SIMAX®: Physical and Chemical Properties

PHYSICAL DATA

Mean linear and thermal coefficient of expansion (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_{k100}		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		$4.0.10^{-6}\ mm^2.N^{-1}$

SIMAX® TUBES AND CAPILLARIES 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 — *Wt = wall thickness in mm*

p = pressure resistance in bar — *K/S = admissible stress in N . mm^{-2}*

SIMAX® borosilicate glass 3.3 admissible stress: K/S = 7 N . mm^{-2} according to ČSN EN 1595 Standard: Pressure Vessels Made of Borosilicate Glass 3.3; General Principles for Construction, Manufacturing and Testing.

Pressure resistance (p) affects, among others, the following:

- thermal difference between the inside and outside walls
- surface quality
- working the ends
- compliance with assembling conditions in accordance with pressure vessels regulations
- tube length

The manufacturer may perform an exact calculation, where necessary.

In addition, the following should be taken into consideration:

- ČSN EN 1595:1998 Pressure Vessels Made of Borosilicate Glass 3.3 General Principles for Construction, Manufacturing and Testing
- ČSN EN 12585:1999 Glass Equipment, Pipes and Pipe Fittings. Piping and Pipe Fittings with a Nominal Diameter of DN 15 to 1000. Compatibility and Interchangeability

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 and rods made of SIMAX® borosilicate glass 3.3 some values measured have been specified hereinafter. These values may be considered indicators, because considerable differences may exist among parts of the same sizes:

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

The manufacturer may perform an exact calculation, where necessary.

CHEMICAL COMPOSITION

(main components in percentage by weight)

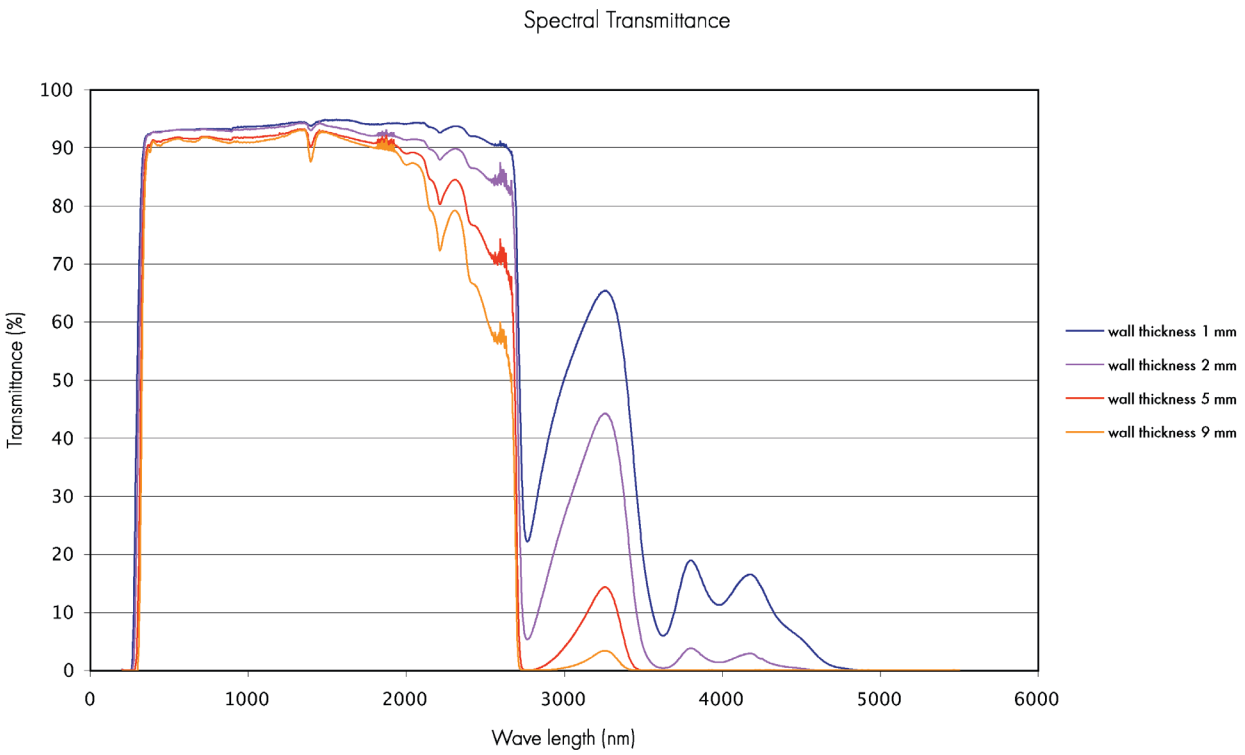
SiO_2	B_2O_3	$Na_2O + K_2O$	Al_2O_3
80.6	13	4	2.4

CHEMICAL DURABILITY

Class of Resistance to Water Effects (ISO 719)	HGB 1
Class of Resistance to Acid Effects (ISO 1776 a DIN 12116)	Class S1
Class of Resistance to Various Kinds of Lye (ISO 695)	Class A2

SIMAX® borosilicate glass 3.3 is highly resistant to water effects, neutral and acid solutions, heavy acids and their mixtures, to chlorine, bromine, iodine and organic compounds. Even in long-term effects and at temperatures above 100 °C, this glass outstrips with its chemical durability most metals and other raw materials. Due to water and acid effects the glass releases small amounts only, mostly those of monovalent ions. At the same time, on the glass surface, there is formed a very thin, permeable siliceous gel layer, which ensures resistance to further effects. Hydrogen fluoride, hot phosphoric acid and alkaline solutions have an affect on the glass surface, depending on concentration and temperature.

LIGHT TRANSMITTANCE



INSTRUCTIONS FOR PROCESSING

SIMAX® tubes, capillaries and rod material properties guarantee a very good workability in glass forming and dividing, which is usual with technical glass. To remove temporary stress, which originates in processing, it is appropriate to warm the glass through well up to a temperature of 550 °C, and, to leave it at this temperature over a period of time of at maximum 30 minutes; as a rule, in thin-walled products a fraction of this time would suffice. With regard to glass chemical durability the stabilization time should be as short as possible. For subsequent cooling down, the cooling speeds have been recommended as per the below table:

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

In the event that it is necessary to cool the product down several times, the sum of all the stabilization times at 550 °C should not exceed two hours. SIMAX® glass may be melted and joined with other brands of borosilicate glass of the same type, without stress, and processed and stabilized at the same temperatures. SIMAX® tubes, capillaries and rods may be printed using silver- and copper-based diffusion colours and silk-screen-printing colours.