TECHNICAL INFORMATION

SIMAX GLASS

The products made from SIMAX glass are smooth and imporous, perfectly transparent, catalytically indifferent, corrosion-resistant even in long-term operations, sufficiently homogeneous, and free from any heterogeneous particles. SIMAX glass is environmentally friendly and is absolutely unexceptionable from an ecological viewpoint.

Kavalier Glassworks, a.s. is considered to be among the most important world producers supplying products from the borosilicate glass, type 3.3.

QUALITY

To ensure high quality of the supplied goods, Kavalierglass, a.s. has a introduced and certified quality management system according to ISO 9001: 2015. The current certificate No. 04100940602 issued by the certification company TÜV NORD CERT GmbH. The products from borosilicate glass 3.3, SIMAX, are suitable for contact with foodstuff within the meaning of regulation (EC) No. 1935/2004 of the European Parliament and of the Council on materials and articles intended to come into contact with food, as amended. The fulfillment of the hygienic requirements according to the decree of the Ministry of health No. 38/2001 Coll., on hygiene requirements for products intended for contact with foodstuffs, as amended and is documented by regular testing in an accredited laboratory ITC a.s. Zlín.

TÜV NORD

CERTIFICATE

Management system as per
EN ISO 9001 : 2015

In accordance with TÜV NORD CERT procedures, it is hereby certified that

KAVALIERGLASS, a.s.,
Křižová 1018/6, Smichov
150 00 Praha 5
Czech Republic

KAVALIER

with the sites acc. to the annex

applies a management system in line with the above standard for the following scope

Design and production of glass products for household, laboratory, technical and pharmaceutical use, decorative glass and glass tubes, including production of metal glass moulds.
Development and production of automatic machines and equipment, moulds and tools, production of small metal products.
Production of plastic products. Production of cardboard.

Certificate Registration No. 04 100 940602
Audit Report No. 623 174

Valid from 2015-11-05
Valid until 2018-11-04
Initial certification 1994

Certification Body
at TÜV NORD CERT GmbH

Praha, 2018-01-16

This certification was conducted in accordance with the TÜV NORD CERT auditing and certification procedures and is subject to regular surveillance audits.
The annex (1 page) is the integral part of the certificate.
TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

IAF DAkkS

CHEMICAL COMPOSITION OF SIMAX GLASS

(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 RESISTANCE OF SIMAX GLASS

SIMAX borosilicate glass 3.3 is highly resistant to the effects of water, neutral and acidic solutions, strong acids (except for hydrofluoric, fluorosilicate, phosphoric acids and hot concentrated lyes) and their mixtures, chlorine, bromine, iodine, and organic compounds. Even in long-term exposure and at temperatures above 100 °C, this glass outstrips, with its chemical durability, most metals and other raw materials. Due to effects of water and acids, the glass releases only small amounts of mostly univalent ions. At the same time, a very thin permeable siliceous gel layer is formed on the glass surface, which ensures resistance to further effects.

Hydrogen fluoride, hot phosphoric acid, and alkaline solutions attack the glass surface, depending on concentration and temperature.

The method according to standard ISO	Acceptable value		Max. value attained for SIMAX glass	
	Class	Value	Class	Value
against water at 98 °C according to ISO 719	HGB1	31	HGB1	25
against water at 121 °C according to ISO 720	HGA1	62	HGA1	28
against acids according to ISO 1776	S1	100	S1	11
against alkalis according to ISO 695	A2	175	A2	120

PHYSICAL PROPERTIES OF SIMAX GLASS

The mean coefficient of thermal expansion α (20 °C; 300 °C) according to ISO 7991	$3,3 \cdot 10^{-6}\ K^{-1}$
The transformational temperature T_g	525 °C
The glass temperature at viscosity η in dPa . s : 10^{13} (upper cooling temperature)	560 °C
The glass temperature at viscosity η in dPa . s : $10^{7,6}$ (softening temperature)	825 °C
The glass temperature at viscosity η in dPa . s : 10^{4} (working temperature)	1260 °C
The highest short-term admissible working temperature	500 °C
The density ρ at 20 °C	$2,23\ g \cdot cm^{-3}$
Modulus of elesticity (Young's modulus)	$64 \cdot 10^3$ MPa
The Poisson ratio μ	0,20
The thermal conductivity λ (20 °C to 100 °C)	$1,2\ W \cdot m^{-1} \cdot K^{-1}$
The temperature for specific electrical resistance 108 Ω · cm (DIN 52326) t_{k100}	250 °C
The logarithm of electrical bulk resistivity (Ω · cm) at 250 °C	8
The logarithm of electrical bulk resistivity (Ω · cm) at 350 ° C	6,5
The dielectric properties (1 MHz, 25 °C)	
The permitivity ε	4,6
The dielectric loss factor tan δ	$37 \cdot 10^{-4}$
The refractive index (λ = 589,26 nm) n_D	1,4723
The photoelastic constant (DIN 52314) K	$4,0 \cdot 10^{-6}\ mm^2 \cdot N^{-1}$

RESISTANCE TO TEMPERATURE CHANGES

The 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 percent 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. 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:

The wall thickness in mm	The resistance to temperature changes in K
1	303
3	175
5	136
7	115

The manufacturer may perform an exact calculation, where necessary.

PRESSURE RESISTANCE OF TUBES AND CAPILLARIES SIMAX

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

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

The calculation of wall thickness (Wt) at 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 . mm²

SIMAX borosilicate glass 3.3 admissible stress: K/S = 7 N . mm² 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:

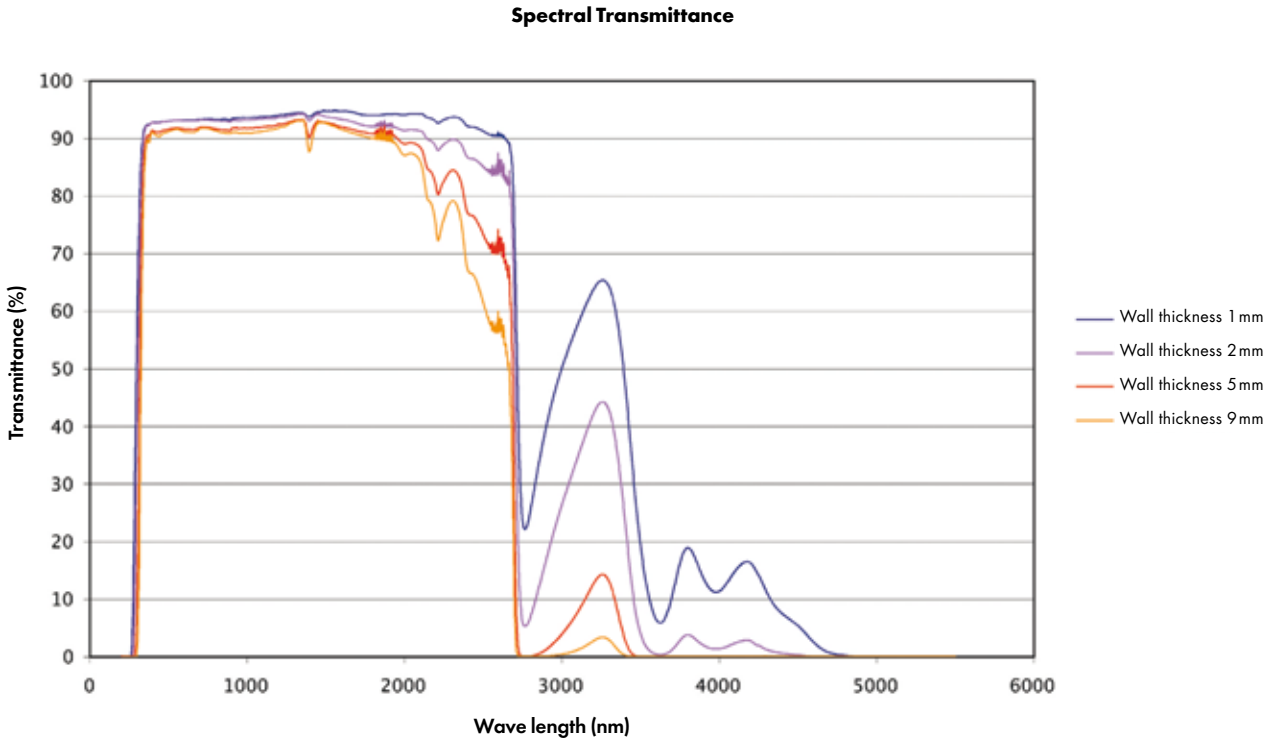
- thermal difference between the inside and outside walls
- surface quality
- working the ends
- compliance with assembling conditions in accordance with pressure vessels regulations
- tube length

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, Tubing and Pipe Fittings. Tubing and Pipe Fittings with a Nominal Diameter of DN 15 to 1000. Compatibility and Interchangeability.

LIGHT TRANSMITTANCE



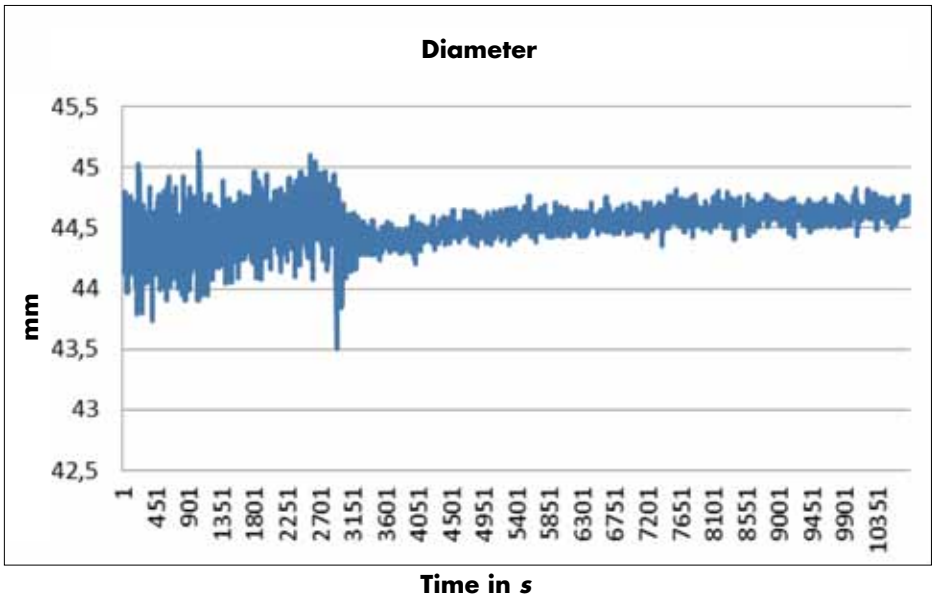
PROCESSING AND COOLING

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 heat the glass to a temperature of 550 °C, and keep it at this temperature for a period of time but a maximum of 30 minutes; as a rule, with 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:

Wall thickness in mm	Range of temperature		
	560–490 °C	490–440 °C	440–20 °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.

EXAMPLE OF A TIME FLUCTUATION IN THE DIAMETER OF THE TUBE



Parameter tracking during production – tube diameter – turning on stabilization.

TUBES PARAMETERS

Length		
	Standard length is:	
Tubing	diameter 4–200 mm	1500 + 10 mm – 0 mm
	diameter 200–250 mm	1500 + 15 mm – 0 mm
Capillary		1500 ±10 mm
Rod	diameter 3–6 mm	1500 ±20 mm
	diameter 7–16 mm	1500 ±10 mm
	diameter 18–30 mm	1500 ±30 mm
Profile assortment		1500 ±20 mm

Specific lengths of tubes (depending on the outside diameter) can be ordered on request in lengths from 1000 to 7500 mm.

OUT-OF-ROUNDNESS

Out-of-Roundness according to ISO 1101 is dependent on external diameter. The following limit values are fixed:

Tubing	∅ <250 mm	s_{max} 0,7 % of the outside diameter
Capillary	∅ < 20 mm	s_{max} 1,0 % of the outside diameter
	20 mm ≤ ∅ ≤ 40	s_{max} 1,5 % of the outside diameter
Rod	∅ < 20 mm	s_{max} 1,0 % of the outside diameter
	20 mm ≤ ∅ ≤ 45	s_{max} 1,5 % of the outside diameter

DIFFERENCE IN WALL THICKNESS

The difference between the maximum and minimum wall thickness at arbitrary point of a tube may not exceed 11 % of the wall nominal thickness.

DEFLECTION

Tubes deflection according to ISO 1101 may be as follows:

Outside diameter 4–<6 mm	max. 4,0 mm/1500 mm
Outside diameter ≥6–<30 mm	max. 1,5 mm/1000 mm
Outside diameter ≥30–<100 mm	max. 2,0 mm/1400 mm
Outside diameter ≥100–≤190 mm	max. 2,5 mm/1400 mm
Outside diameter ≥190–≤250 mm	max. 3,0 mm/1400 mm

Rods and capillaries are supplied with deflection of maximum 4 mm over 1500 mm of the product length.
This deflection applies to rod and capillary diameters 3 ≤ ∅ ≤ 6 mm.
The rods and capillaries with diameters of 6 ≤ ∅ <45 mm are delivered with a maximum deflection of 1,5 mm to 1000 mm product length.

Non-circular assortment is supplied as follows:

- tubes with deflection of maximum 0,4 % of nominal length
- capillaries and rods with deflection of maximum 0,6 % of nominal length

STRESS

Tubes

Outside diameter in mm	**∅ < 40**	**40 ≤ ∅ ≤ 60**	**∅ > 60**
Internal stress over the tube length	3,0 MPa 102,9 nm/cm	3,5 MPa 120,05 nm/cm	2,5 MPa 85,75 nm/cm
Internal stress at the edge	4,0 MPa 137,2 nm/cm	3,5 MPa 120,05 nm/cm	2,5 MPa 85,75 nm/cm

Rods are not normally annealed, however, rods 18–30 mm diameter can be delivered annealed, if requested by the customer.

Profiles, and capillary tubes are not annealed.

STONES AND TAILS

Stones	**Stones/ 1 kg of glass**
Size <0,3 mm	permitted
Size ≥0,3–<1,0 mm	max. 2
Size ≥1,0–≤2,0 mm	max. 1
Size >2,0 mm	prohibited

Tails	**Tails/ 1 kg of glass**
Size <0,3 mm	permitted
Size ≥0,3–<1,0 mm	max. 4
Size ≥1,0–≤3,0 mm	max. 2
Size >3,0 mm	prohibited

The grain size is considered as corresponding to stones or tail size.

BUBBLES

Length

Bubbles length corresponds to the length of all bubbles ≥20 mm.
Permitted length of bubbles is 0,8 m/10 m of a tube.
Bubbles <20 mm: 20 pcs/1 kg glass mass.
≥ 20 mm: 0,8 m/10m of the length of the product

Width

Bubbles wider than 1 mm are prohibited in tubes with a diameter of ∅ ≤100 mm.
Bubbles wider than 2 mm are prohibited in tubes with a diameter of ∅ >100 mm.

Note:
Capillary bubble is a bubble drawn in the direction of the length of a product in the form of a capillary with a length greater than 2 mm.

END FINISH AND FRONT SURFACES PERPENDIC ULARITY DEVIATION

Tubes

Tubes	Tube Ends	Front surfaces perpendicularity deviation
4 ≤ ∅ ≤ 5	not flame polished	–
5 < ∅ ≤ 100	flame polished	2,5
100 < ∅ ≤ 180	flame polished	4,0
200 < ∅ ≤ 250	flame polished	6,0

Note:
In flame polishing the ends, wall thickness may get enlarged by 0,1 mm.

Capillaries and rods

Capillaries and rods are not flame polished.

Profile assortment

Profiles are not flame polished at the ends, with the exception of tubes fluted inside, which are flame polished at the ends.

PACKING

Products are supplied in conveniently sized cartons, with sufficient protection against damage in transportation and storage.