Specification

Physical and chemical properties

PCP
D 1426 / D 1526

PHOTOSOLAR® SUPERGREY — D 1426
PHOTOSOLAR® B SUPERGREY — D 1526 (Bifocal)

Colour:	grey
Application:	Glass sensitive to light for corrective lenses and sun glare filter; luminous transmittance range 91 % (τ_0) / 25 % (τ_1) or filter categories 0 / 2 respectively and UV - absorption

The subsequent properties are based primarily upon the measuring results of the very latest standards and measuring methods, which are defined in corresponding "Measuring and Test Procedures".
We retain the right to change the data in keeping with the latest technical standards.
Non-toleranced numerical values are reference values of an average production quality.

Values marked with ◊ do not apply to the type of glass or no values are available.

Requirements deviating from these specifications must be defined in writing in a **customer agreement**.

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1. Optical properties

1.1 Refractive indices (20 °C)

Pretreatment of samples
[x] Condition as supplied (D 1426)
[x] annealed at 40 °C/h for bifocal (D 1526) *± 0,0003

n_g	1.5342
$n_{F'}$	1.5298
n_F	1.5293
n_e	1.5251 ± 0.001*
n_d	1.5229
n_D	1.5228
$n_{C'}$	1.5205
n_C	1.5201

1.1.1 Abbe value

v_e	56.5 ± 0.6
v_d	56.7

1.2 Transmittance data

1.2.1 Spectral transmittance $\tau(\lambda)$

1.2.1.1 $\tau(\lambda)$ - curve

Plot of spectral transmittance $\tau(\lambda)$ for the light state $\tau_{0'}$ and dark state $\tau_{15'}$: see annex

1.2.1.2 $\tau(\lambda)$ - individual values in % (d = 2.0 mm)

	$\tau_{0'}$	$\tau_{15'}$
$\tau(\lambda)_{max}$ for the λ - range 280 nm to 315 nm	< 0.001	< 0.001
$\tau(\lambda)_{max}$ for the λ - range 315 nm to 350 nm	5.2	1.8
τ_{380}	31.7	9.2
$\tau(\lambda)_{min}$ for the λ - range 500 nm to 650 nm	91	24.5

1.2.1.3 Edge wavelength (d = 2.0 mm)

Edge wavelength $\lambda_{c\ (\tau = 0.46)}$ in nm for $\tau_{0'}$: 392

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1.2.2 Luminous transmittance τ_v

1.2.2.1 Luminous transmittance τ_{vD65} or τ_{vA} in % respectively under standard conditions (d = 2.0 mm)

Light state	τ_{vD65}	$\tau_{0'}$ (τ_0)	91 ± 1	-
Dark state		$\tau_{15'}$(τ_1)	25 ± 2	-
Regeneration	τ_{vA}	$\tau_{R5'}$	-	67 ± 2
		$\tau_{R10'}$	-	73 ± 2
		$\tau_{R30'}$	-	80 ± 2
Darkening-fading curve for 23 °C			see annex	

Luminous transmittance τ_{vD65} in % in relationship to the thickness

Thickness in mm	$\tau_{0'}$ (τ_0)	$\tau_{15'}$ (τ_1)
2.0	91	25
3.0	91	20
4.0	90	15

1.2.2.2 Scale number / Filter category (d = 2.0 mm)

Scale number	5 - 1.1 < 2.5	
	$\tau_{0'}$ (τ_0)	$\tau_{15'}$ (τ_1)
Filter category	0	2

1.2.2.3 Luminous transmittance dark state $\tau_{15'}$ in % in relationship to the sample temperature ϑ in °C (d = 2.0 mm)

	-	-	τ_w	τ_1	τ_s	-
ϑ	-10	-5	5	23	35	50
$\tau_{15'}$	◊	◊	17	25	39	57

1.2.2.4 Luminous transmittance dark state $\tau_{15'}$ in % in relationship to the illuminance E in klx (d = 2.0 mm)

	τ_1	-	-	τ_a	-	-
E	50	30	20	15	10	5
$\tau_{15'}$	25	31	36	41	47	57

1.2.2.5 Luminous transmittance dark state $\tau_{15'}$ in % in relationship to the variation the excitation spectrum in dependance of the edge wavelength λ_c of a sharp cut filter in nm (d = 2.0 mm)

λ_c	328	353	369	389	410	433	454	468
$\tau_{15'}$	25	27.5	30.5	37	52.5	83.5	91	91
Diagram							see annex	

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1.2.3	**Special transmittance values in % (d = 2.0 mm)**		
1.2.3.1	**UV - transmittance for $\tau_{15'}$**		
		τ_{UVA}	2.7
		τ_{SUV}	1.0
		τ_{SUVA}	1.5
		τ_{SUVB}	< 0.05
1.2.3.2	**IR - transmittance**	τ_{SIR}	$\geq \tau_{vD65}$
1.2.3.3	**Solar blue - light transmittance**	τ_{sb}	23.8
1.3	**Colour**		
1.3.1	**Visual evaluation**		
	The visual evaluation is made on the basis of a simultaneous comparison with internal limit samples.		
1.3.2	**Colorimetry**		
	Chromaticity coordinates	A x_{10}	0.321_2
		y_{10}	0.333_7
	Chromaticity coordinates (colour locus) are referred to the Standard Illuminant D_{65} according to CIE 10°-observer	B x_{10}	0.326_2
		y_{10}	0.332_2
	for $\tau_{15'}$ (τ_1) - for the time being they are only reference values (d = 2.0 mm) in view of the relative calibration possibility	C x_{10}	0.329_3
		y_{10}	0.337_7
	In case of verification, the measured values may additionally deviate by the measuring uncertainty of the used measuring devices.	D x_{10}	0.324_3
		y_{10}	0.339_1
	part of chromaticity coordinates		see annex
1.3.3	**Signal light recognition**		
	Relative visual attenuation coefficient (quotient) Q for signal light recognition for $\tau_{15'}$ (τ_1) (d = 2.0 mm)	Q_{blue}	1.00
		Q_{green}	0.97
		Q_{yellow}	1.04
		Q_{red}	1.10
1.3.4	**Yellowness index (d = 10 mm)**		
		Y_i	◊

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2. Thermal properties

2.1 Viscosities and corresponding temperatures

Designation	Viscosity lg η in dPas	Temperature ϑ in °C
Strain point	14.5	482
Annealing point	13.0	508
Softening point	7.6	673
Forming temperature	6.0	766
Forming temperature	5.0	848
Forming temperature	4.0	957

2.2	**Transformation temperature *Tg* in °C**	504
2.3	**Coefficient of mean linear thermal expansion α (20 °C;300 °C) in 10^{-6} K^{-1}** (Static measurement)	6.5
2.4	**Fuseability**	
	Stress-free fusing with lower segments from Barberini GmbH, listed in the margin is possible with a maximum birefringence of 70 nm/cm measured 0.5 mm from the fusing area in the major blank.	V 512 V 513 V 514
2.5	**Mean specific heat capacity c_p (20 °C to 100 °C) in J/(g · K)**	◊

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3.	**Mechanical properties**	
3.1	**Density ρ in g/cm³**	2.41
3.2	**Stress optical coefficient C in 1.02 · 10^{-12} m²/N**	3.48
3.3	**Breaking strength**	
	A higher mechanical strength can be realized by chemical toughening according to the ion exchange procedure (refer to annex 3.3.1). This toughening method may cause in slightly transmittance - and colourchange.	
3.3.1	**Chemical toughening**	
	Processing temperature ϑ in °C	390
	Processing time t in h	16
	Compressive stress Ds as birefringence in nm/cm	3930
	Penetration depth Nz up to neutral zone in µm	63
	Further information	see annex
3.4	**Young´s modulus E in kN/mm²**	◊
3.5	**Poisson´s ratio μ**	◊
3.6	**Torsion modulus G in kN/mm²**	◊
3.7	**Knoop hardness HK 0.1/20**	◊

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4. Chemical properties

4.1 Hydrolytic resistance acc. to DIN ISO 719

Hydrolytic class	HGB 3
Equivalent of alkali (Na_2O) per gram of glass grains in µg/g	105

4.2 Acid resistance acc. to DIN 12 116

Acid class	S 4
Half surface weight loss after 6 hours in mg/dm²	200

4.3 Alkali resistance acc. to DIN ISO 695

Class	A 3
Surface weight loss after 3 hours in mg/dm²	350

4.4 Hazardous Substances

EC-directive 2002/95/EC (RoHS-directive)	on request

5. Electrical properties

disregard

6. Other properties

6.1 Anti-reflection processes

Luminous transmittance dark state $\tau_{15'}$ for d = 2.0 mm
in relationship of the additional heat treatment

	temperature/time	$\tau_{15'}$ in %
additional heat treatment	275 °C/30´	25

Additional heat treatment

The sample is put on a kaolin plate (room temperature) and then placed in a box furnace, in which the treatment temperature is already existing.
After the specified time, the sample and the kaolin plate are taken out and immediately put on a cold (room temperature) kaolin plate for rapid cooling.

7. Annex (diagrams, curves)

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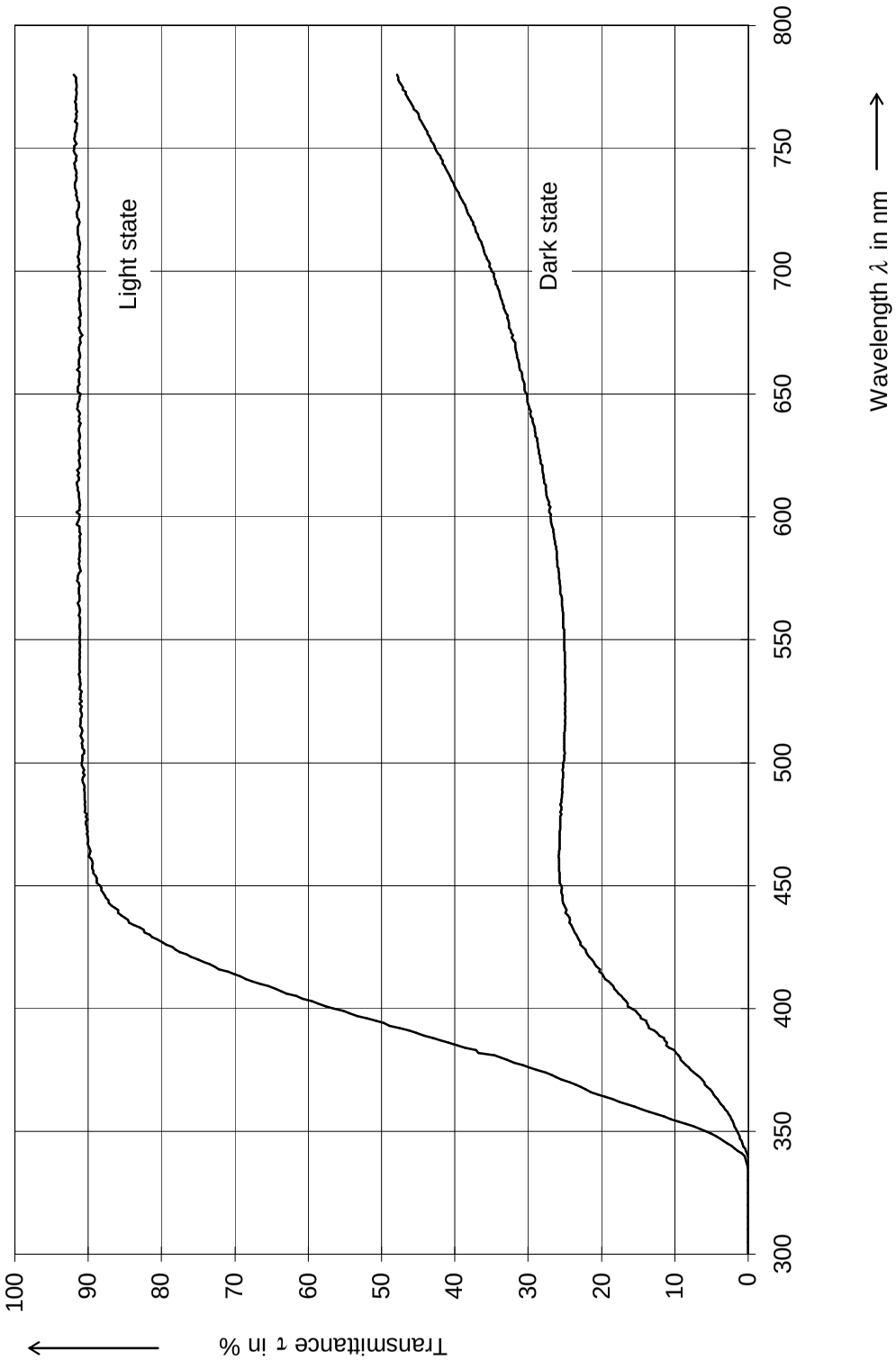
Spectral Transmittance

Type of Glass: PHOTOSOLAR® SUPERGREY

Thickness: 2 mm



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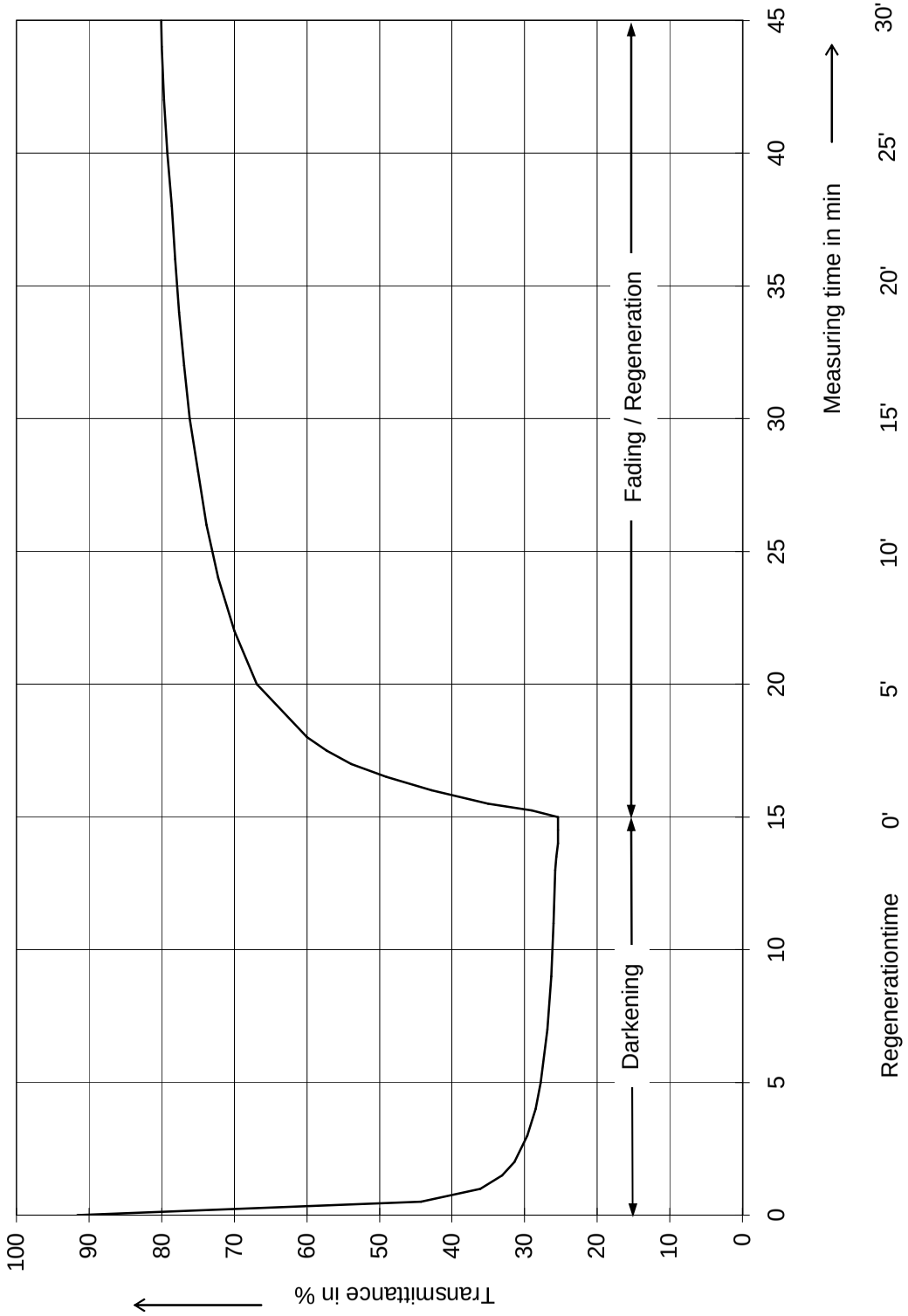
Darkening - Fading - Curve

Type of Glass: PHOTOSOLAR® SUPERGREY
Thickness: 2 mm



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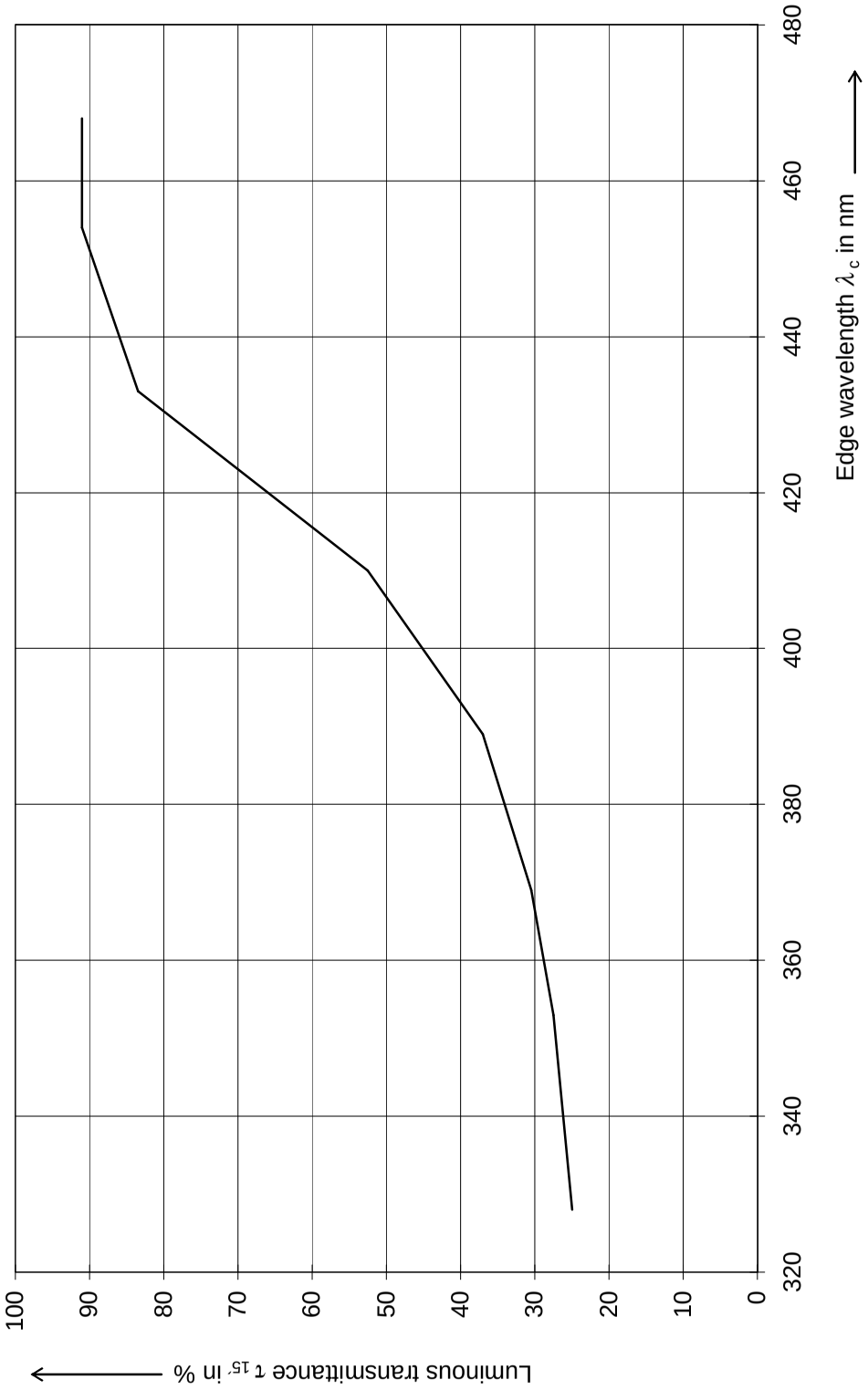
Luminous transmittance dark state in relationship to the variation the excitation spektrum (sharp cut filter)

Type of Glass: PHOTOSOLAR® SUPERGREY

Thickness: 2 mm



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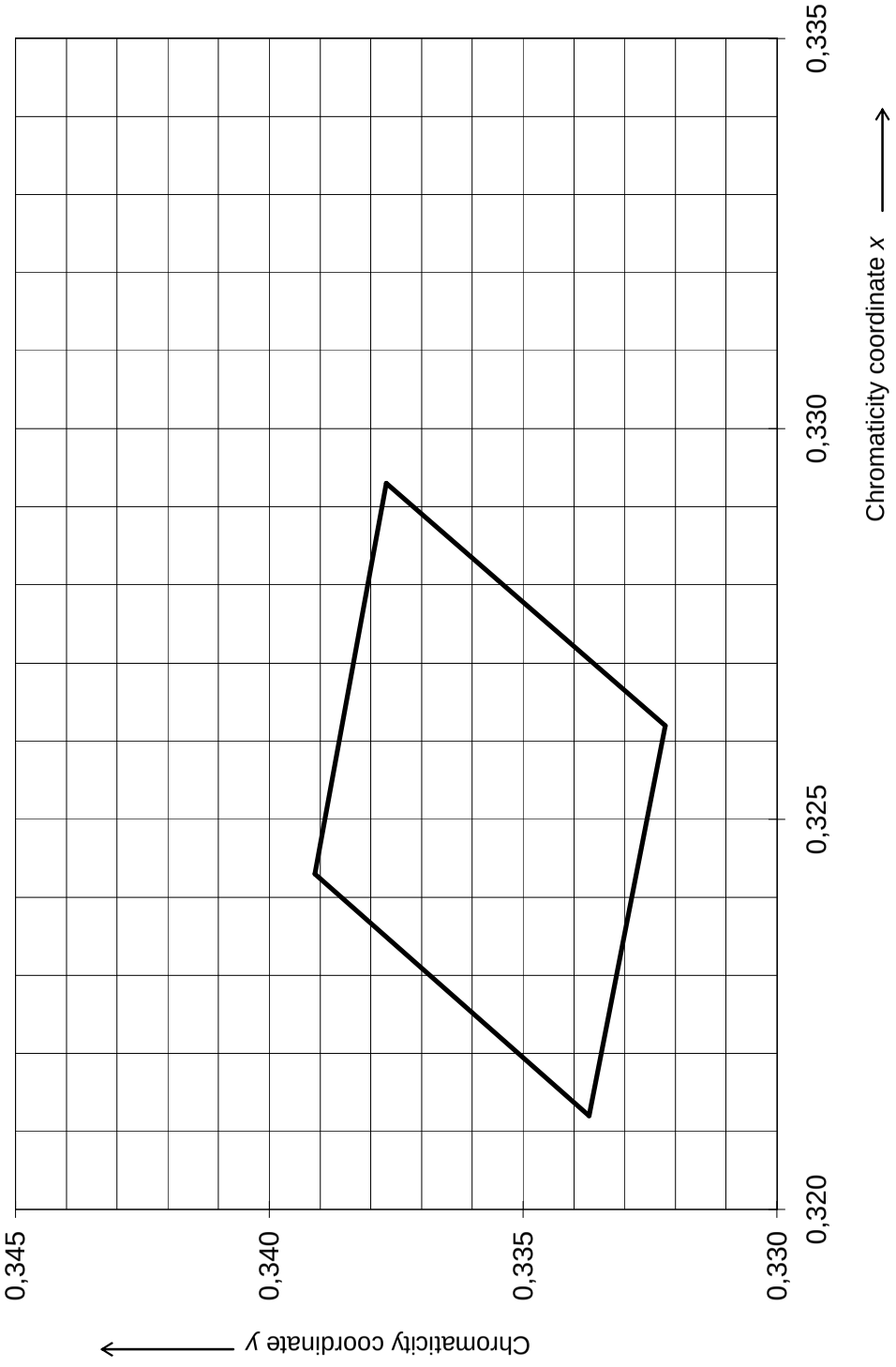
Chromaticity Coordinates

Type of Glass: PHOTOSOLAR® SUPERGREY
Thickness: 2 mm



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Chemical toughening parameter

Glass and chemical toughening parameters		
Transformation temperature	°C	504
Glass thickness	mm	2
Processing time	h	16
Processing temperature	°C	390
Salt bath (* weight percentages)	$NaNO_3$ in % *	40.0
	KNO_3 in % *	59.5
	SiO_2 x H_2O in % *	0.5

Chemical toughening results *		
Penetration depth	µm	63
Birefringence	nm/cm	3930

* measured across at a sample piece ground down to 0.3 mm ± 0.05 mm

Ball drop test acc. FDA	% failed	passed
Ball drop test acc. DIN	% failed	not carried out