



**KAVALIER**

# TUBING, RODS, CAPILLARIES

RÖHREN, STÄBE, KAPILLAREN | TRUBICE, TYČE, KAPILÁRY

**SIMAX**<sup>®</sup>  
Glass that Lasts



## **SIMAX** GLASS THAT CONQUERS THE ELEMENTS

In the beginning there was the darkness. Then came the light. And it produced opposites:

**FIRE** – red and raw, whose power was the key to the emergence of one of the most significant discoveries of all times – glass... and its opposite, frosty, solid and clean **ICE**. These elements create a harmonious combination, the perfect opposites which are also enemies who fight for life and death... the winner of the collision between these elements is the durable SIMAX glass, which will endure the fiercest heat of fire and the ruthless cold and hardness of ice.

**SIMAX – the glass that can tame the elements.**

## **SIMAX** - GLAS EROBERT DIE ELEMENTE

Am Anfang war die Dunkelheit. Dann kam das Licht. Es gestaltete Gegensätze:

**FEUER** – rot und glühend, dessen Kraft war der Schlüssel eines der bedeutendsten Entdeckungen aller Zeiten – Glas... und dessen Gegensatz frostig, stabil und klar – **EIS**. Diese Elemente bilden eine harmonische Kombination, die perfekten Gegensätze, welche gleichzeitig Feinde sind und um Leben und Tod kämpfen... der Gewinner dieses Zusammenpralls der Elemente ist das beständige SIMAX-Glas, welches die heftige Hitze des Feuers und die unbarmherzige Kälte und Härte des Eises aushält.

**SIMAX – das Glas, welches die Elemente zähmen kann.**

## **SIMAX** SKLO KTERÉ ZKROTÍ ŽIVLY

Na počátku byla temnota. Potom přišlo světlo. A s ním se zrodily protiklady

**OHĚŇ** – rudý a surový, jehož síla byla stěžejní při vzniku jednoho z nejvýznamnějších objevů všech dob – skla... a jeho opak mrazivý, pevný, čistý **LED**. Tyto živly vytvářejí ve spojení harmonický celek, jsou dokonalé protiklady, zároveň nepřátelé, kteří bojují na život a na smrt... vítězem střetu těchto živlů je odolné sklo SIMAX, které vydrží energický a silný žár ohně i nemilosrdný chlad a tvrdost ledu.

**SIMAX – sklo které dokáže zkrotit živly.**



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*Dear Business Partners*

*in your hands, you are holding our new company catalog Kavalierglass, a.s., that was founded in 1837 by František Kavalír. The factory has the longest-running tradition in the field of technical glass production in Europe.*

*Kavalierglass, a.s. is one of the world's leading manufacturers of borosilicate glass, type 3.3, you can find a large number of proven and desirable products sold under the brand name SIMAX in the catalogue.*

*SIMAX, with its chemical composition and glass properties, fully meets the requirements specified in the International Standard ISO 3585. SIMAX glass products excel in their thermal and chemical resistance, they have a smooth and non-porous surface, are perfectly transparent, catalytically neutral and corrosion-resistant even in long-term operations and sufficiently homogeneous. SIMAX glass is environmentally friendly.*

*Kavalierglass, a.s. is a holder of a quality management system certificate according to the international ISO 9001 standard, demonstrating a high level of quality assurance in the production and supply of laboratory glassware, household glass, tubing and apparatus from SIMAX.*

*The goal of the company is to continue to offer products and services that will fully satisfy the needs of yours as well as your customers. And the new catalog will become the best source of all the necessary information and product details.*

*Kavalierglass, a.s. means years of proven quality, built on considerable experience.*

**your Kavalierglass, a.s.  
www.kavalier.cz**



**KAVALIER**

*Sehr geehrte Geschäftspartner,*

*in Ihren Händen halten Sie einen neuen Katalog der Firma Kavalierglass, a.s., eine Fabrik mit der ältesten Tradition in Europa auf dem Gebiet der technischen Glasproduktion. Sie wurde 1837 von František Kavalír gegründet.*

*Kavalierglass, a.s. ist einer der weltweit führenden Hersteller von Borosilikatglas, Typ 3.3 und unter dem Markennamen SIMAX finden Sie im Katalog eine Vielzahl bewährter und begehrter Produkte.*

*SIMAX erfüllt mit seiner chemischen Zusammensetzung und seinen Glaseigenschaften die Anforderungen der internationalen Norm ISO 3585. SIMAX-Glas-Produkte zeichnen sich durch ihre thermische und chemische Beständigkeit aus, sie haben eine glatte und porenfreie Oberfläche, sind vollkommen transparent, katalytisch neutral und korrosionsbeständig auch im Langzeitbetrieb und ausreichend homogen. Das Glas SIMAX ist umweltfreundlich.*

*Kavalierglass, a.s. ist Inhaber eines Zertifikats des Qualitätsmanagementsystem nach der internationalen Norm ISO 9001, dass ein hohes Maß an Qualitätssicherung bei der Herstellung und Lieferung von Laborglas und Haushaltsglas, Schläuchen und Apparaten aus SIMAX Glas belegt.*

*Das Ziel des Unternehmens ist es, weiterhin Produkte und Dienstleistungen anzubieten, die sowohl Ihren Bedürfnissen als auch Ihren Kunden gerecht werden. Der neue Katalog ist die beste Quelle für alle notwendigen Informationen und Produktdetails.*

*Kavalierglass, a.s. bedeutet jahrelang erprobte Qualität, auf viel Erfahrung aufgebaut.*

Ihr Kavalierglass, a.s.  
[www.kavalier.cz](http://www.kavalier.cz)

*Vážený obchodní partneri,*

*ve svých rukách držíte nový katalog společnosti Kavalierglass, a.s., která byla založena roku 1837 Františkem Kavalírem a je továrnou s nejdelsí tradicí v Evropě v oblasti výroby technického skla.*

*Kavalierglass, a.s. patří k nejvýznamnějším světovým výrobcům borosilikátového skla, typu 3.3, a v katalogu naleznete značné množství osvědčených a žádaných produktů, jenž se prodávají pod obchodní značkou SIMAX.*

*Svým chemickým složením a vlastnostmi sklo SIMAX plně odpovídá požadavkům specifikovaným v mezinárodním standardu ISO 3585. Výrobky ze skla SIMAX vynikají svou tepelnou a chemickou odolností, mají hladký a neporézní povrch, jsou dokonale průhledné, katalyticky neutrální a odolné proti korozi i při dlouhodobých operacích a dostatečně homogenní. SIMAX je šetrný k životnímu prostředí a je z ekologického hlediska zcela nezávadný.*

*Sklárny Kavalierglass, a.s. jsou držiteli certifikátu pro systém managementu kvality dle mezinárodní normy ISO 9001, čímž dokazují vysokou úroveň v zajišťování kvality výroby a dodávek laboratorního a domáckého skla, aparatur a trubic ze skla SIMAX.*

*Cílem společnosti je Vám i nadále nabízet takové výrobky a služby, které zcela uspokojí požadavky nejen Vaše, ale i Vašich zákazníků a nový katalog se pro Vás stane maximálně přehledným zdrojem všech potřebných informací a produktových detailů.*

*Kavalierglass, a.s. totiž znamená léty prověřenou kvalitu, vybudovanou na letitých zkušenostech.*

Váš Kavalierglass, a.s.  
[www.kavalier.cz](http://www.kavalier.cz)

# 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 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.



## CHEMICAL COMPOSITION OF SIMAX GLASS

(main components in percentage by weight)

SiO <sub>2</sub>	B <sub>2</sub> O <sub>3</sub>	Na <sub>2</sub> O + K <sub>2</sub> O	Al <sub>2</sub> O <sub>3</sub>
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 $\alpha$ (20 °C; 300 °C) according to ISO 7991	3,3 · 10 <sup>-6</sup> K <sup>-1</sup>
The transformational temperature T <sub>g</sub>	525 °C
The glass temperature at viscosity $\eta$ in dPa · s : 10 <sup>13</sup> (upper cooling temperature)	560 °C
The glass temperature at viscosity $\eta$ in dPa · s : 10 <sup>7,6</sup> (softening temperature)	825 °C
The glass temperature at viscosity $\eta$ in dPa · s : 10 <sup>4</sup> (working temperature)	1260 °C
The highest short-term admissible working temperature	500 °C
The density $\rho$ at 20 °C	2,23 g · cm <sup>-3</sup>
Modulus of elasticity (Young's modulus)	64 · 10 <sup>3</sup> MPa
The Poisson ratio $\mu$	0,20
The thermal conductivity $\lambda$ (20 °C to 100 °C)	1,2 W · m <sup>-1</sup> · K <sup>-1</sup>
The temperature for specific electrical resistance 108 $\Omega \cdot \text{cm}$ (DIN 52326) t <sub>k100</sub>	250 °C
The logarithm of electrical bulk resistivity ( $\Omega \cdot \text{cm}$ ) at 250 °C	8
The logarithm of electrical bulk resistivity ( $\Omega \cdot \text{cm}$ ) at 350 °C	6,5
The dielectric properties (1 MHz, 25 °C)	
The permittivity $\epsilon$	4,6
The dielectric loss factor tan $\delta$	37 · 10 <sup>-4</sup>
The refractive index ( $\lambda = 589,26 \text{ nm}$ ) n <sub>D</sub>	1,4723
The photoelastic constant (DIN 52314) K	4,0 · 10 <sup>-6</sup> mm <sup>2</sup> · N <sup>-1</sup>

## 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 . mm<sup>2</sup>*

SIMAX borosilicate glass 3.3 admissible stress:  $K/S = 7 \text{ N} \cdot \text{mm}^2$  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

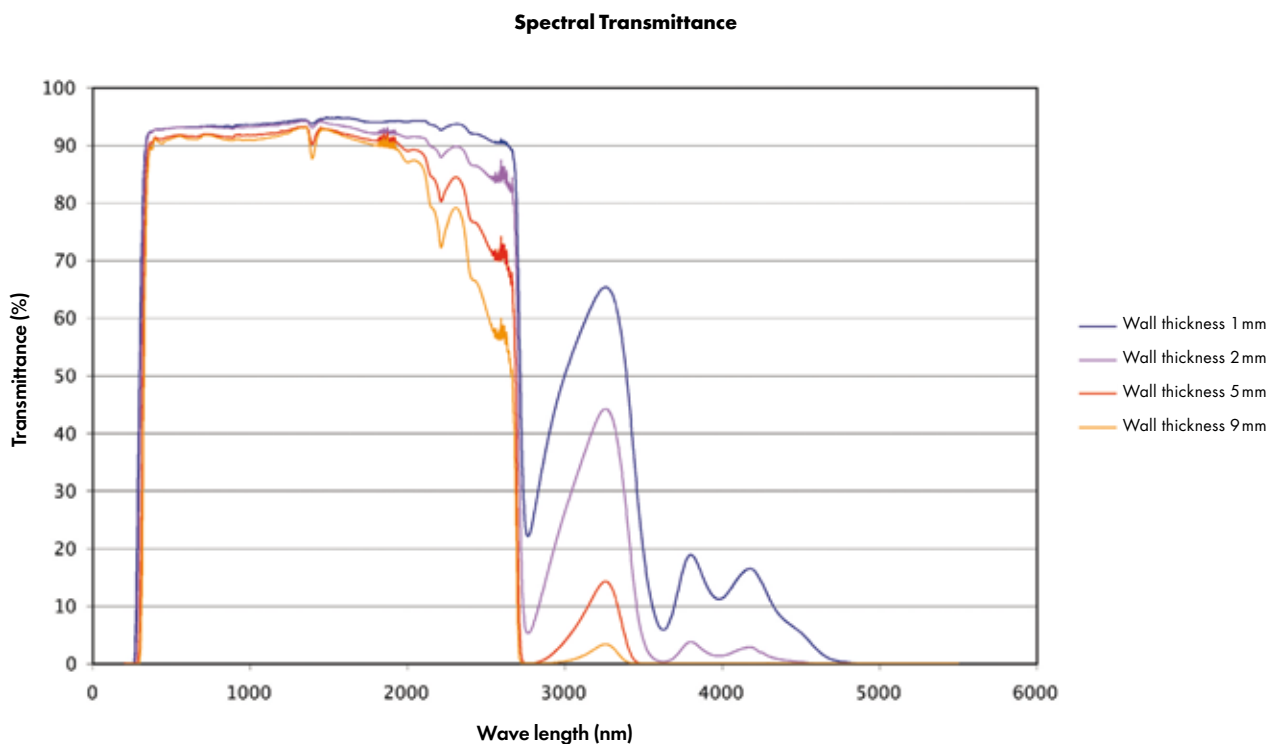
*The manufacturer may perform an exact calculation, where necessary.*

**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, Tubing and Pipe Fittings. Tubing and Pipe Fittings with a Nominal Diameter of DN 1.5 to 1000. Compatibility and Interchangeability.



## LIGHT TRANSMITTANCE



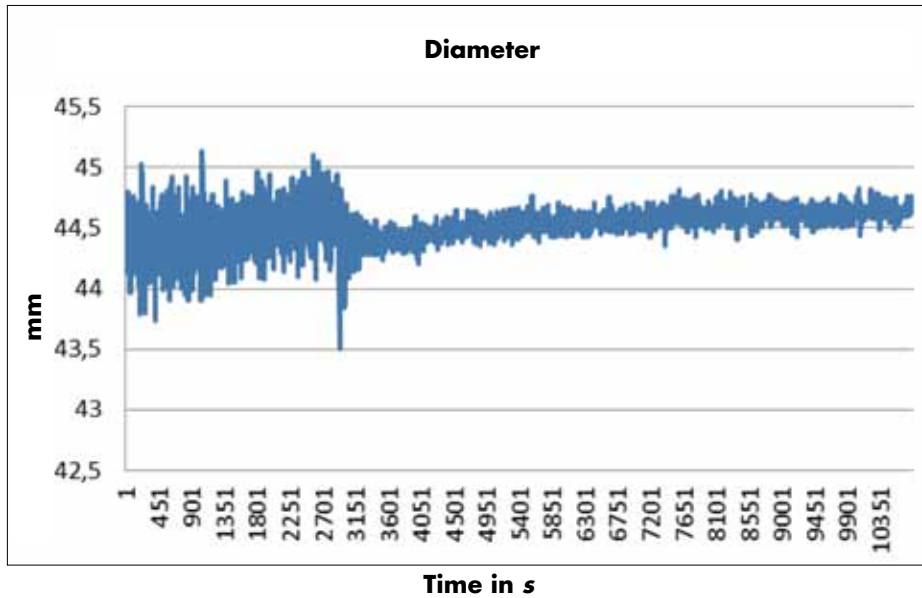
## PROCESSING AND COOLING

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	$\varnothing < 250$ mm	$s_{\max}$ 0,7% of the outside diameter
Capillary	$\varnothing < 20$ mm	$s_{\max}$ 1,0% of the outside diameter
	$20 \text{ mm} \leq \varnothing \leq 40$	$s_{\max}$ 1,5% of the outside diameter
Rod	$\varnothing < 20$ mm	$s_{\max}$ 1,0% of the outside diameter
	$20 \text{ mm} \leq \varnothing \leq 45$	$s_{\max}$ 1,5% of the outside diameter