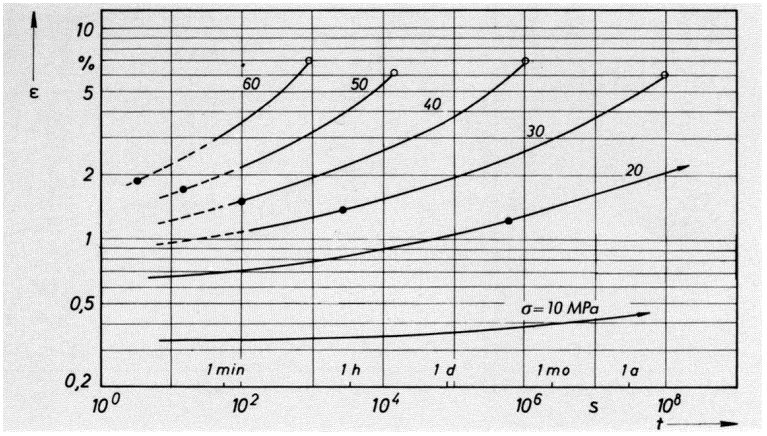


PLEXIGLAS® XT: Long-term mechanical behaviour



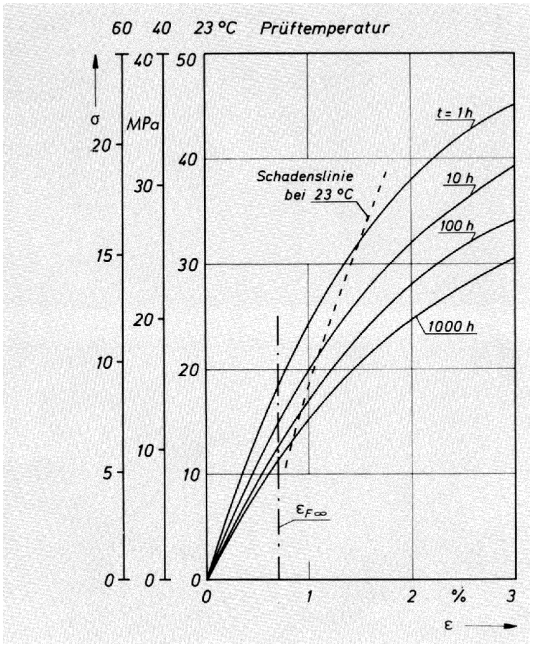
σ = Stress
t = Time in seconds
ε = Strain
Zeitbruchlinie = Long term tensile strength
Schadenslinie = Long term crazing strength
Zeit-Spannungs-Linien = Long term stress relaxation

PLEXIGLAS® XT: Creep curves at constant stress σ (23 °C / 50 % RH)



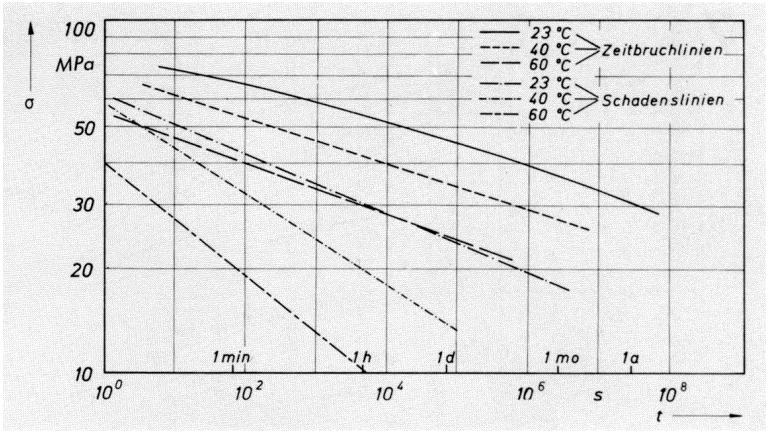
• = onset of crazing o = fracture

PLEXIGLAS® XT: Isochronous stress-strain curves at 23, 40 and 60 °C



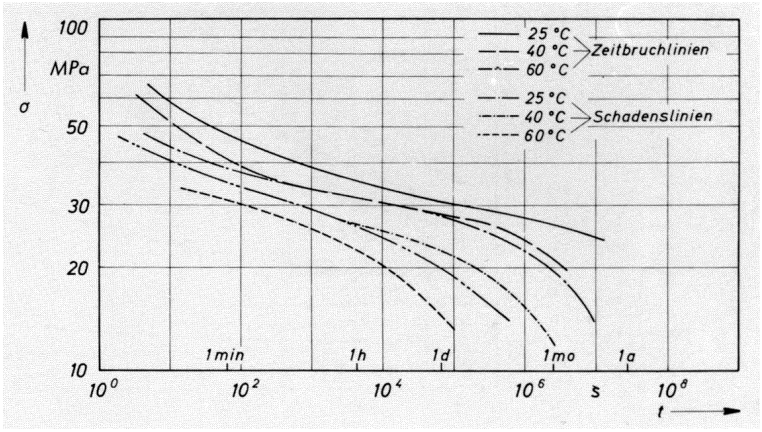
Prüftemperatur = experimental temperature
Schadenslinie bei 23 °C = crazing line at 23 °C

PLEXIGLAS® XT: Long-term mechanical behaviour in air at increased temperatures: 23, 40 and 60°C



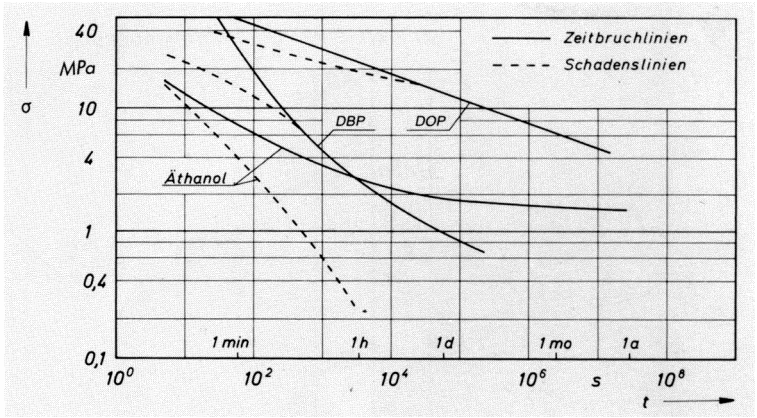
Zeitbruchlinien = Long term tensile strength
Schadenslinien = Long term crazing strength

PLEXIGLAS® XT: Long-term mechanical behaviour under the influence of water at different temperatures



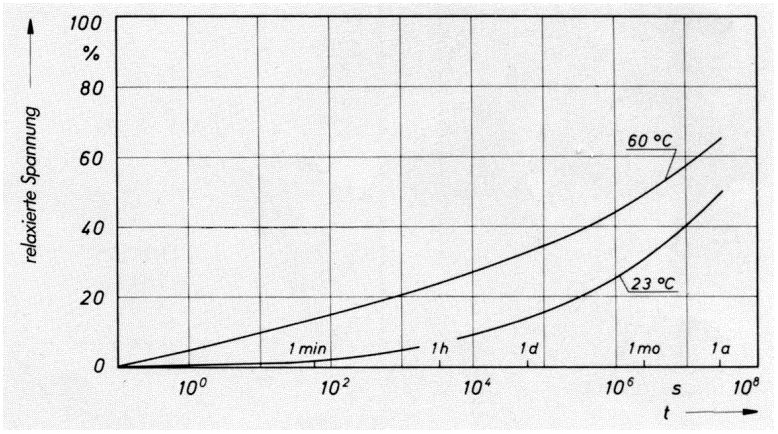
Zeitbruchlinien = Long term tensile strength
Schadenslinien = Long term crazing strength

PLEXIGLAS® XT: Long-term mechanical behaviour towards various corrosive agents at 23 °C

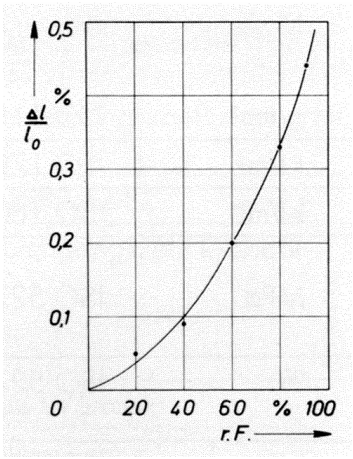


Äthanol = Ethanol
DBP = Dibutyl phthalate
DOP = Dioctyl phthalate
_____ = Zeitbruchlinien = Long-term tensile strength
---------- = Schadenslinien = Long-term crazing strength

Stress relaxation of PLEXIGLAS® XT in per cent at different temperatures

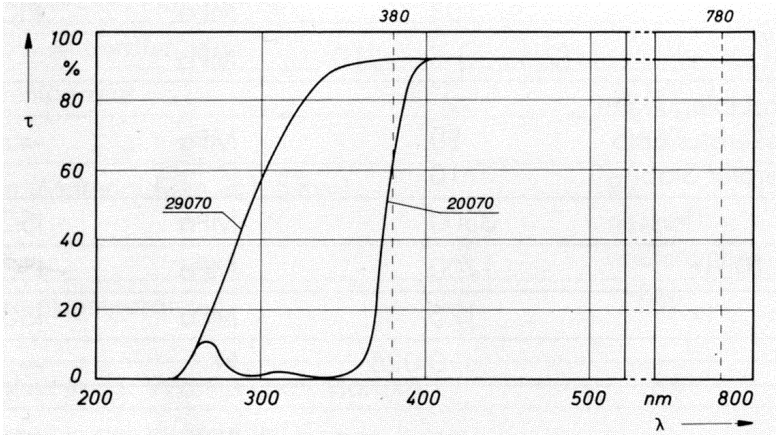


PLEXIGLAS® XT: Relative increase in length $\Delta l / l_0$ under the influence of atmospheric humidity at 25 °C

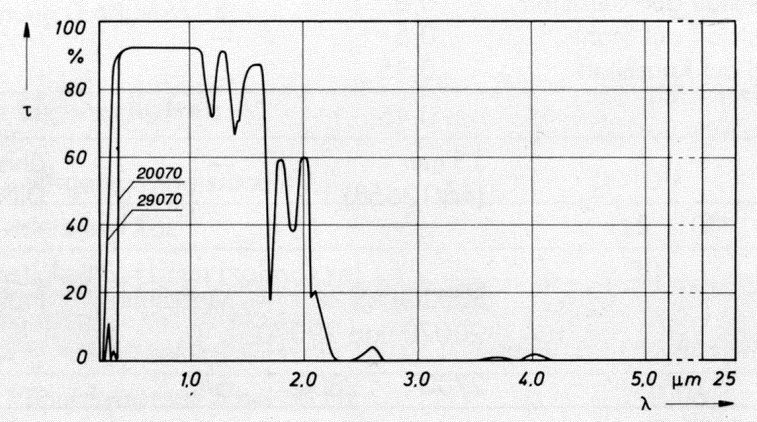


r.h. = relative humidity

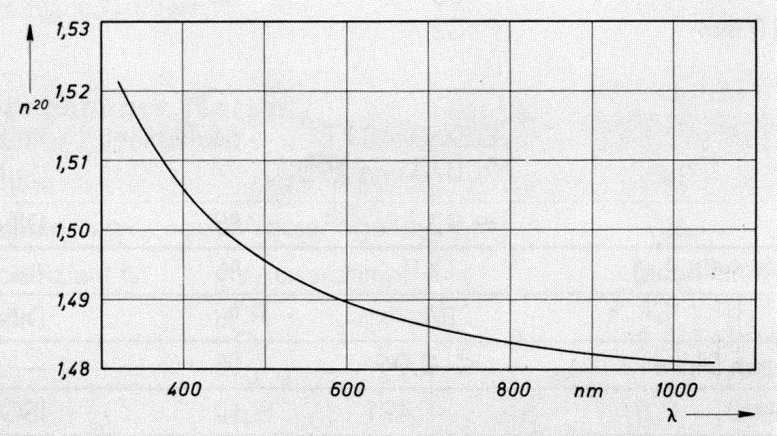
PLEXIGLAS® XT Clear 20070 and 29070: Spectral transmittance τ in the ultraviolet and visible range (λ = wavelength, thickness: 3 mm)



PLEXIGLAS® XT Clear 20070 and 29070: Spectral transmittance τ (λ = wavelength, thickness: 3 mm)



PLEXIGLAS® XT Clear 20070 and 29070: Refractive index n^{20} as a function of wavelength λ (at 20 °C)



Design hints

When designing a project, care must be taken not to exceed certain limits of deflection and/or stress.

If PLEXIGLAS® XT is used for flat glazing elements, deflections beyond the limits set for conventional materials - usually 0.5 to 1.0% of the shorter sheet length - can be permitted. The inherent stability and break resistance of PLEXIGLAS® XT allow you to increase this value - material-specifically - to l / 50, i.e. 2 % of the shorter sheet length (= l).

Taking the usual environmental influences into account, the maximum safety stress for a structural element of PLEXIGLAS® XT in long-term use is

$\sigma_{max.}$ = 5 ... 10 MPa

(for tubes of PLEXIGLAS® XT $\sigma_{max.}$ = 2.5 MPa).

The lower, safer value is recommended if the structural element is subject to influences that cause the above-mentioned reducing factors (e.g. increased temperatures, moisture, chemical influences, weathering, etc.). The higher value may be allowed for if the element is rarely or only briefly exposed to such influences.
What must be borne in mind is that the stress caused by external influences may be further increased by unintentional deformation, e.g. distortion during installation. Moreover, internal stress may be present, generated by unskilful treatment, local heating, rapid cooling after thermoforming, etc. PLEXIGLAS® XT normally relaxes such internal stress. At elevated temperatures (80°C) relaxation process occurs within a short period of time, whereas at room temperature relaxation to only half the original value already takes several months. Hence the recommendation that internally stressed parts of PLEXIGLAS® XT be annealed.

Typical property values (at 23 °C and 50 % RH)

Mechanical properties	PLEXIGLAS® XT 20070 and 29070	Unit	Test standard
Density	1.19	g/cm^3	ISO 1183
Impact strength (Charpy)	15	kJ/m^2	ISO 179/1fu
Notched impact strength (Izod)	1.6	kJ/m^2	ISO 180/1 A
Tensile strength			
(a) -40 °C	100		
(b) 23 °C	72	MPa	ISO 527-2/1B/5
(c) 70 °C	35		
Elongation at break	4.5	%	ISO 527-2/1B/5
Flexural strength Standard test specimen (80 x 10 x 4 mm)	105	MPa	ISO 178
Compressive yield stress	103	MPa	ISO 604
Max. safety stress (up to 40 °C)	5 ... 10	MPa	–
Fatigue strength in alternating bending test, approx. 10^6 cycles			
(a) unnotched test specimen	30	MPa	–
(b) notched test specimen	10	MPa	–
Modulus of elasticity (short-term value)	3300	MPa	ISO 527-2/1B/1
Dynamic shear modulus at approx. 10 Hz	1700	MPa	ISO 537
Indentation hardness $H_{961/30}$	175	MPa	ISO 2039-1
Abrasion resistance in Taber abraser test (100 rev.; 5.4 N; CS-10F)	20 ... 30	% haze	ISO 9352
Coefficient of friction			
a) plastic / plastic	0.8		
b) plastic / steel	0.5	–	–
c) steel / plastic	0.45		
Poisson's ratio (Dilatation rate of 5% per min, up to 2 % dilatation; at 23 °C	0.37	–	ISO 527-1
Resistance to puck impact from thickness (Test Certificate No.)	15 mm (46/13658)	–	Similar to DIN 18032

Acoustical properties	PLEXIGLAS® XT 20070 and 29070	Unit	Test standard
Sound velocity (at room temperature)	2700 ... 2800	m/s	–
Weighted sound reduction index Thickness:			
4 mm	26	dB	–
6 mm	30		
8 mm	-		
10 mm	32		
Optical properties (of clear grades, 3 mm thickness)	PLEXIGLAS® XT 20070 and 29070	Unit	Test standard
Transmittance τ_{D65}	~ 92	%	DIN 5036, Part 3
Reflection loss in visible range (for each surface)	4	%	–
Total energy transmittance	85	%	DIN EN 410
Absorption in visible	< 0.05	%	–
Refractive index n_D^{20}	1.491	–	ISO 489
Thermal properties	PLEXIGLAS® XT 20070 and 29070	Unit	Test standard
Coefficient of linear thermal expansion for 0 ... 50 °C	$7 \bullet 10^{-5}$ (= 0.07)	1/K (mm/m °C)	DIN 53752-A
Thermal conductivity	0.19	W/mK	DIN 52612
U-value			
at 1 mm thickness	5.8		
at 3 mm thickness	5.6	W/m^2K	DIN 4701
at 5 mm thickness	5.3		
at 10 mm thickness	4.4		
Specific heat	1.47	J/gK	–
Forming temperature	150 ... 160	°C	–
Max. surface temperature (IR radiator)	180	°C	–
Max. permanent service temperature	70	°C	–
Reverse forming temperature	>80	°C	–
Ignition temperature	430	°C	DIN 51794
Fire rating (material thickness ≥ 2 mm)	B 2, normally flammable	–	DIN 4102
	Class 3	–	BS 476, part 7 + 6
	TP(b)	–	BS 2782, method 508 A
	M 4	–	NF P 92 501 + 92 505
Vicat softening temperature	102	°C	ISO 306, method B50
Dimensional stability under heat (Martens method)	85	°C	DIN 53458
Heat deflection temperature under load (HDT)			
(a) deflection 1.8 MPa	90	°C	ISO 75
(b) deflection 0.45 MPa	95	°C	ISO 75

Electrical properties	PLEXIGLAS® XT 20070 and 29070	Unit	Test standard
Volume resistivity	$>10^{15}$	ohm • cm	DIN VDE 0303,
Surface resistivity	$5 \cdot 10^{13}$	ohm	Part 3
Dielectric strength (1 mm specimen thickness)	~30	kV/mm	DIN VDE 0303, Part 2
Dielectric constant			
at 50 Hz	3.7	–	DIN VDE 0303,
at 0.1 MHz	2.8	–	Part 4
Dissipation factor			
at 50 Hz	0.06	–	DIN VDE 0303,
at 0.1 MHz	0.03	–	Part 4
Tracking, CTI-Value	600	–	DIN VDE 0303, Part 1
Behaviour towards water	PLEXIGLAS® XT 20070 and 29070	Unit	Test standard
Water absorption (24 hrs, 23 °C) from dry state	30	mg	ISO 62, Method 1
Max. weight grain during immersion	2.1	%	ISO 62, Method 1
Permeability to water vapour	$2.3 \cdot 10^{-10}$		
N_2	$4.5 \cdot 10^{-15}$	g • cm	
O_2	$2.0 \cdot 10^{-14}$	$cm^2 \cdot h \cdot Pa$	–
CO_2	$1.1 \cdot 10^{-13}$		
air	$8.3 \cdot 10^{-15}$		

Degussa
Methacrylates

Röhm GmbH
Certified to DIN EN ISO 9001 (Quality)
and DIN EN ISO 1400 (Environment)

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