

<b>Specification</b> Physical and chemical properties	<b>PCP</b> <b>D 1511</b>
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## Grau 1511

## D 1511

Colour: grey

Application: dark tinted sunglare filter with  
IR- and high UV-absorption  
filter category 3 acc. to DIN EN 1836

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  $\diamond$  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**.

<b>Specification</b>		<b>PCP D 1511</b>	
Physical and chemical properties			
<b>1.</b>	<b>Optical properties</b>		
<b>1.1</b>	<b>Refractive indices (20 °C)</b>		
	Pretreatment of samples	$n_g$	1.5360
	[ x ] Condition as supplied	$n_{F'}$	1.5306
	[ ] annealed at 40 °C/h	$n_F$	1.5302
		$n_e$	1.5251
		$n_d$	1.5225
		$n_D$	1.5224
		$n_{C'}$	1.5199
		$n_C$	1.5196
<b>1.1.1</b>	<b>Abbe value</b>	$v_e$	49.1 ± 0.6
		$v_d$	49.3
<b>1.2</b>	<b>Transmittance data</b>		
<b>1.2.1</b>	<b>Spectral transmittance <math>\tau(\lambda)</math></b>		
<b>1.2.1.1</b>	<b><math>\tau(\lambda)</math> - curve</b>		
	Plot of spectral transmittance $\tau(\lambda)$ for $d = 2.0$ mm ( $\lambda = 300$ nm to 1500 nm)	see annex	
<b>1.2.1.2</b>	<b><math>\tau(\lambda)</math> - individual values in % (<math>d = 2.0</math> mm)</b>		
	$\tau(\lambda)_{\max}$ for the $\lambda$ - range 280 nm to 315 nm	< 0.001	
	$\tau(\lambda)_{\max}$ for the $\lambda$ - range 315 nm to 350 nm	< 0.002	
	$\tau_{380}$	0.9	
	$\tau(\lambda)_{\min}$ for the $\lambda$ - range 500 nm to 650 nm	8	
<b>1.2.1.3</b>	<b>Edge wavelength (<math>d = 2.0</math> mm)</b>		
	Edge wavelength $\lambda_C$ ( $\tau = 0.46$ ) in nm	◇	
<b>1.2.2</b>	<b>Luminous transmittance <math>\tau_v</math></b>		
<b>1.2.2.1</b>	<b>Luminous transmittance <math>\tau_{vD65}</math> in % at nominal thickness <math>d = 2.0</math> mm * nominal transmittance</b>	11.0 * ± 2	
	Luminous transmittance as a function of thickness		
	Thickness in mm	1.4	2.0
		3.0	4.0
		5.0	6.0
	$\tau_{vD65}$ in %	20.8	11.0
		◇	◇
	$\tau_{vA}$ in %	20.5	10.8
		◇	◇
	$\tau_{vC}$ in %	20.8	11.0
		◇	◇
		◇	◇
		◇	◇

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Physical and chemical properties			
<b>1.2.2.2</b>	<b>Scale number / Filter category</b>		
	$N$ for mean thickness $d = 1.9$ mm ( $\tau_{vD65} = 12.6$ %)		6 - 3.1
	$N$ for mean thickness $d = 2.8$ mm ( $\tau_{vD65} = 4.7$ %)		6 - 4.1
	filter category for nominal transmittance $\tau_{vD65} = 11.0$ %		3
<p><b>This "very dark" sunglare filter acc. to DIN EN 172 for <math>N = 6 - 3.1</math> not recommended for driving and for <math>N = 6 - 4.1</math> (extremely dark) not suitable for driving</b></p> <p><b>Reaching filter category 4 acc. DIN EN 1836 this sunglare filter not suitable for driving and road use.</b></p>			
<b>1.2.3</b>	<b>Special transmittance values in % (<math>d = 2.0</math> mm)</b>		
<b>1.2.3.1</b>	<b>UV - transmittance</b>		
		$\tau_{UVA}$	0.2
		$\tau_{SUV}$	< 0.5
		$\tau_{SUVA}$	< 0.5
		$\tau_{SUVB}$	< 0.05
<b>1.2.3.2</b>	<b>IR - transmittance</b>	$\tau_{SIR}$	6
<b>1.2.3.3</b>	<b>Solar blue - light transmittance</b>	$\tau_{sb}$	9.3
<b>1.3</b>	<b>Colour</b>		
<b>1.3.1</b>	<b>Visual evaluation</b>		◇
<b>1.3.2</b>	<b>Colorimetry</b>		
	Chromaticity coordinates	A $x_{10}$	0.311 <sub>0</sub>
		$y_{10}$	0.360 <sub>0</sub>
	Chromaticity coordinates (colour locus) are referred to the Standard Illuminant $D_{65}$ according CIE 10°-observer for the nominal transmittance $\tau_{vD65} = 11.0$ % (refer to 1.2.2.1)	B $x_{10}$	0.317 <sub>0</sub>
		$y_{10}$	0.360 <sub>0</sub>
		C $x_{10}$	0.317 <sub>0</sub>
		$y_{10}$	0.366 <sub>0</sub>
	In case of verification, the measured values may additionally deviate by the measuring uncertainty of the used measuring devices.	D $x_{10}$	0.311 <sub>0</sub>
		$y_{10}$	0.366 <sub>0</sub>
	part of chromaticity coordinates		see annex
<b>1.3.3</b>	<b>Signal light recognition</b>		
	Relative visual attenuation coefficient (quotient) $Q$	$Q_{blue}$	1.03
	for signal light recognition referred to the	$Q_{green}$	1.04
	nominal transmittance $\tau_{vD65} = 11.0$ %	$Q_{yellow}$	0.95
	(refer to 1.2.2.1)	$Q_{red}$	0.82
<b>1.3.4</b>	<b>Yellowness index (<math>d = 10</math> mm)</b>		
		$Y_i$	◇

<b>Specification</b>		<b>PCP D 1511</b>	
Physical and chemical properties			
<b>2. Thermal properties</b>			
<b>2.1 Viscosities and corresponding temperatures</b>			
Designation	Viscosity lg $\eta$ in dPas	Temperature $\vartheta$ in °C	
Strain point	14.5	445	
Annealing point	13.0	476	
Softening point	7.6	667	
Forming temperature	6.0	777	
Forming temperature	5.0	874	
Forming temperature	4.0	1006	
<b>2.2</b>	<b>Transformation temperature <math>T_g</math> in °C</b>	480	
<b>2.3</b>	<b>Coefficient of mean linear thermal expansion <math>\alpha(20\text{ °C};300\text{ °C})</math> in <math>10^{-6}\text{ K}^{-1}</math> (Static measurement)</b>	10.0	
<b>2.4</b>	<b>Fuseability</b>	◇	
<b>2.5</b>	<b>Mean specific heat capacity <math>c_p(20\text{ °C to }100\text{ °C})</math> in <math>\text{J}/(\text{g} \cdot \text{K})</math></b>	◇	

<b>Specification</b>		<b>PCP D 1511</b>
Physical and chemical properties		
<b>3.</b>	<b>Mechanical properties</b>	
<b>3.1</b>	Density $\rho$ in g/cm <sup>3</sup> (annealed at 40 °C/h)	2.55
<b>3.2</b>	Stress optical coefficient $C$ in $1.02 \cdot 10^{-12}$ m <sup>2</sup> /N	◇
<b>3.3</b>	<b>Breaking strength</b>	
	A higher mechanical strength can be realized by chemical toughening according to the ion exchange procedure (refer to annex 3.3.1) or by thermal toughening. Both toughening methods may cause slight transmittance - and colourchanges.	
<b>3.3.1</b>	<b>Chemical toughening</b>	
	Processing temperature $\vartheta$ in °C	380
	Processing time $t$ in h	16
	Compressive stress $D_s$ as birefringence in nm/cm	7300
	Penetration depth $N_z$ up to neutral zone in $\mu\text{m}$	55
	Further information	see annex
<b>3.3.2</b>	<b>Thermal toughening</b>	
	Recommended minimum thickness $d$ in mm for toughened safety glass lenses without corrective effect as per ball drop test (DIN EN 168)	2.5
<b>3.4</b>	Young´s modulus $E$ in kN/mm <sup>2</sup>	◇
<b>3.5</b>	Poisson´s ratio $\mu$	◇
<b>3.6</b>	Torsion modulus $G$ in kN/mm <sup>2</sup>	◇
<b>3.7</b>	Knoop hardness $HK$ 0.1/20	499

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Physical and chemical properties		<b>D 1511</b>
<b>4.</b>	<b>Chemical properties</b>	
<b>4.1</b>	<b>Hydrolytic resistance acc. to DIN ISO 719</b>	
	Hydrolytic class	HGB 4
	Equivalent of alkali (Na <sub>2</sub> O) per gram of glass grains in µg/g	422
<b>4.2</b>	<b>Acid resistance acc. to DIN 12 116</b>	
	Acid class	S 3
	Half surface weight loss after 6 hours in mg/dm <sup>2</sup>	1.7
<b>4.3</b>	<b>Alkali resistance acc. to DIN ISO 695</b>	
	Class	A 2
	Surface weight loss after 3 hours in mg/dm <sup>2</sup>	99
<b>4.4</b>	<b>Hazardous Substances</b>	
	EC-directive 2002/95/EC (RoHS-directive)	on request
<b>5.</b>	<b>Electrical properties</b>	disregarded
<b>6.</b>	<b>Other properties</b>	disregarded
<b>7.</b>	<b>Annex (diagrams, curves)</b>	

Form 0050/1e

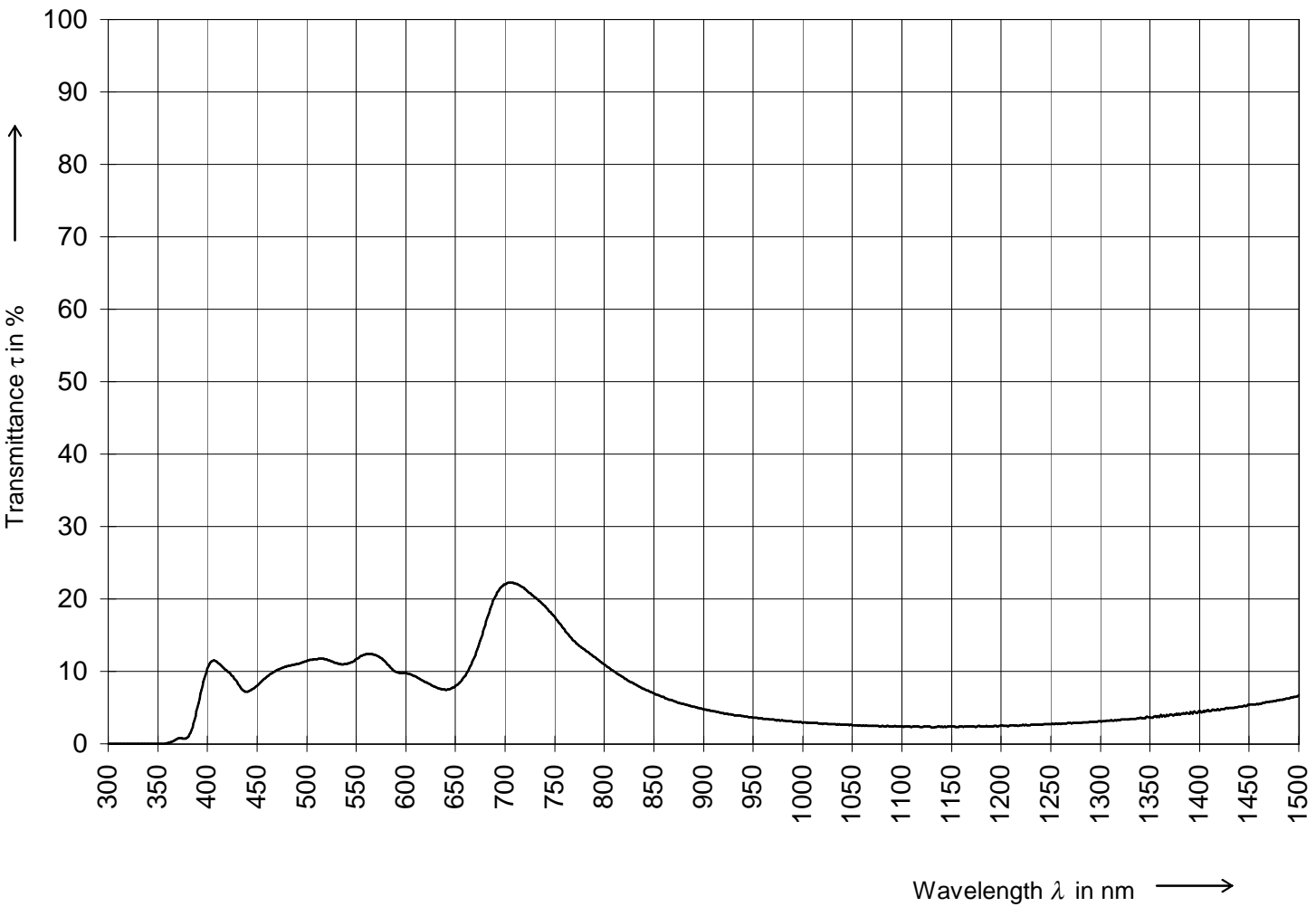
## Specification

Physical and chemical properties

PCP  
D 1511

## Spectral Transmittance

Type of Glass: **Grau 1511**  
Thickness: 2.00 mm



## Specification

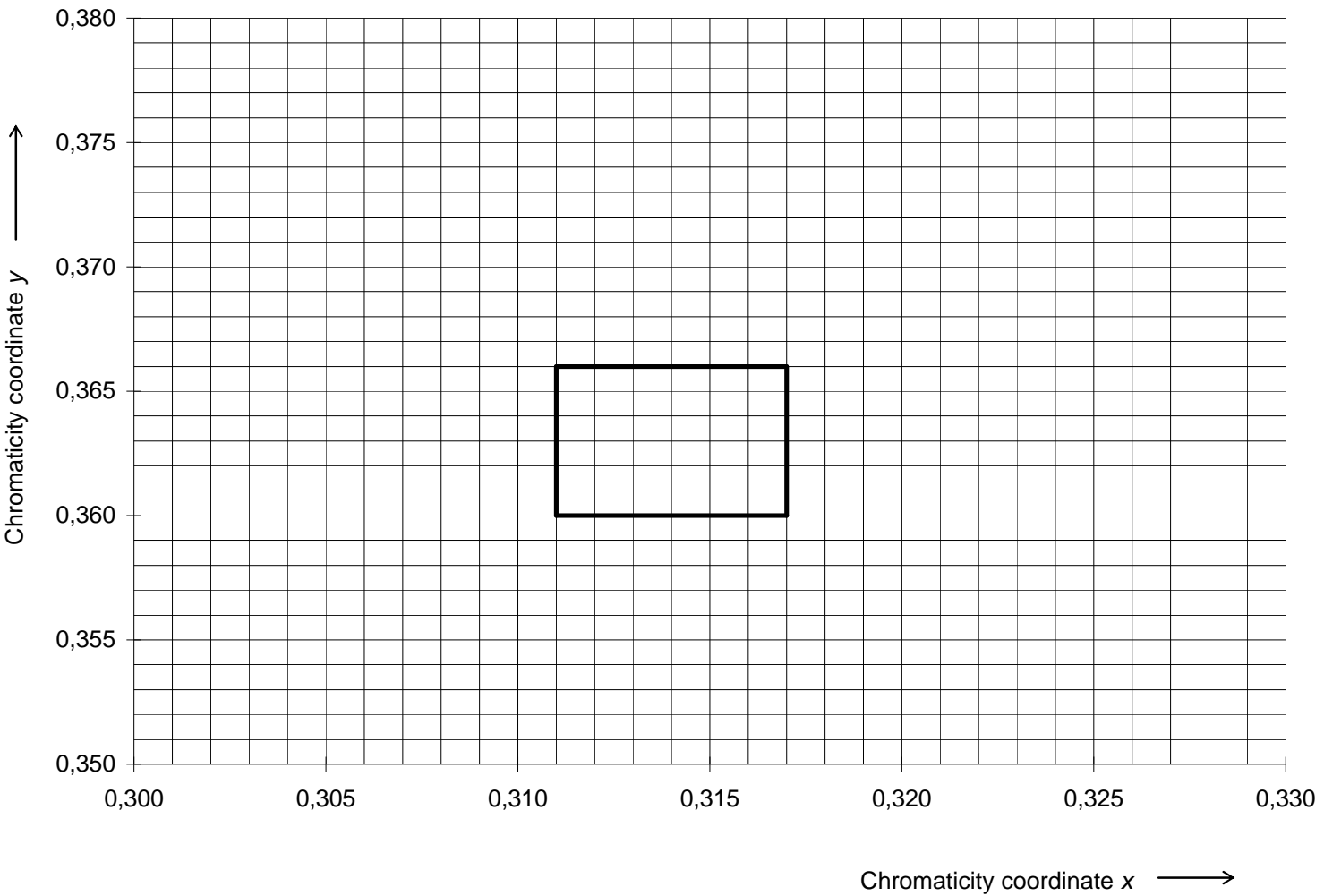
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## Chromaticity Coordinates

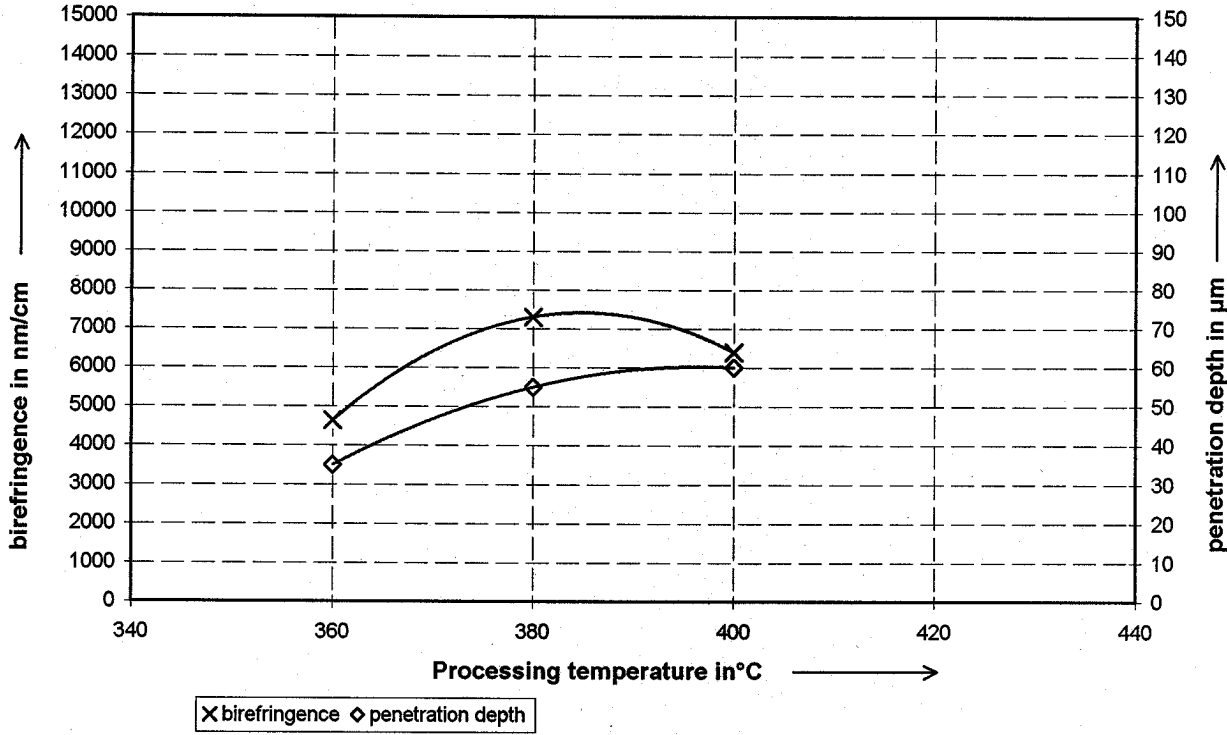
Type of Glass: **Grau 1511**

Thickness: 2.0 mm





Annex 3.3.1

<b>Specification</b>		<b>PCP D 1511</b>													
Physical and chemical properties															
<b>Chemical toughening parameter</b>															
<b>Glass and chemical toughening parameters</b>															
Transformation temperature	°C	480													
Glass thickness	mm	2													
Processing time	h	16													
Processing temperature	°C	380													
Salt bath (* weight percentages)	KNO <sub>3</sub> in % *	99.5													
	SiO <sub>2</sub> x H <sub>2</sub> O in % *	0.5													
<b>Chemical toughening results *</b>															
Penetration depth	µm	55													
Birefringence	nm/cm	7300													
* measured across at a sample piece ground down to 0.3 mm ± 0.05 mm															
Ball drop test acc. FDA	% failed	not carried out													
Ball drop test acc. DIN	% failed	not carried out													
 <table border="1"> <caption>Graph Data</caption> <thead> <tr> <th>Processing temperature (°C)</th> <th>Birefringence (nm/cm)</th> <th>Penetration depth (µm)</th> </tr> </thead> <tbody> <tr> <td>360</td> <td>4500</td> <td>35</td> </tr> <tr> <td>380</td> <td>7200</td> <td>55</td> </tr> <tr> <td>400</td> <td>6200</td> <td>60</td> </tr> </tbody> </table>				Processing temperature (°C)	Birefringence (nm/cm)	Penetration depth (µm)	360	4500	35	380	7200	55	400	6200	60
Processing temperature (°C)	Birefringence (nm/cm)	Penetration depth (µm)													
360	4500	35													
380	7200	55													
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