

Specification Physical and chemical properties	PCP AF 45™		
<table><tr><td><p>AF 45™</p><p>AF 45™ is an aluminoborosilicate glass which is produced by the drowndraw method, enabling production in a very thin thickness range between 0.05 mm and 1.1 mm. It is alkali-free in synthesis (however, contents of alkali oxide up to 0.2 weight percentages are possible by contamination of the raw materials and refractory material).</p><p>The special composition of this substrate glass with fire-polished surfaces makes it suitable for a variety of applications:</p><ul style="list-style-type: none">· Optical and electrical Sensors· LCD-Substrate· MEMS (Micro-Electro-Mechanical Systems)· Slides and Micro-Arrays· Wafer Level Chip Size Packaging· Microoptics on wafer level· High-temperature applications up to approx. 600 °C<p>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.</p><p>Values marked with \diamond do not apply to the type of glass or no values are available.</p><p>Requirements deviating from these specifications must be defined in writing in a customer agreement.</p></td><td><p>D 0890 0</p></td></tr></table>		<p>AF 45™</p> <p>AF 45™ is an aluminoborosilicate glass which is produced by the drowndraw method, enabling production in a very thin thickness range between 0.05 mm and 1.1 mm. It is alkali-free in synthesis (however, contents of alkali oxide up to 0.2 weight percentages are possible by contamination of the raw materials and refractory material).</p> <p>The special composition of this substrate glass with fire-polished surfaces makes it suitable for a variety of applications:</p> <ul style="list-style-type: none">· Optical and electrical Sensors· LCD-Substrate· MEMS (Micro-Electro-Mechanical Systems)· Slides and Micro-Arrays· Wafer Level Chip Size Packaging· Microoptics on wafer level· High-temperature applications up to approx. 600 °C <p>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.</p> <p>Values marked with \diamond do not apply to the type of glass or no values are available.</p> <p>Requirements deviating from these specifications must be defined in writing in a customer agreement.</p>	<p>D 0890 0</p>
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VX 0050/1e

Specification		PCP AF 45™	
Physical and chemical properties			
1.	Optical properties		
1.1	Refractive indices		
	Pretreatment of samples	n_g	1.5359
	Condition as supplied	$n_{F'}$	1.5318
	["as drawn"]	n_F	1.5313
		n_e	1.5275
		n_d	1.5255
		n_D	1.5254
		$n_{C'}$	1.5233
		n_C	1.5229
1.1.1	Abbe value	v_e	62.2
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 $d = 0.5$ mm, $d = 1.1$ mm ($\lambda = 250$ nm to 2000 nm)	see annex	
1.2.1.2	$\tau(\lambda)$ - individual values in % ($d = 1.1$ mm)	see annex	
1.2.1.3	Edge wavelength		
		Thickness in mm	0.5 1.1
	Edge wavelength	$\lambda_c (\tau = 0.46)$ in nm	291 315
1.2.2	Luminous transmittance τ_v		
1.2.2.1	Luminous transmittance as a function of thickness		
		Thickness in mm	0.5 1.1
		τ_{VD65} in %	91.8 91.8

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Specification		PCP AF 45™	
Physical and chemical properties			
2.	Thermal properties		
2.1	Viscosities and corresponding temperatures		
	Designation	Viscosity lg η in dPas	Temperature ϑ in °C
	Strain point	14.5	627
	Annealing point	13.0	663
	Softening point	7.6	883
	Forming temperature	6.0	1000
	Forming temperature	5.0	1098
	Forming temperature	4.0	1225
2.2	Transformation temperature T_g in °C		662
2.3.	Coefficient of thermal expansion α		
2.3.1	Coefficient of mean linear thermal expansion $\alpha(20\text{ °C};300\text{ °C})$ in 10^{-6} K^{-1} (Static measurement)		4.5
2.4 - 2.5			disregard
2.6	Thermal conductivity λ in W/ (m·K) for the indicated temperatures		
		$\vartheta = 25\text{ °C}$	0.93
		$\vartheta = 87\text{ °C}$	1.04
		$\vartheta = 127\text{ °C}$	1.10
		$\vartheta = 166\text{ °C}$	1.13

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Specification		PCP
Physical and chemical properties		AF 45™
3.	Mechanical properties	
3.1	Density ρ in g/cm ³ (annealed at 40 °C/h)	2.72
3.2	Stress optical coefficient C in $1,02 \cdot 10^{-12}$ m ² /N	3.2
3.3	Breaking strength	
3.3.1	Chemical toughening	
	A higher mechanical strength for chemical toughening according to the ion exchange procedure is not possible by alkali-free glasses.	
3.3.2	Thermal toughening	disregard
3.4	Young's modulus E in kN/mm ²	66.0
3.5	Poisson's ratio μ	0.235
3.6	Torsion modulus G in kN/mm ²	26.7
3.7	Knoop hardness HK 0.1/20	555

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Specification		PCP AF 45™	
Physical and chemical properties			
4.	Chemical properties		
4.1	Hydrolytic resistance acc. to DIN ISO 719		
		Hydrolytic class	HGB 1
	Equivalent of alkali (Na ₂ O) per gram of glass grains in µg/g		10
4.2	Acid resistance acc. to DIN 12116		
		Acid class	S 4
	Half surface weight loss after 6 hours in mg/dm ²		> 250
4.3	Alkali resistance acc. to DIN ISO 695		
		Class	A 3
	Surface weight loss after 3 hours in mg/dm ²		460
4.4	Hazardous Substances		
EC-directive 2002/95/EC (RoHS-directive)			
	Test Items	RoHS Limit in mg/kg	Value* in mg/kg
	Cadmium (Cd)	100	< Limit
	Lead (Pb)	1000	< Limit
	Mercury (Hg)	1000	< Limit
	Hexavalent chromium (Cr(VI))	1000	< Limit
	Polybrominated biphenyls (Sum of PBBs)	1000	< Limit
	Polybrominated diphenyl ethers (Sum of PBDEs)	1000	< Limit
* Test Report SGS INSTITUTE			

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Specification		PCP
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5. Electrical properties		
5.1	Dielectric constant (Permittivity) ϵ_r at 1 MHz	6.2
5.2	Dissipation factor $\tan \delta$ at 1 MHz	$9 \cdot 10^{-4}$
5.3	Electric volume resistivity ρ_D in $\Omega \cdot \text{cm}$ at the specified temperatures	
5.3.1	ρ_D for alternating current	◇
5.3.2	ρ_D for direct current	
	$\vartheta = 250 \text{ }^\circ\text{C}$	$6.0 \cdot 10^{13}$
	$\vartheta = 350 \text{ }^\circ\text{C}$	$3.2 \cdot 10^{11}$
	$\vartheta = 500 \text{ }^\circ\text{C}$	$1.6 \cdot 10^9$
5.4	Temperature t_{k100} in $^\circ\text{C}$ for a specific electric volume resistivity of $10^8 \Omega \cdot \text{cm}$	610
6. Other properties		
6.1	Compaction	
	Compaction specifies small negative changes in length which may occur after heat treatment ($\vartheta > 250 \text{ }^\circ\text{C}$) made by the customer. For three typical examples, i.e. 1 h at 350 $^\circ\text{C}$, 1 h at 450 $^\circ\text{C}$ and 16 h at 450 $^\circ\text{C}$ the compaction values are specified in $\mu\text{m}/\text{m}$ hereafter:	
	Temperature treatment made by customer	AF 45™ "as drawn"
		AF 45™ with SCHOTT AG Low-compaction-treatment
		Compaction in $\mu\text{m}/\text{m}$
	1 h at 350 $^\circ\text{C}$	< 12
	1 h at 450 $^\circ\text{C}$	< detection limit ($\pm 1 \mu\text{m} / 300 \text{ mm}$)
	1 h at 450 $^\circ\text{C}$	< 55
	16 h at 450 $^\circ\text{C}$	< 240
		< 30*
	*Closer tolerances of compaction can be achieved as long as heat treatment data of further processing are available.	
7. Annex (diagrams, curves)		

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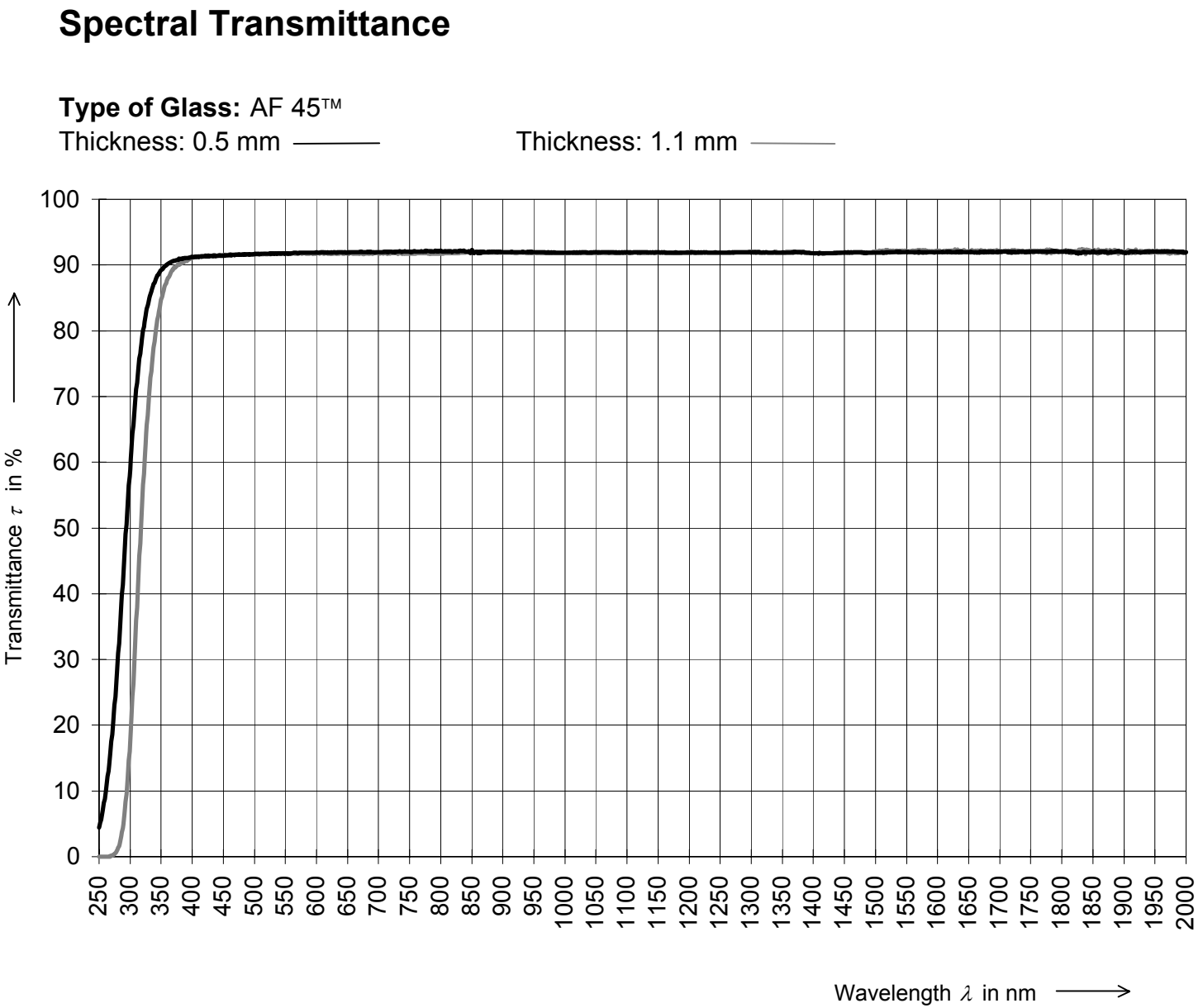
Annex 1.2.1.1

Specification

Physical and chemical properties

PCP

AF 45™



Annex 1.2.1.2

Specification		PCP	
Physical and chemical properties		AF 45™	
Spectral transmittance for the thickness 1.1 mm			
λ in nm	τ (λ) in %	λ in nm	τ (λ) in %
280	1.2	510	91.7
290	5.7	520	91.7
300	17.6	530	91.7
310	36.0	540	91.7
320	54.9	550	91.7
330	69.6	560	91.8
340	79.1	570	91.8
350	84.7	580	91.8
360	87.8	590	91.8
370	89.5	600	91.8
380	90.1	610	91.8
390	90.7	620	91.8
400	91.2	630	91.8
410	91.3	640	91.8
420	91.4	650	91.8
430	91.4	660	91.8
440	91.4	670	91.9
450	91.5	to	
460	91.6	770	91.9
470	91.6	780	92.0
480	91.6	to	
490	91.6	810	92.0
500	91.6		

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