SIMAX Technical Information

The chemical composition and properties of SIMAX glass place it in “group 3.3” of clear “hard” borosilicate glasses, characterised by their high heat-resistance and chemical stability, as defined by the international standard ISO 3585 and the Czech standard CSN ISO 3585. It fully complies with the requirements which these standards place on its properties.

SIMAX glass is used to produce a wide range of technical and laboratory glass products, industrial apparatus and heat-resistant household glassware, whose characteristics and practical value have made them much sought-after products in many countries throughout the world.

Because of its properties, SIMAX glass is used in situations which place the highest demands on the heat-resistance and chemical stability of products as well as their neutrality with respect to the substances or preparations with which they come into contact, i.e. in chemistry, petrochemistry, the food, energy and metalworking industries, health care, microbiology, pharmacy, mechanical engineering and laboratories.

Products made from SIMAX glass are smooth, non-porous and perfectly transparent, with no catalytic action, and are corrosion-resistant even in demanding operating conditions up to 300°C without sudden changes of temperature.

SIMAX glass is an environment-friendly product and is completely harmless from an ecological point of view.

Chemical composition of SIMAX glass

Component	**Amount (% by mass)**
SiO_2	80,4
B_2O_3	13,0
Al_2O_3	2,4
$Na_2O + K_2O$	4,2

Chemical Properties of SIMAX Glass

Products made from SIMAX glass are chemically stable, practically inert and characterised by high resistance to the effects of water, water vapour, acids and salt solutions and relatively high resistance to alkalis.

The glass is etched by hydrofluoric acid and concentrated trihydrogenphosphoric acid and corroded by hot concentrated alkaline solutions. Constant alternation of acid and alkaline environments increases corrosion.

The chemical resistance of SIMAX glass is specified by the ISO 3585 and CSN ISO 3585 standards and is evaluated precisely by the international standard testing methods defined by ISO and DIN ISO standards.

Chemical resistance of SIMAX glass to

water at 98 °C (in accordance with ISO 719) HGB 1
water at 121 °C (in accordance with ISO 720) HGA 1
acids (in accordance with ISO 1776) 1
effects of a boiling aqueous solution of mixed alkalis (in accordance with ISO 695) A2 or better

Physical Properties of SIMAX Glass

The physical properties of SIMAX glass are evaluated precisely by the international standard testing methods defined by ISO and DIN ISO standards.

The physical properties of Simax glass, as shown in the following table, comply with the ISO 3585 and CSN ISO 3585 standards.

Mean coefficient of linear thermal expansion (ISO 7991) $A_{20/300}$ .....$3,3 \times 10^{-6}\ K^{-1}$
Density .....$2,23\ g \times cm^{-3}$
Thermal conductivity (at 100 °C) $_w$ .....$1,2\ W \times m^{-1} \times K^{-1}$
Specific heat capacity at constant pressure c_p .....$0,8 \times 103\ J \times Kg^{-1} \times K^{-1}$

Temperatures of main points in terms of viscosity in dPa × s

- 10^4 working temperature (ISO 7884 -- 2, ISO 7884--5) ..... 1260 °C
- $10^{7,5}$ softening point - Littleton point (ISO 7884--6) ..... 820 °C
- $10^{13,2}$ upper cooling temperature (ISO 7884-7) ..... 560 °C
- $10^{14,7}$ lower cooling temperature (ISO 7884-7) ..... 510 °C

Transformation temperature (ISO 7884-8) .....525 °C
Modulus of elasticity E .....64×10^3 MPa
Poisson constant 0,20
Tensile strength R .....35 to 100 MPa

Viscosity is also an important property of glass, and is significant in all stages of glass production and working. It also affects electrical properties through its effect on the mobility of ions.

SIMAX glass is counted among viscously “shorter” glasses, i.e. it has a relatively narrow temperature range for working.

Mechanical stability of SIMAX glass

The mechanical properties and service life of products made from SIMAX glass are largely determined by the condition of the surface, especially its integrity, i.e. the depth of damage to the surface in handling and secondary heat treatment.

Scratch hardness of glass on Mohs scale 6

Allowable tensile stress .....3,5 MPa
Allowable bending stress .....7 MPa
Allowable compressive stress .....100 MPa

Thermal Properties of SIMAX Glass

The high resistance of products made from SIMAX glass to sudden changes of temperature - their heat resistance - is due to a low coefficient of linear thermal expansion, a relatively low modulus of tensile elasticity E and relatively high thermal conductivity.

When the glass product is heated or cooled, unwanted internal stress arises. Breaking on rapid cooling of the product occurs when the unwanted internal stress exceeds the allowable limit. Values of resistance to thermal shock (∆ °C) for Simax glass products are shown in the following table against the thickness of the wall.

Wall thickness (mm) Resistance to thermal shock (∆°C)

1	303
3	175
6	124
10	96

Cooling of SIMAX glass

Cooling is a thermal process whose purpose is to prevent unwanted and unacceptable thermal stress from appearing in the glass, which would weaken the product, or to remove stress which is already present.

The cooling cycle consists of three stages:

Temperature increase (heating of the product) at a given heating rate from the initial temperature to the upper cooling temperature.

Maintenance of temperature (hold, tempering, stabilisation) - the product is kept at the upper cooling temperature for some time while the temperature differences within the product equalise and stress decreases to an acceptable level.

Temperature decrease (initial and final cooling) at a given cooling rate from the upper cooling temperature to the lower cooling temperature (this stage is important, as permanent stress may arise) and from the lower cooling temperature to a final temperature or to the ambient temperature (important for subsequent practical handling of the product).

A specific cooling cycle is shown in the table

Temperature Ranges
Temperature increase hold decrease
Max. wall thickness 20 -- 550 °C 560 °C 560 -- 490 °C 490 -- 440 °C 440 -- 40 °C
3 mm 140 °C/min 5 °C/min 14 °C/min 28 °C/min 140 °C/min
6 mm 30 10 3 6 30
9 mm 15 18 1,5 3 15
12 mm 8 30 0,6 1,6 8

Optical Properties of SIMAX Glass

Simax glass is transparent and colourless and does not show significant absorption in the visible spectrum. Its transmittance at ultraviolet wavelengths allows products to be used for photochemical reactions.

Refractive index of Simax glass (l = 589,30 nm) n_d 1,472
Photoelastic constant B $3{,}6.10^{-6}$ MPa^{-1}.

The optical transmittance of SIMAX glass in the visible area of the spectrum is between 90 and 92% for a wall thickness of 3 mm, and is shown in the following graph.

Electrical Properties of SIMAX Glass

SIMAX glass is non-conductive at normal temperatures - it is an insulator.

Electrical resistivity in a humidity-free environment (20 °C)	greater than 10^{13}- 10^{15} W× cm
Permitivity e (20 °C, 1 MHz)	4,6
Loss angle tg d	4,9 × 10^{-3}

Dielectric losses rise sharply with increasing temperature and change with frequency.

Standard tolerance of dimensional parameters of tubes, rods and capillary tubes SIMAX

Lengths and the end treatment

Tubes - outside diameter	*length*	*end treatment*
4 mm ≤ Ø ≤ 7 mm	1500 ± 20 mm	cut only
7 mm < Ø ≤ 10 mm	1500 ± 10 mm	cut only
10 mm < Ø ≤ 48 mm	1500 ± 10 mm	trimmed and glazed
48 mm < Ø ≤ 150 mm	1500 ± 5 mm	trimmed and glazed
Capillary tubes and rods		
3 mm ≤ Ø ≤ 7 mm	1500 ± 20 mm	cut only
8 mm < Ø ≤ 17 mm	1500 ± 10 mm	cut only
18 mm < Ø ≤ 30 mm	1500 ± 30 mm	cut only

Special lengths of tubes in range of 1000-3000 mm can be delivered on demand in dependence on outside diameter.

Tubes cut in special way in length of 15-3500 mm can be delivered in dependence on outside diameter.

Out-of-roundness
Out-of-roundness of tubes, rods and capillary tubes is related to outside diameter.

Tubes
In any place of tube there the difference of maximum and minimum diameter must not exceed 2 % of nominal outside diameter.

Rods and capillary tubes
In any place of rod or capillary tube there the difference of maximum and minimum diameter must not exceed 3 % of nominal outside diameter.

Siding
Siding in any place of the tube cut must not exceed the values as follows:
- 25 % of nominal wall thickness for the thin-wall tubes
- 15 % of nominal wall thickness for the medium and thick wall tubes medium wall thickness or these thick-wall ones

Deflection
The tube deflection is related to nominal length L = 1500 mm

Tubes

Ø ≤ 6 mm	0,6 % of the tube length
6 mm ≤ Ø ≤ 10 mm	0,4 % of the tube length
10 mm < Ø ≤ 150 mm	0,3 % of the tube length

Rods and capillary tubes

Ø ≤ 6 mm	0,6 % of the tube length
6 mm ≤ Ø ≤ 16 mm	0,5 % of the tube length
16 mm < Ø ≤ 30 mm	0,15 % of the tube length

Stones

For tubes with outside diameter of 4 - 20 mm incl. are allowed the following dimensions and numbers of stones in 1 kg of glass :

Ø < 0,3 mm	allowed
0,3 mm ≤ Ø ≤ 1 mm	4 pieces in maximum per 1 kg of glass
1 mm < Ø ≤ 2 mm	2 pieces in maximum per 1 kg of glass

For tubes with outside diameter over 20 mm are allowed the following dimensions and numbers of stones in 1 kg of glass :

Ø < 0,3 mm	allowed
0,3 mm ≤ Ø ≤ 1 mm	2 pieces in maximum per 1 kg of glass
1 mm < Ø ≤ 2 mm	1 piece in maximum per 1 kg of glass

For rods and capillary tubes are allowed the following dimensions and number of stones in 1 piece of product with length of 1 500 mm :

Ø < 0,3 mm	allowed
0,3 mm ≤ Ø ≤ 1,0 mm	3 pieces in maximum per 1 piece of tube Ø < 24 mm
0,3 mm < Ø ≤ 1,0 mm	4 pieces in maximum per 1 piece of tube Ø ≥ 24 mm

Knots, stringy knots

Tubes

Ø < 0,3 mm	allowed
0,3 mm ≤ Ø ≤ 1,0 mm	4 pieces in maximum per 1 kg of glass
1,0 mm < Ø ≤ 3,0 mm	2 pieces in maximum per 1 kg of glass

Rods and capillary tubes

Ø < 0,3 mm	allowed
0,3 mm ≤ Ø ≤ 1,5 mm	3 pieces in maximum per 1 piece of tube or rod Ø < 24 mm
0,3 mm < Ø ≤ 1,5 mm	4 pieces in maximum per 1 piece of tube or rod Ø ≥ 24 mm

Capillary bubbles

Capillary bubbles to length ≤ are allowed.

Total length of capillary bubbles with length > 20 mm is allowed in maximum 1,5 m per 10 m of the tube length.

Width of capillary bubbles is allowed:

for tubes 4 mm ≤ Ø ≤ 40 mm	max. 0,2 mm
for tubes Ø > 40 mm	max. 0,7 mm
for rods and capillary tubes	max. 0,3 mm

Notes

- Tubes up to Ø 43 mm are delivered in the not cooled stage, if it is not agreed in other way.
- Tubes of Ø 44 mm and bigger are standardly delivered in the cooled stage.
- Rods and capillary tubes are delivered in the not cooled stage, if it is not agreed in other way.
- If it is not agreed with customer in other way, tubes of outside diameter 8 – 40 mm are protected on surface with PE cover to increase their resistance against scratches.
- In additional to the standard forms of profiled tubes mentioned in catalogue it is possible to ask for other forms of profiled tubes.