BOROSILICATE 3.3 GLASS

PHYSICAL DATA

Mean linear and thermal coefficient of expansion		
α (20 °C; 300 °C) according to ISO 7991	$3{,}3 \cdot 10^{-6}\ K^{-1}$	
Transformation temperature Tg	525 °C	
Glass temperature at	10^{13} (upper chilling temperature)	560 °C
Viscosity η in dPa . s:	$10^{7{,}6}$ (softening temperature)	825 °C
	10^{4} (working range)	1,260 °C
Highest short-term admissible working range		500 °C
Density ρ at 20 °C		$2.23\ g.\ cm^{-3}$
Modulus of elasticity E (Young's modulus)		64.103 MPa
Poisson's ratio μ		0.20
Thermal conductivity λ (20 to 100 °C)	$1.2\ W.m^{-1}.K^{-1}$	
Temperature for specific electric resistance		
10^{8} Ω.cm (DIN 52326) t_{kIOO}		250 °C
Logarithm of electric	at 250 °C	8
bulk resistivity (Ω . cm)	at 350 °C	6.5
Dielectric properties (1 MHz, 25 °C)		
Permitivity ε		4.6
Loss factor tan δ		37.10^{-4}
Refractive index (λ = 587.6 nm) n_d		1.473
Photoelastic constant (DIN 52314) K		$4.0.10^{-6}\ mm^2.N^{-1}$

PRESSURE RESISTANCE

Pressure resistance (p) calculation with a known wall thickness (Wt) and a given outside diameter (OD):

$$p = \frac{Wt \cdot 20 \cdot \frac{K}{S}}{OD - Wt}$$

Wall thickness (Wt) calculation with a given pressure resistance (p) and outside diameter (OD):

$$Wt = \frac{OD \cdot p}{20 \cdot \frac{K}{S} + p}$$

OD = outside diameter in mm
p = pressure resistance in bar

Wt = wall thickness in mm
K/S = admissible stress in N . mm^{-2}
borosilicate glass 3.3 admissible stress: K/S = 7 N . mm^{-2}

RESISTANCE TO TEMPERATURE VARIATIONS

Resistance to temperature variations corresponds according to ISO 718 to the thermal difference between the hot test piece and the cold water bath (room temperature), where the first cracks appear on 50 per cent of samples, when these will have been quickly dipped into the water bath. Resistance to temperature variations of tubes, capillaries and rods depends on the wall thickness, shape and size of the cooled surface, surface condition, tension and final working. Uneven, flash heating or fast cooling may easily lead to cracking due to the resulting tension. It is recommended not to exceed the thermal difference of 120 °C. At thicker walls, this thermal difference is limited to lower values. As for examples of resistance to temperature variations of tubes

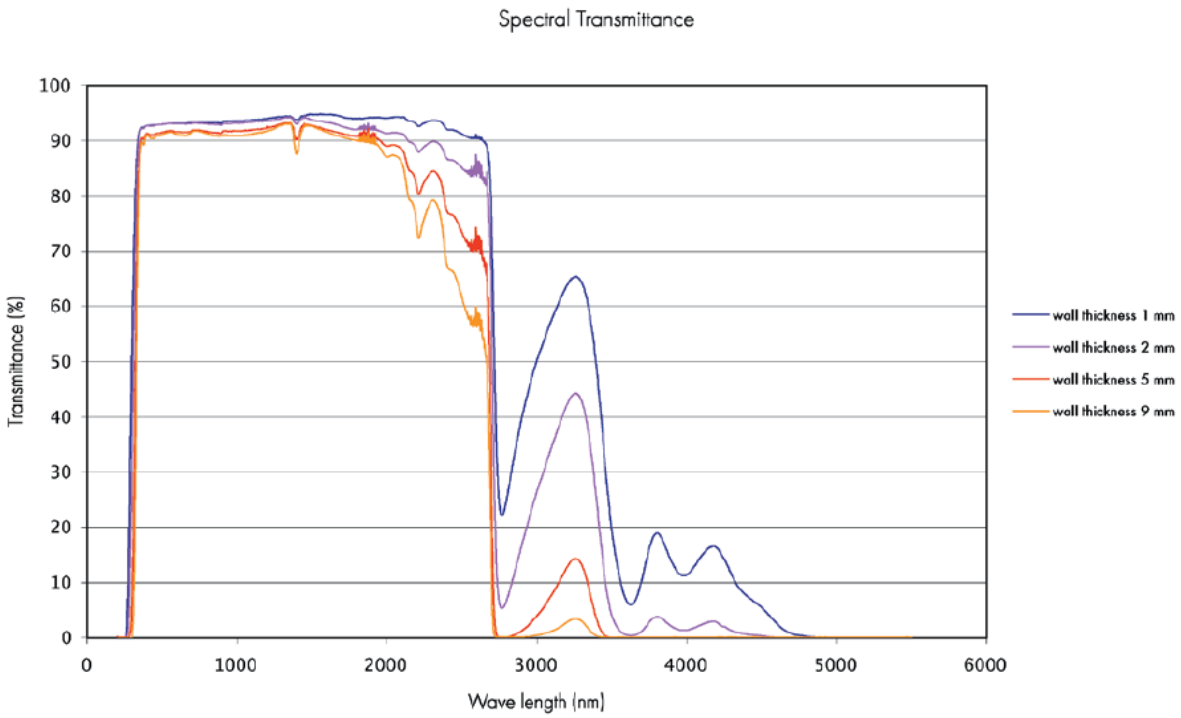
Wall thickness in mm	Resistance to temperature variations in K
1	303
3	175
5	136
7	115

CHEMICAL COMPOSITION

(main components in percentage by weight)

SiO_2	B_2O_3	$Na_2O + K_2O$	Al_2O_3
80.6	13	4	2.4

LIGHT TRANSMITION



COOLING SPEED

Wall thickness in mm	Range of temperature		
	560 to 490 °C	490 to 440 °C	440 to 20 °C
3	14 °C /min	28 °C /mm	up to 447 °C /min
6	3 °C /min	6 °C /min	up to 111 °C /min
12	0.6 °C /min	1.6 °C /min	up to 28 °C /min