

Glass

Types

Physical and
chemical properties

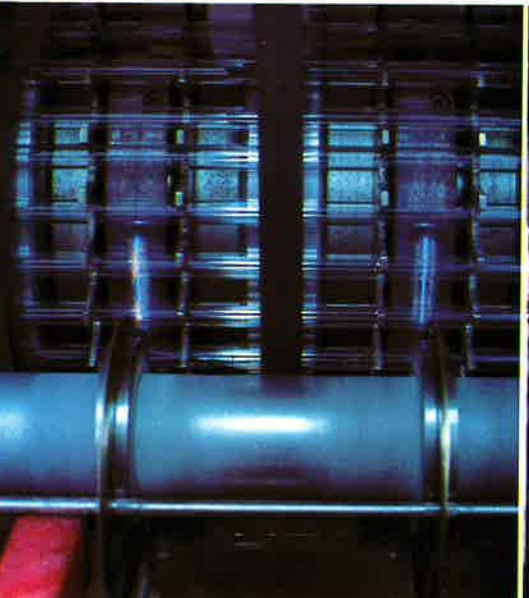
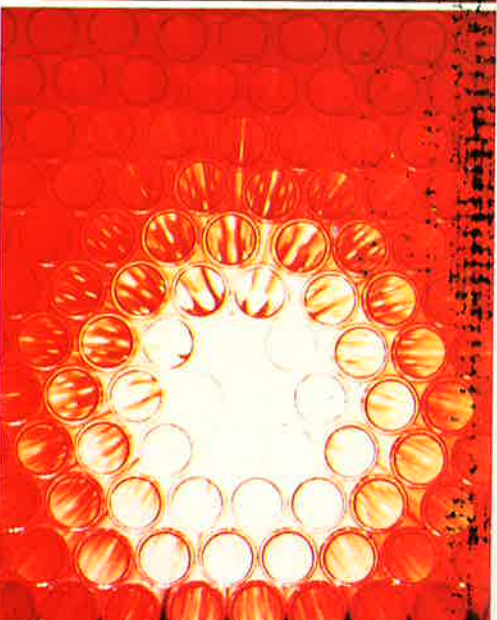
Sealing properties

Application

Modes of supply

OSRAM

Glasses



Glass

For many years OSRAM has manufactured a large number of different types of glass and has acquired great knowledge and experience in their manufacture and processing.

Glass is manufactured as tubing, rods and hollow vessels (bulbs) which are used as envelopes and seals for incandescent and discharge lamps, radio valves, parts of television tubes, etc.

Mass production, especially of lamps, requires rational manufacturing processes and glass products of the highest precision. Constant quality testing guarantees these characteristics.

Our glass is melted in oil, gas or electrically fired tanks or small furnaces. The flexibility of the manufacturing methods and their economical optimization are of great advantage to the user of these products.

The many types of lamps manufactured by OSRAM require glass with various geometrical shapes and properties. These types of glass must meet the requirements of the many different types of lamps manufactured by us and in addition must be suitable for many other purposes.

Our glass is available as the following:
machine-drawn tubings and rods;
all types of precut rods;
mouth-blown bulbs of various sizes;
bulbs made of tubing (pigmy bulbs);
parts made of sintered glass can be manufactured upon application;
tubing and rods of quartz glass OVISIL®.

The various types of glass available are divided into glass with the following properties:
glass with differing thermal expansion coefficients for sealing to other glasses, metals, ceramics or intermediate glass for sealing to quartz glass, e.g. OVISIL®;

glass suitable to withstand changing temperatures;
glass with high specific resistivity and adapted to dielectric values;
glass with sufficient resistance against metal vapours and other chemical influences through water, acids and lyes;
glass with increased or decreased transmission in the visible and invisible spectral range.

Our specializes in the manufacture of glass with special properties, therefore most demands from our customers can be met.

Glass

Summary of types

Glass 125

Glass 125 is a lead glass containing 22% PbO which softens at relatively low temperature levels. It has good sealing properties with metals having a similar thermal expansion coefficient. Because of its electrical insulation properties it is generally suitable for electrotechnical as well as high-frequency technical applications. It does not contain emitter poisons, e.g. arsenic or fluorine.

Glass 172

Glass 172 is a highly insulating leadoxide-free soft glass which is suitable for use in thermal and electrical high-load parts used in the electrotechnical industry. It can be used in place of Glass 125 if the lead content is not desired. It cannot be sealed, however, to copper-clad wire.

Glass 714

Glass 714 is a hard borosilicate glass. Its linear thermal expansion coefficient makes it suitable for sealing to tungsten. It is suitable also, however, for sealing to glass in the expansion coefficient range of $4.0-4.5 \times 10^{-6} \text{K}^{-1}$. Compared with soft glass Glass 714 offers a considerably higher thermal stress factor and better electrical insulation. Its chemical resistance against water is very high; against acids and lyes, however, it is relatively low.

Glass 905

Glass 905 is a soft soda glass with high alkaline contents, suitable for sealing to glass and metals having expansion coefficients in the range of $9-10 \times 10^{-6} \text{K}^{-1}$.

Glass 936

Glass 936 is a very soft borosilicate glass free of leadoxide with excellent electrical insulation properties. Its expansion coefficient makes it particularly suitable for certain iron-nickel-cobalt alloys as well as for sealing to molybdenum. Glass 936, however, is not capable to withstanding permanent high thermal loads and has a relatively low resistance against chemical influences.

Glass 937

Glass 937 is a borosilicate glass with excellent electrical insulation properties and is especially adapted to the expansion coefficient of molybdenum. It finds its application mainly in electrotechnical components which are subjected to high electrical and thermal loads.

Glass

Summary of types

OVISIL®

OVISIL® quartz glass consists up to 99.9% of silicic acid. It is a particularly viscous and hard glass. Its good optical transmission ranging from ultraviolet to close infrared in combination with its high transformation and softening temperatures as well its thermal stress factor make OVISIL® quartz glass more suitable for the manufacture of light sources subjected to high loads than any other type of material. OVISIL® quartz glass is able to withstand permanent loads of up to 1000° C provided its surface is free of impurities, especially alkaline compounds (e.g. perspiration from fingers) otherwise devitrification with consequent opaqueness and less mechanical strength can be expected.

Glass

Physical and chemical properties of glass

Linear expansion coefficient $\alpha_{20/300}$ [10^{-6}K^{-1}]

The values measured as per DIN 52328 between 20°C and 300°C show the suitability of the glass (with its behaviour in the transformation range) for its durable sealing to metals, ceramics and other glasses.

Poisson factor μ at room temperature

This factor shows the relative diameter decrease in relation to the relative linear expansion measured by the axial tensile load of an elastic rod. It is an important factor for the calculation of elastic behavior of glasses and of the thermal stress factor.

Young's modulus E [GPa] at room temperature

This factor is necessary for the conversion of strain to stress which occurs in glass-to-metal seals as well as for the calculation of the thermal stress factor.

Density ρ [g cm^{-3}] at room temperature

Measured at room temperature with tension-free samples having no blisters or flaws.

Thermal stress resistance $\Delta T_{\sigma 8}$ [K]

Shows the difference between the inside temperature and the outer surface temperature of a glass rod after the technically permissible tensile load of $\sigma = 8\text{N/mm}^2$. The higher the permissible temperature difference, the higher the thermal shock resistance of the glass.

Surface tension γ in the working range [mN/m]

Surface tension exists all flow processing stages of glass. It causes the spontaneous rounding of fractures during softening, the formation of drops during the heating of glass wires and the vacuum sealing of exhaust tubing after evacuation. Adhesion and wettability of glass on the surface of other materials are also related to the surface tension.

Transformation temperature t_g [°C]

as per the dilatometric method of DIN 52 324 at 5K/min heating rate.

Viscosity data η [dPas]

The dynamic viscosity of glass is shown with four characteristic values:

- a) at $10^{14,5}$ dPas (strainpoint per ASTM C 336)
- b) at 10^{13} dPas (annealingpoint per ASTM C 336)
- c) at $10^{7,6}$ dPas (softening point per ASTM C 338)
- d) at 10^4 dPas (working point per DIN 52 312)

They correspond with the viscosities during which

- a) stress in the glass is relieved within a few hours,
- b) stress in the glass is relieved within a few minutes,
- c) deformations become evident within a few minutes,
- d) many mechanical or manual processes can be carried out.

The values a-c are time-dependent, i.e. inbalanced values. Viscosity values in time-temperature balance are shown in the diagrams.

Glass

Physical and chemical properties glass

Electrical resistivity ρ_D in fluid state

For comparative calculations and as information for electrical melting processes this value in Ωcm is shown with a uniform viscosity of 10^3dPas . The measuring frequency is 4 kHz. A diagram shows the dependence of the electrical resistivity on the temperature throughout the complete range of application of glass.

Dielectric constant ϵ and dielectric loss factor $\text{tg } \delta$.

Both values are shown for $20^\circ\text{C}/300^\circ\text{C}$ and 10 MHz.

Stress-optical constant C ($10^{-6}\text{mm}^2/\text{N}$)

at room temperature and wavelength 540 nm. This gives the relative wavelength retardation in nm/cm with a sample load of $0,1\text{ N/mm}^2$.

Optical refraction coefficient n_D at room temperature

The refraction coefficient shown is for the yellow sodium lines.

Chemical resistance [class]

These values are determined as per

DIN 12 111 for water resistance (classes 1-5)

DIN 12 116 for acid resistance (classes 1-4)

DIN 52 322 for alkali resistance (classes 1-5)

Larger class-number signify increased solubilities.

Glass

Types

Glass 125

Glass 125 is a lead glass containing 22% PbO which softens at relatively low temperature levels. It has good sealing properties with metals having a similar thermal expansion coefficient. Because of its electrical insulation properties it is generally suitable for electrotechnical as well as high-frequency technical applications. It does not contain emitter poisons, e.g. arsenic or fluorine.

Physical and chemical properties

Linear coefficient of thermal expansion 20...300° C	[10 ⁻⁶ K ⁻¹]	9,8	Temperature [° C] at electrical resistivity	10 ¹² Ω cm	125
				10 ⁸ Ω cm \cong t_{K100}	280
				10 ⁴ Ω cm	554
Young's Modulus	[GPa]	62	electrical resistivity		
Poisson factor	[1]	0,22	at 10 ³ dPa · s viscosity	[Ω cm]	12,7
Density	[gcm ⁻³]	2,86	Dielectric constant	20° C [1]	–
			at 10 MHz and	300° C [1]	–
Thermal stress resistance for 8 N mm ⁻²	[K]	21	Dielectric loss factor	20° C [10 ⁻³]	–
			at 10 MHz and	300° C [10 ⁻³]	–
Surface tension	[mN · m ⁻¹]	239	stress-optical constant		
Transformation temperature	[° C]	435	at 540 nm	[10 ⁻⁶ mm ² N ⁻¹]	3,2
Temperature at 10 ^{14,5} (strain point)		388	Optical refraction		
viscosity [dPa · s] 10 ¹³ (annealing point)		429	coefficient at $\lambda = 587,6$ nm [1]		1,54
			Chemical	water	4
10 ^{7,6} (softening point) [° C]		635	solubility class	acid	2
10 ⁴ (working point)		1000	per DIN in	alkali	3

Sealing properties

Glass 125 can be sealed to

the following glass types: 123, 584, 904, 905, 914, 172 as well as other soft glasses e.g. bulb glass manufactured by Emgo, Lommel (Belgium)

copper-clad wire (F-wire) and certain iron-nickel alloys, e. g. Vacovit®480 and 485

other materials

In this case a prior test is recommended which can be carried out by our laboratories.

Glass

Types

Glass 125

Application:

Structural parts of incandescent- and fluorescent lamps equipped with copper-clad lead-in wires.

bulbs of miniature lamps, flashbulbs etc.

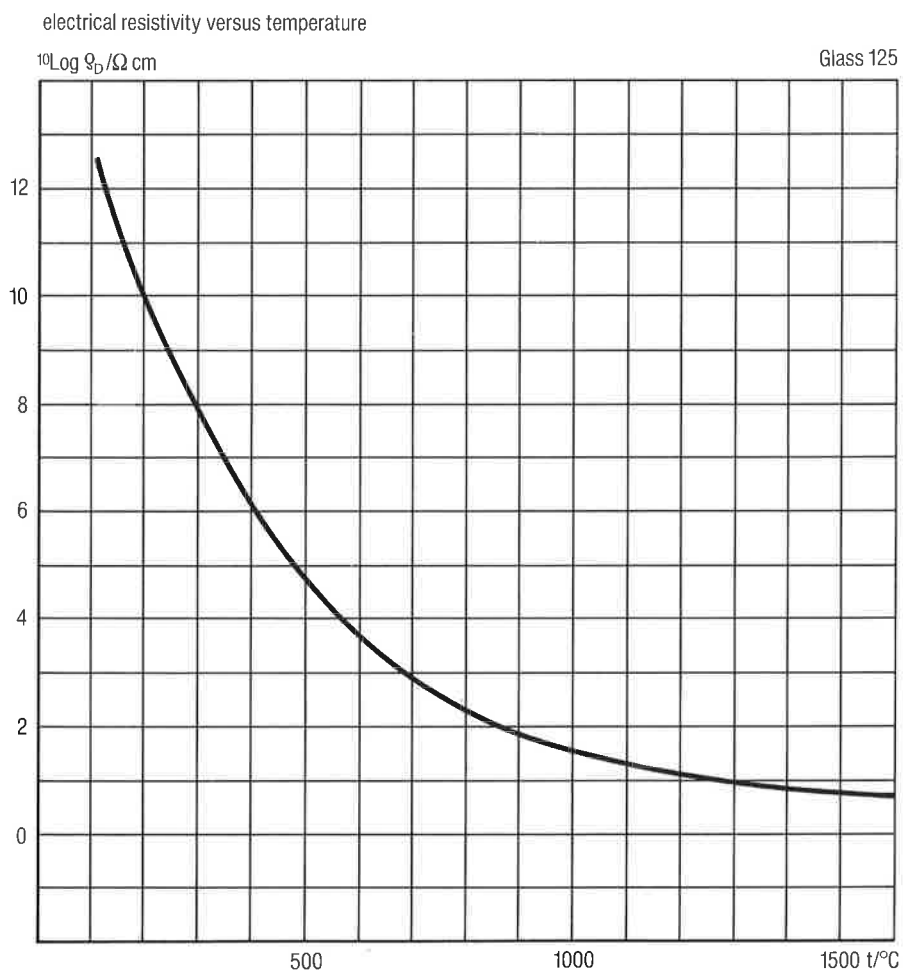
parts used by the radio and electronic industrie

Glass

Types

Glass 125

Curve of electrical resistivity as a function of temperature

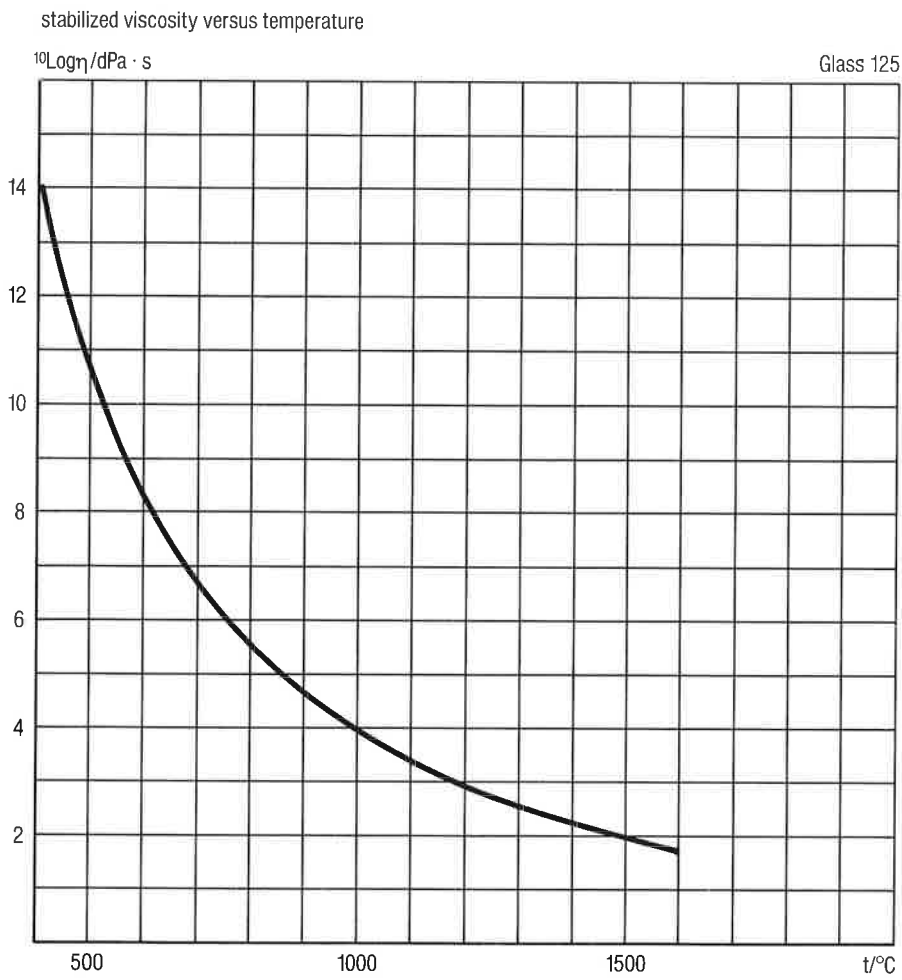


Glass

Types

Glass 125

Curve of stabilized viscosity as a function of temperature



Glass

Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 125						
Modes of supply						
Glass 125 is continuously melted in furnaces and is available as tubing, rods and sintered glass powder.						
The following dimensions are in constant supply.						
Table with unit lengths:						
1,9 - 2,2	± 0,10	0,45 - 0,60	± 0,05	1240	± 10	ends unfirepolished
2,2 - 2,8	± 0,10	0,45 - 0,80	± 0,05	1240	± 10	ends unfirepolished
2,8 - 3,8	± 0,10	0,45 - 1,00	± 0,05	1240	± 10	ends unfirepolished
3,8 - 6,0	± 0,10	0,45 - 1,10	± 0,05	1240	± 10	ends unfirepolished
6,0 - 8,0	± 0,15	0,55 - 0,95	± 0,05	1240	± 10	Delivery in assorted adjacent grades possible. Permissible tolerance 0,2 mm. Ends unfirepolished
		1,00 - 1,40	± 0,075	1240	± 10	
8,0 - 10,5	± 0,20	0,55 - 0,95	± 0,05	1240	± 10	Delivery in assorted adjacent grades possible. Permissible tolerance 0,3 mm. Ends firepolished
		1,00 - 1,40	± 0,075	1240	± 10	
10,5 - 15,0	± 0,25	0,60 - 1,10	± 0,05	1240	± 10	Delivery in assorted adjacent grades possible. Permissible tolerance 0,3 mm. Ends firepolished
		1,10 - 1,60	± 0,10	1240	± 10	
15,0 - 20,0	± 0,35	0,70 - 1,70	± 0,10	1240	± 10	Delivery in assorted adjacent grades possible. Permissible tolerance 0,5 mm. Ends firepolished
20,0 - 30,0	± 0,50	0,90 - 1,90	± 0,10	1240	± 10	Ends firepolished

Different dimensions and tolerances can be considered upon request.

Glass

Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 125						
Rods with unit lengths						
1,5 - 4,0	± 0,15			1240	± 10	ends unfirepolished
4,0 - 8,0	± 0,25			1240	± 10	ends unfirepolished
Precut tubing						
1,9 - 5,0	± 0,1	0,45 - 0,80	± 0,05	60/65/70/ 74/80/85/ 90/95/ 100/105/ 110/115/ 117/120/	± 0,5	ends firepolished
5,0 - 8,4	± 0,1	0,45 - 1,20	± 0,05	57/73/80	± 0,5	
8,8 - 9,2	± 0,1	0,60 - 0,70	± 0,05	41/	± 0,8	ends firepolished
11,2 - 11,7	± 0,15	0,60 - 0,70	± 0,05	57	± 0,8	ends firepolished
Precut rods						
2,2 - 4,0	± 0,15			14,0 - 60,0	± 0,5	ends unfirepolished
4,0 - 5,5	± 0,25			60,0 - 90,0	± 0,8	ends firepolished

Different dimensions and tolerances can be considered upon request.

Glass

Types

Glass 172

Glass 172 is a highly insulating leadoxide-free soft glass which is suitable for use in thermal and electrical high-load parts used in the electrotechnical industry. It can be used in place of Glass 125 if the lead content is not desired. It cannot be sealed, however, to copper-clad wire.

Physical and chemical properties

Linear coefficient of thermal expansion 20...300° C	[10 ⁻⁶ K ⁻¹]	10,7	Temperature [° C] at electrical resistivity	10 ¹² Ω cm	140
				10 ⁸ Ω cm \cong t _{K100}	300
				10 ⁴ Ω cm	602
Young's Modulus	[GPa]	68	electrical resistivity at 10 ³ dPa · s viscosity	[Ω cm]	6,9
Poisson factor	[1]	0,23	Dielectric constant	20° C [1]	6,0
Density	[gcm ⁻³]	2,56	at 10 MHz and	300° C [1]	6,8
Thermal stress resistance for 8 N mm ⁻²	[K]	17	Dielectric loss factor	20° C [10 ⁻³]	-
Surface tension	[mN · m ⁻¹]	285	at 10 MHz and	300° C [10 ⁻³]	-
Transformation temperature	[° C]	530	stress-optical constant at 540 nm	[10 ⁻⁶ mm ² N ⁻¹]	2,6
Temperature at 10 ^{14,5} (strain point)		482	Optical refraction coefficient at	$\lambda = 587,6$ nm [1]	1,52
viscosity [dPa · s] 10 ¹³ (annealing point)		523	Chemical solubility class per DIN in	water	4
10 ^{7,6} (softening point)	[° C]	710		acid	3
10 ⁴ (working point)		1042		alkali	2

Sealing properties:

Glass 172 can be sealed to:
glass types: 123, 125, 796, 905.

Application:

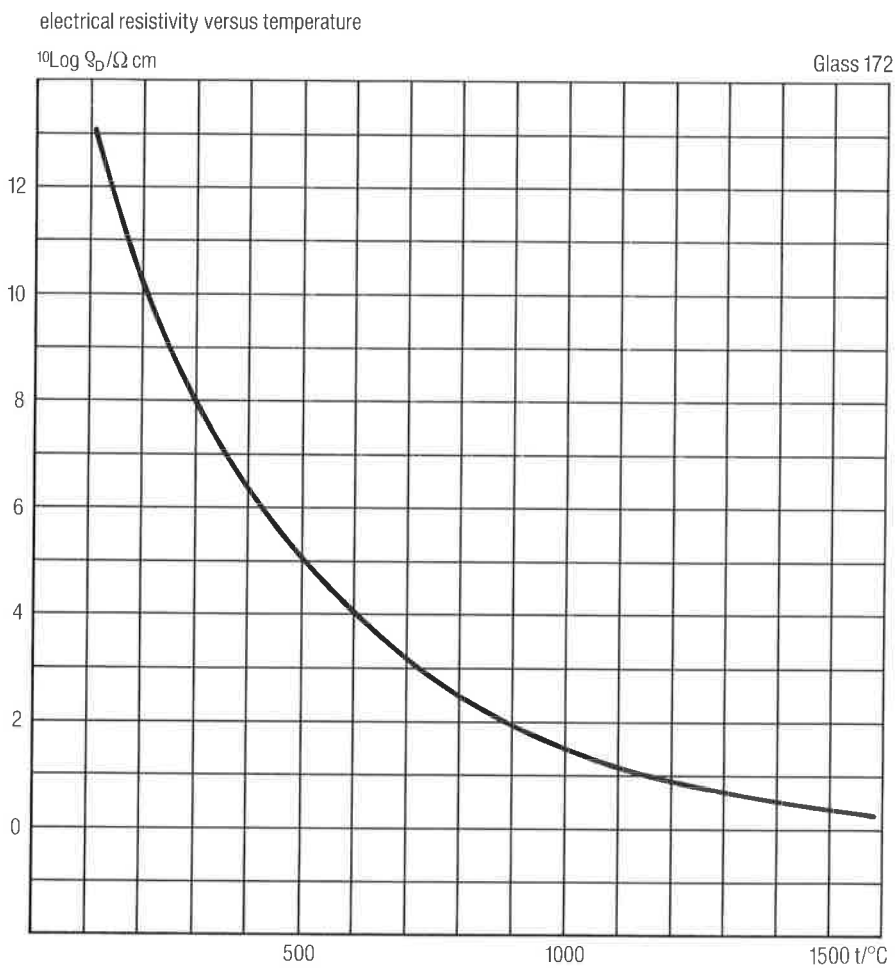
For the inner structures of lamps exposed to high loads.

Glass

Types

Glass 172

Curve of electrical resistivity as a function of temperature

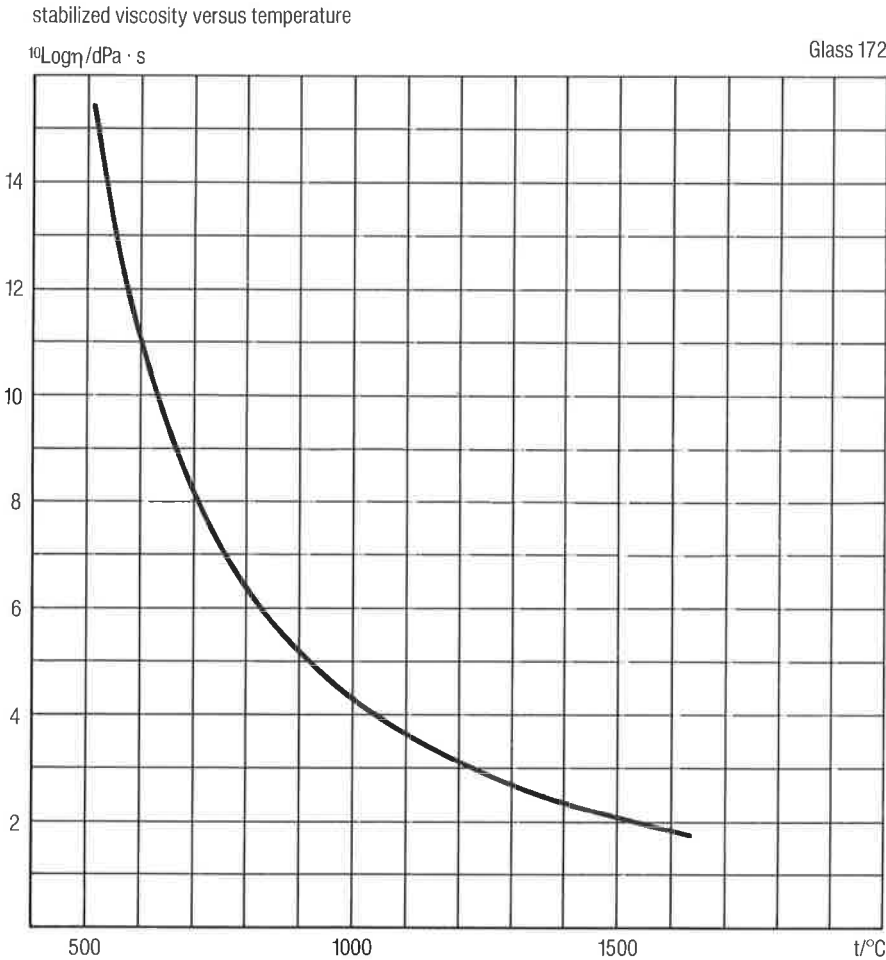


Glass

Types

Glass 172

Curve of stabilized viscosity as a function of temperature



Glass

Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 172						
Modes of supply						
Glass 172 is melted periodically and is available as tubing and rods with the following dimensions:						
Tubing with unit lengths						
3,0 - 4,0	± 0,1	0,5 - 0,7	± 0,1	1250	± 10	ends unfirepolished
4,0 - 6,0	± 0,15	0,5 - 1,2	± 0,15	1250	± 10	ends unfirepolished
6,0 - 10,0	± 0,25	0,7 - 1,3	± 0,15	1250	± 10	ends unfirepolished
10,0 - 14,0	± 0,35	0,9 - 1,8	± 0,2	1250	± 10	ends unfirepolished
14,0 - 20,0	± 0,5	1,2 - 1,8	± 0,25	1250	± 10	ends unfirepolished
20,0 - 28,0	± 1,0	1,4 - 2,0	± 0,35	1250	± 10	ends unfirepolished
Precut tubing						
3,0 - 4,0	± 0,1	0,5 - 0,7	± 0,10	60 - 90	± 0,5	ends unfirepolished
4,0 - 6,0	± 0,15	0,7 - 1,2	± 0,15	90 - 200	± 1,0	ends unfirepolished
Rods with unit lengths						
2,0 - 4,0	± 0,15			1250	± 10	ends unfirepolished
Precut rods						
2,0 - 4,0	± 0,15			14 - 60	± 0,4	ends unfirepolished
Different dimensions and tolerances can be considered upon request.						

Glass

Types

Glass 714

Glass 714 is a hard borosilicate glass. Its linear thermal expansion coefficient makes it suitable for sealing to tungsten. It is also suitable for sealing to glass in the expansion coefficient range of $4,0-4,5 \times 10^{-6} \text{K}^{-1}$. Compared with soft glass, Glass 714 offers considerably higher thermal stress factor and better electrical insulation. Its chemical resistance against water is very high; against acids and alkalies, however, it is relatively low.

Physical and chemical properties:

Linear coefficient of thermal expansion 20...300° C	[10^{-6}K^{-1}]	4,2	Temperature [° C] at electrical resistivity	$10^{12} \Omega \text{ cm}$ $10^8 \Omega \text{ cm} \triangleq t_{K100}$ $10^4 \Omega \text{ cm}$	116 317 715
Young's Modulus	[GPa]	61	electrical resistivity at $10^3 \text{ dPa} \cdot \text{s}$ viscosity	[$\Omega \text{ cm}$]	85
Poisson factor	[1]	0,19	Dielectric constant at 10 MHz and	20° C [1] 300° C [1]	- -
Density	[gcm^{-3}]	2,26	Dielectric loss factor at 10 MHz and	20° C [10 ⁻³] 300° C [10 ⁻³]	- -
Thermal stress resistance for 8 N mm^{-2}	[K]	51	stress-optical constant at 540 nm	[$10^{-6} \text{mm}^2 \text{N}^{-1}$]	3,9
Surface tension	[$\text{mN} \cdot \text{m}^{-1}$]	289	Optical refraction coefficient at	$\lambda = 587,6 \text{ nm}$ [1]	1,48
Transformation temperature	[° C]	540	Chemical solubility class per DIN in	water acid alkali	1 3 3
Temperature at viscosity [dPa · s]					
	$10^{14,5}$ (strain point)	500			
	10^{13} (annealing point)	545			
	$10^{7,6}$ (softening point)	[° C] 803			
	10^4 (working point)	1226			

Sealing properties:

Glass 714 can be sealed to:
glass types: 713, 742

tungsten and molybdenum wire with up to 0,4 mm diameter

Application:

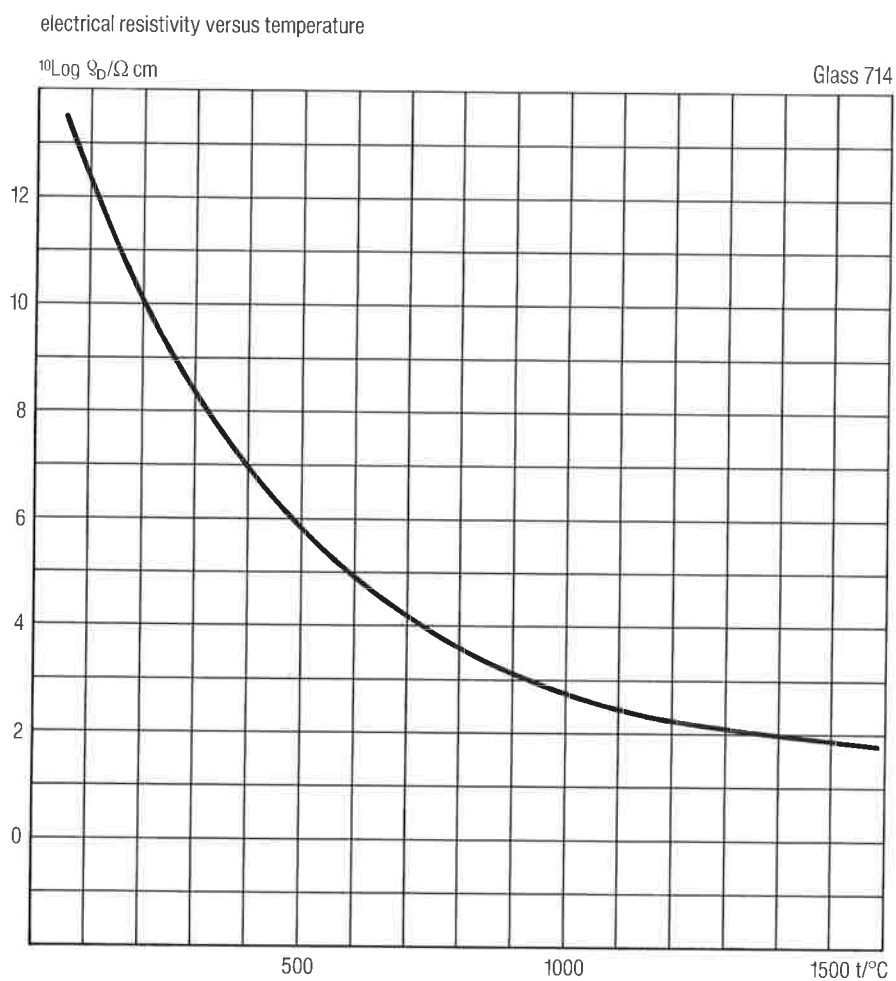
For the inner structures of lamps exposed to high electrical and thermal loads.

Glass

Types

Glass 714

Curve of electrical resistivity as a function of temperature

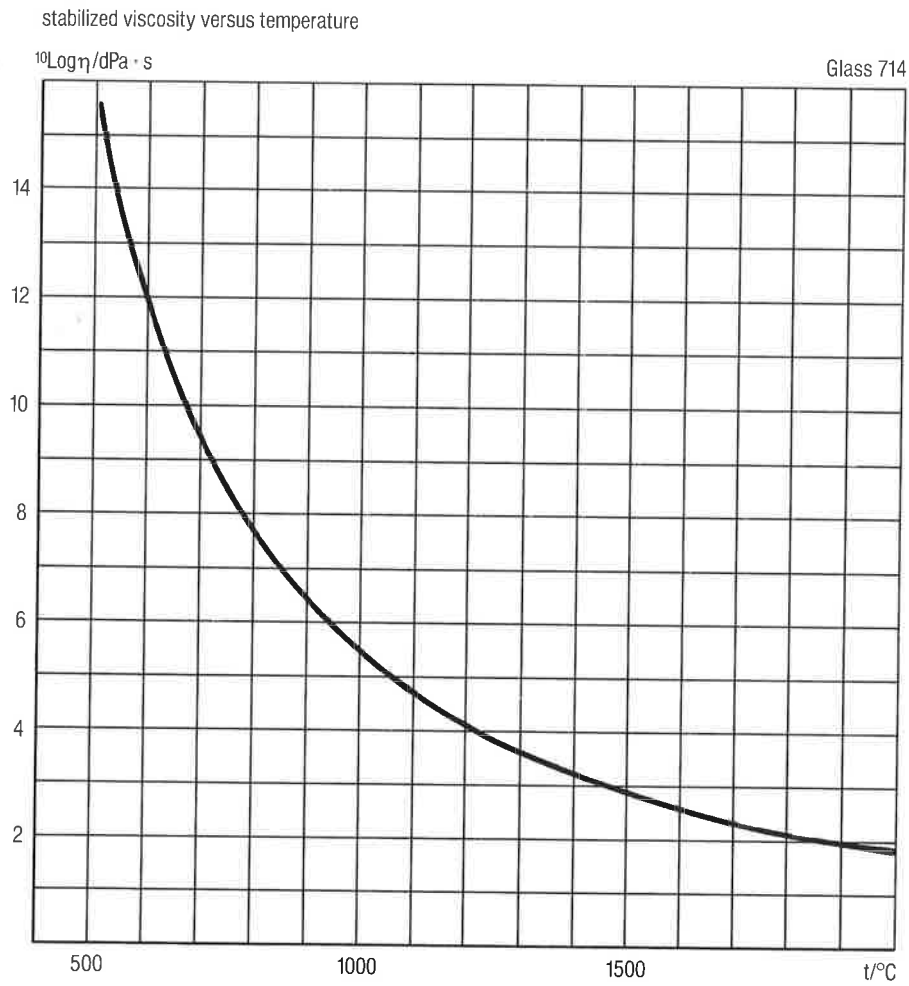


Glass

Types

Glass 714

Curve of stabilized viscosity as a function of temperature



Glass

Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 714						
Modes of supply:						
Glass 714 is melted periodically and is available as tubing and rods with the following dimensions:						
Tubing with unit lengths						
3,0 - 4,0	± 0,1	0,5 - 0,7	± 0,1	1250	± 10	ends unfirepolished
4,0 - 6,0	± 0,15	0,5 - 1,2	± 0,15	1250	± 10	ends unfirepolished
6,0 - 10,0	± 0,25	0,7 - 1,3	± 0,15	1250	± 10	ends unfirepolished
10,0 - 14,0	± 0,35	0,9 - 1,8	± 0,2	1250	± 10	ends unfirepolished
14,0 - 20,0	± 0,5	1,2 - 1,8	± 0,25	1250	± 10	ends unfirepolished
20,0 - 28,0	± 1,0	1,4 - 2,0	± 0,35	1250	± 10	ends unfirepolished
Precut tubing						
3,0 - 4,0	± 0,1	0,5 - 0,7	± 0,10	60 - 90	± 0,5	ends unfirepolished
4,0 - 6,0	± 0,15	0,7 - 1,2	± 0,15	90 - 200	± 1,0	ends unfirepolished
Rods with unit lengths						
4,0 - 5,8	± 0,2			1250	± 10	ends unfirepolished
Precut rods						
4,0 - 5,8	± 0,2			14 - 60	± 0,4	ends unfirepolished

Different dimensions and tolerances can be considered upon request.

Glass

Types

Glass 905

Glass 905 is a soft soda glass with high alkaline contents suitable for sealing to glass and metals having expansion coefficients in the range of $9-10 \times 10^{-6} \text{ K}^{-1}$.

Physical and chemical properties:

Linear coefficient of thermal expansion 20...300° C	[10 ⁻⁶ K ⁻¹]	10,2	Temperature [° C] at electrical resistivity	10 ¹² Ω cm	35
				10 ⁸ Ω cm $\cong \tau_{K100}$	130
				10 ⁴ Ω cm	450
Young's Modulus	[GPa]	70	electrical resistivity at 10 ³ dPa · s viscosity	[Ω cm]	6,7
Poisson factor	[1]	0,23	Dielectric constant	20° C [1]	6,0
Density	[gcm ⁻³]	2,48	at 10 MHz and	300° C [1]	7,7
Thermal stress resistance for 8 N mm ⁻²	[K]	17	Dielectric loss factor	20° C [10 ⁻³]	5
			at 10 MHz and	300° C [10 ⁻³]	130
Surface tension	[mN · m ⁻¹]	258	stress-optical constant at 540 nm	[10 ⁻⁶ mm ² N ⁻¹]	3,0
Transformation temperature	[° C]	505	Optical refraction coefficient at	$\lambda = 587,6 \text{ nm}$ [1]	1,51
Temperature at 10 ^{14,5} (strain point)		462	Chemical	water	4
viscosity [dPa · s] 10 ¹³ (annealing point)		504	solubility class	acid	1
10 ^{7,6} (softening point)	[° C]	700	per DIN in	alkali	2
10 ⁴ (working point)		1020			

Sealing properties:

Glass 905 can be sealed to:

glass types: 123, 125 as well as many other soft glasses;

copper-clad wire (F-wire) and certain iron-nickel alloys, e.g. Vacovit® 480 and 485.

Prior tests are recommended which can be carried out by our laboratories.

Application:

General purpose glass for the manufacture of bulbs for the electric lamp industry, especially tubular bulbs for fluorescent lamps (see Spectral transmission curve).

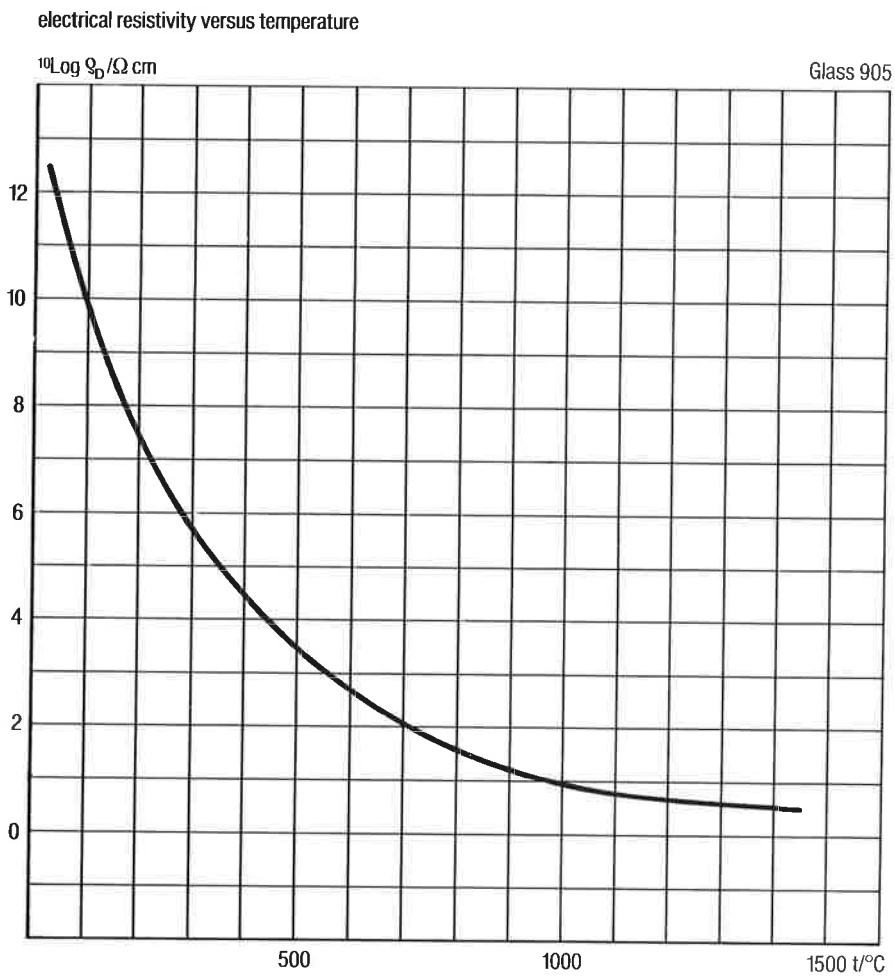
Like other soda glasses, Glass 905 is suitable also for the manufacture of technical and industrial glassware.

Glass

Types

Glass 905

Curve of electrical resistivity as a function of temperature



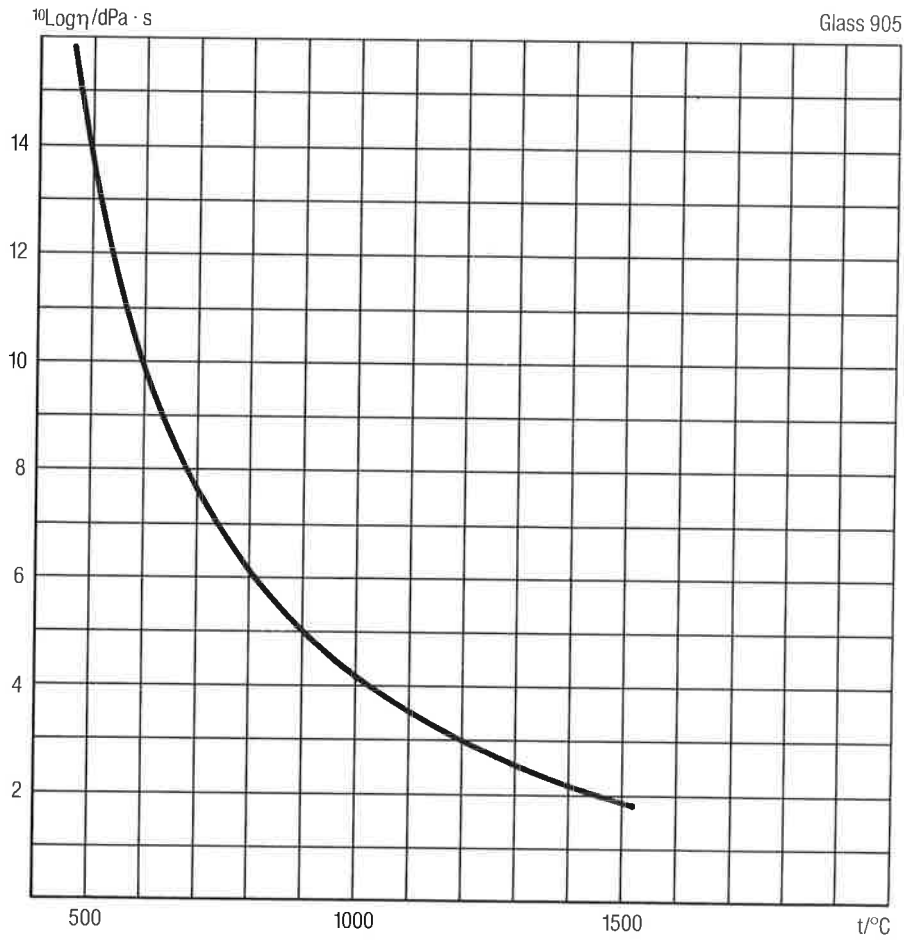
Glass

Types

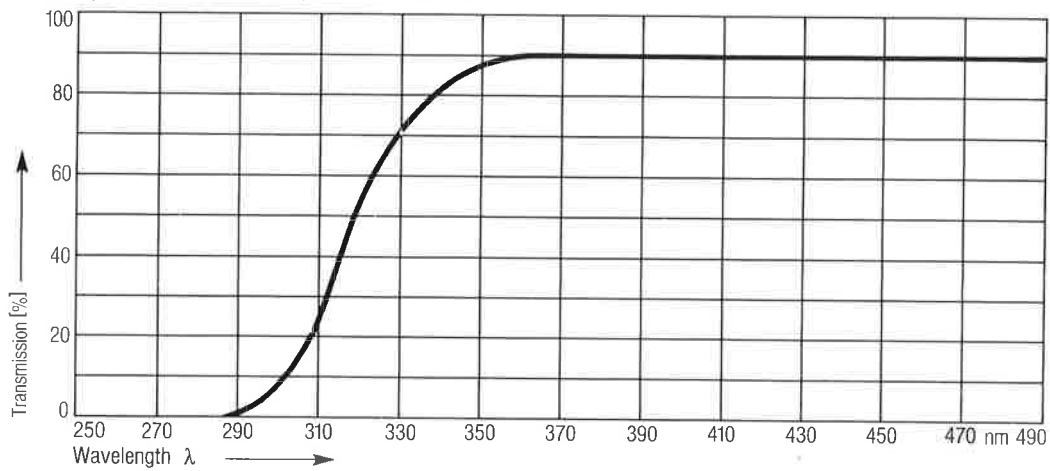
Glass 905

Curve of stabilized viscosity as a function of temperature

stabilized viscosity versus temperature



Spectral transmission for 0,8 mm wall thickness



Glass

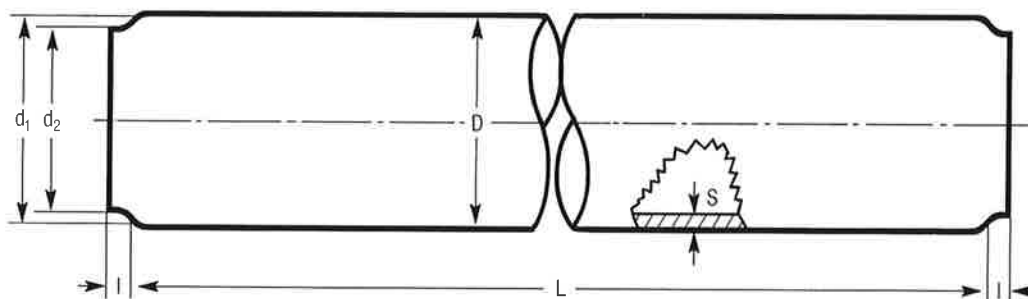
Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 905						
Modes of supply:						
Glass 905 is continuously melted in furnaces and is available as tubing and bulbs with the following dimensions:						
Tubing with unit lengths:						
12,0 - 22,0	± 0,25	0,50 - 0,90	± 0,05	1240	± 10	ends firepolished
		0,90 - 1,20	± 0,075	1500	± 10	ends firepolished
22,0 - 32,0	± 0,50	0,50 - 0,90	± 0,05	1240	± 10	ends firepolished
		0,90 - 1,20	± 0,075	1500	± 10	ends firepolished
32,0 - 40,0	± 0,65	0,70 - 2,00	± 0,10	1240	± 10	ends firepolished
				1500	± 10	ends firepolished
40,0 - 60,0	± 1,00	1,00 - 2,00	± 0,15	1240	± 10	ends firepolished
				1500	± 10	ends firepolished
Tubing for the manufacture of bulbs for fluorescent lamps						
25,0 - 26,0		0,75 - 0,90		500 - 1580	± 1,5	ends firepolished
25,0 - 26,0		1,05 - 1,20		500 - 1580	± 1,5	ends firepolished
31,4 - 32,4		0,90 - 1,05		500 - 1580	± 1,5	ends firepolished
36,2 - 37,5		0,70 - 0,84		500 - 1580	± 1,5	ends firepolished
36,5 - 38,1		0,76 - 0,90		500 - 1580	± 1,5	ends firepolished
36,7 - 38,0		1,50 - 1,65		500 - 1580	± 1,5	ends firepolished
Different dimensions and tolerances can be considered upon request.						

Glass

Types

D mm	S mm	L mm	l mm	d ₁ mm	d ₂ mm
Glass 905					
Tubular bulbs					
25,0 - 26,0	0,70 - 0,85	570,2 - 571,3	4,1 - 5,3	24,0	21,0 - 21,8
25,0 - 26,0	0,70 - 0,85	874,5 - 875,3	4,1 - 5,3	24,0	21,0 - 21,8
25,0 - 26,0	0,70 - 0,85	1178,1 - 1180,9	4,1 - 5,3	24,0	21,0 - 21,8
25,0 - 26,0	0,70 - 0,85	1478,7 - 1481,5	4,1 - 5,3	24,0	21,0 - 21,8
31,4 - 32,4	0,90 - 1,05	803,4 - 804,9 ¹⁾	3,0 - 4,5	–	23,4 - 24,2
31,4 - 32,4	0,90 - 1,05	1098,5 - 1100,0	3,0 - 4,5	–	23,4 - 24,2
36,2 - 37,5	0,70 - 0,84	416,7 - 417,5	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	569,8 - 570,6	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	720,4 - 721,2	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	949,9 - 950,7	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1027,2 - 1028,0	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1177,2 - 1178,0	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1179,4 - 1180,2	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1480,6 - 1481,4	4,1 - 5,3	35,0	30,9 - 31,7



1) Total length = $L + 2 \times l$

Glass

Types

Glass 936

Glass 936 is a very soft borosilicate glass free of leadoxide with excellent electrical insulation properties. Its expansion coefficient makes it particularly suitable for certain iron-nickel-cobalt alloys as well as for sealing to molybdenum. Glass 936, however, is not capable of withstanding permanent high thermal loads and has a relatively low resistance to chemical influences.

Physical and chemical properties:

Linear coefficient of thermal expansion 20...300° C	[10 ⁻⁶ K ⁻¹]	5,0	Temperature [° C] at electrical resistivity	10 ¹² Ω cm 10 ⁸ Ω cm $\hat{=}$ t _{K100} 10 ⁴ Ω cm	110 282 615
Young's Modulus	[GPa]	56	electrical resistivity at 10 ³ dPa · s viscosity	[Ω cm]	31
Poisson factor	[1]	0,20	Dielectric constant at 10 MHz and	20° C [1] 300° C [1]	- -
Density	[gcm ⁻³]	2.27	Dielectric loss factor at 10 MHz and	20° C [10 ⁻³] 300° C [10 ⁻³]	- -
Thermal stress resistance for 8 N mm ⁻²	[K]	46	stress-optical constant at 540 nm	[10 ⁻⁶ mm ² N ⁻¹]	4,3
Surface tension	[mN · m ⁻¹]	203	Optical refraction coefficient at	λ = 587,6 nm [1]	1,48
Transformation temperature	[° C]	475	Chemical solubility class per DIN in	water acid alkali	4 4 3
Temperature at 10 ^{14,5} (strain point)		440			
viscosity [dPa · s] 10 ¹³ (annealing point)		485			
10 ^{7,6} (softening point)	[° C]	710			
10 ⁴ (working point)		1084			

Sealing properties:

Glass 936 can be sealed to:

Vacon® 10

molybdenum wire

Application

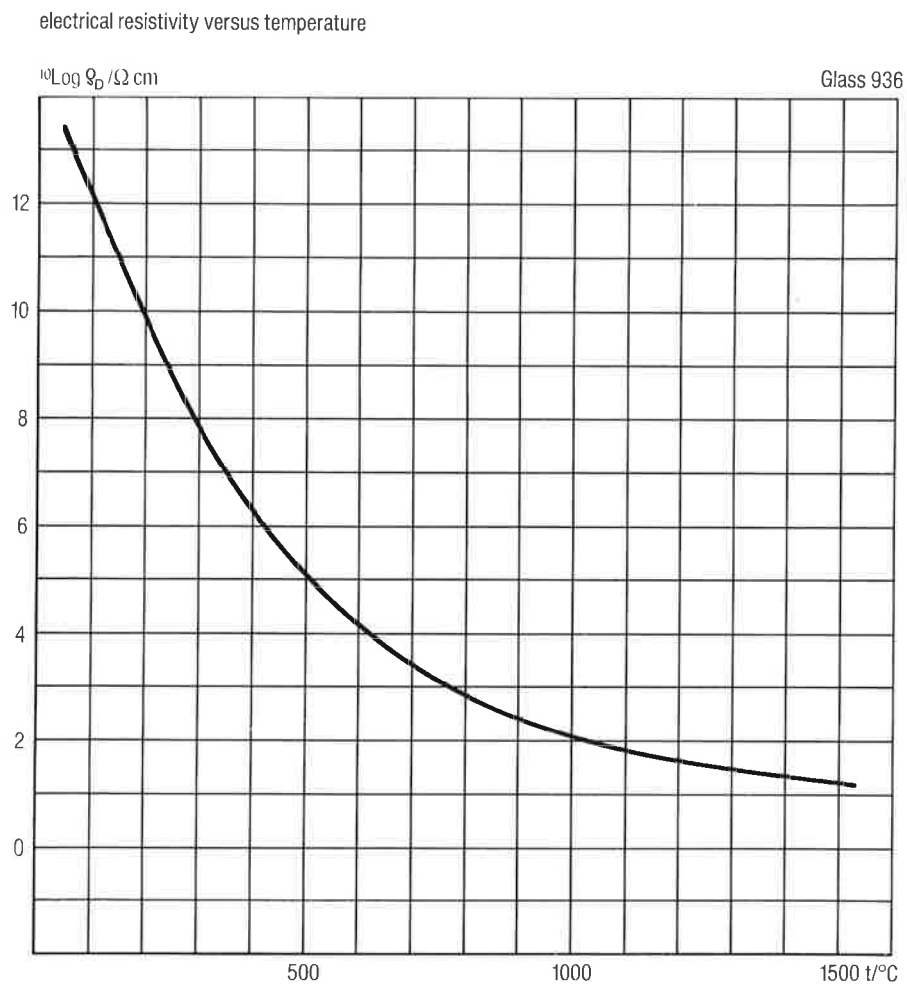
The special properties of Glass 936 allow the sealing, also for large and complicated components, to iron-nickel-cobalt alloys with Curie-temperatures below 500°C.

Glass

Types

Glass 936

Curve of electrical resistivity as a function of temperature

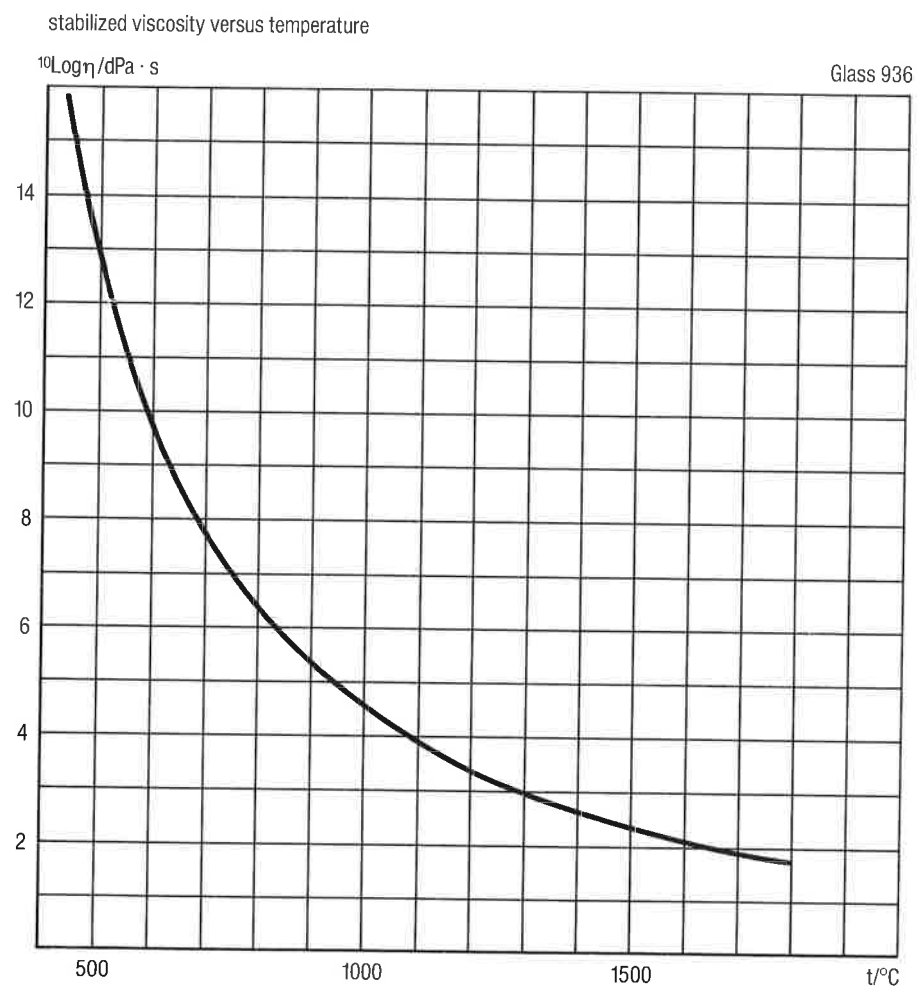


Glass

Types

Glass 936

Curve of stabilized viscosity as a function of temperature



Glass

Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 936						
Modes of supply:						
Glass 936 is melted periodically and is available as tubing and rods with the following dimensions:						
Tubing with unit lengths:						
3,0-4,0	± 0,1	0,5-0,7	± 0,1	1250	± 10	ends unfirepolished
4,0-6,0	± 0,15	0,5-1,2	± 0,15	1250	± 10	ends unfirepolished
6,0-10,0	± 0,25	0,7-1,3	± 0,15	1250	± 10	ends unfirepolished
10,0-14,0	± 0,35	0,9-1,8	± 0,2	1250	± 10	ends unfirepolished
14,0-20,0	± 0,5	1,2-1,8	± 0,25	1250	± 10	ends unfirepolished
20,0-28,0	± 1,0	1,4-2,0	± 0,35	1250	± 10	ends unfirepolished
Precut tubing:						
3,0-4,0	± 0,1	0,5-0,7	± 0,10	60-90	± 0,5	ends firepolished
				90-200	± 1,0	ends firepolished
4,0-6,0	± 0,15	0,7-1,2	± 0,15	60-90	± 0,5	ends firepolished
				90-200	± 1,0	ends firepolished
6,0-8,0	± 0,20	0,7-1,2	± 0,15	60-90	± 0,5	ends firepolished
				90-200	± 1,0	ends firepolished
Rods with unit lengths:						
4,0-5,8	± 0,2			1250	± 10	ends unfirepolished
Precut rods:						
4,0-5,8	± 0,2			14-60	± 0,4	ends unfirepolished
The following dimensions are constantly available:						
6,9-7,3		0,72-0,82		1250	± 10	ends firepolished
6,9-7,3		0,72-0,82		35	± 0,8	ends firepolished
Different dimensions and tolerances can be considered upon request.						

Glass

Types

Glass 937

Glass 937 is a borosilicate glass with excellent electrical insulation properties and is especially adapted to the expansion coefficient of molybdenum. It finds its application mainly in electrotechnical components which are subjected to high electrical and thermal loads.

Physical and chemical properties

Linear coefficient of thermal expansion 20...300° C	[10 ⁻⁶ K ⁻¹]	4,9	Temperature [° C] at electrical resistivity	10 ¹² Ω cm	122
				10 ⁸ Ω cm $\hat{=}$ t _{K100}	301
				10 ⁴ Ω cm	672
Young's Modulus	[GPa]	62	electrical resistivity		
Poisson factor	[1]	0,21	at 10 ³ dPa · s viscosity	[Ω cm]	31
Density	[gcm ⁻³]	2,30	Dielectric constant	20° C [1]	–
			at 10 MHz and	300° C [1]	–
Thermal stress resistance for 8 N mm ⁻²	[K]	42	Dielectric loss factor	20° C [10 ⁻³]	–
			at 10 MHz and	300° C [10 ⁻³]	–
Surface tension	[mN · m ⁻¹]	308	stress-optical constant		
Transformation temperature	[°C]	520	at 540 nm	[10 ⁻⁶ mm ² N ⁻¹]	3,9
Temperature at 10 ^{14,5} (strain point)		479	Optical refraction		
viscosity [dPa · s] 10 ¹³ (annealing point)		526	coefficient at $\lambda = 587,6$ nm [1]		1,48
			Chemical	water	2
10 ^{7,6} (softening point) [°C]		762	solubility class	acid	3
10 ⁴ (working point)		1217	per DIN in	alkali	3

Sealing properties:

Glass 937 can be sealed to:

molybdenum and also glass whose thermal expansion coefficient is adapted to molybdenum (e.g. glass 911).

Application:

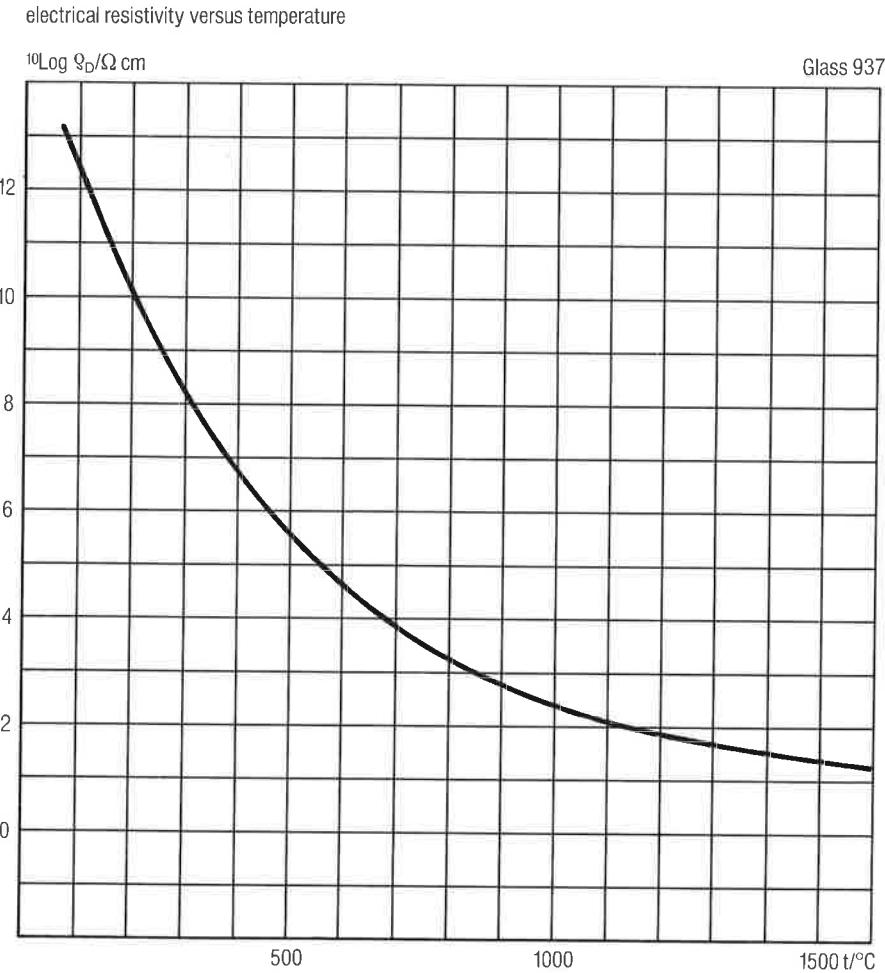
The inner structures of lamps exposed to high electrical and thermal loads.

Glass

Types

Glass 937

Curve of electrical resistivity as a function of temperature

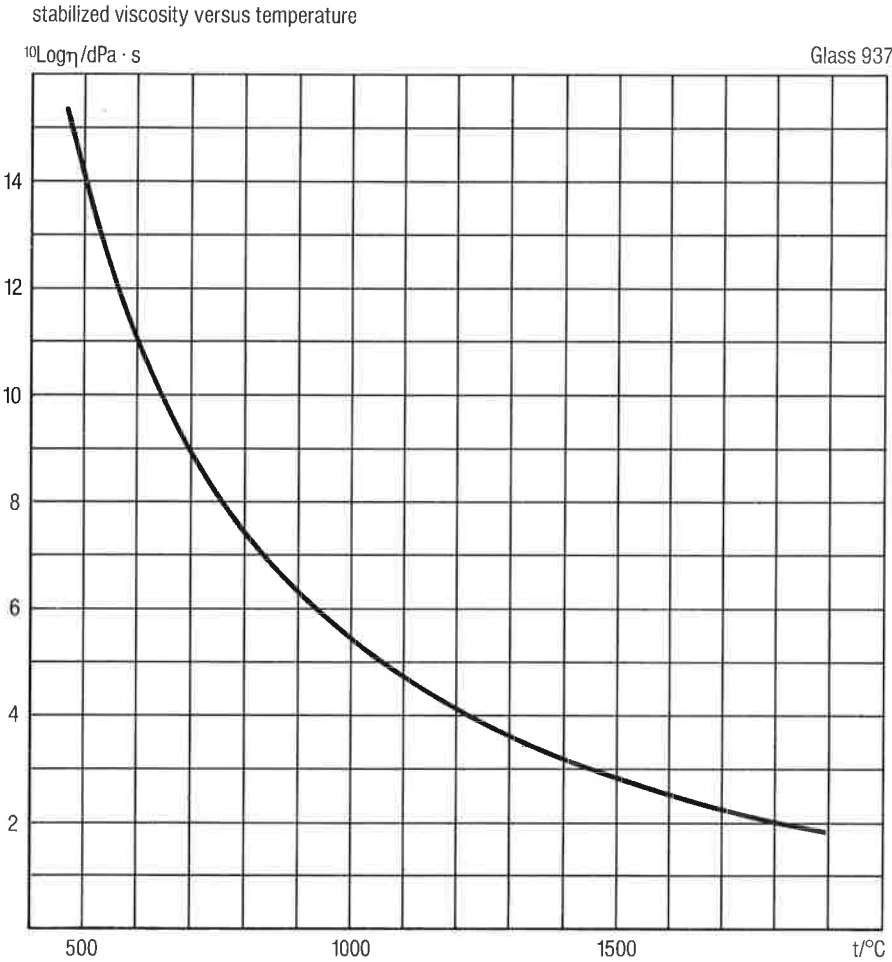


Glass

Types

Glass 937

Curve of stabilized viscosity as a function of temperature



Glass

Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 937						
Modes of supply:						
Glass 937 is melted periodically and is available as tubing and rods with the following dimensions:						
Tubing with unit lengths:						
3,0-4,0	± 0,1	0,5-0,7	± 0,1	1250	± 10	ends unfirepolished
4,0-6,0	± 0,15	0,5-1,2	± 0,15	1250	± 10	ends unfirepolished
6,0-10,0	± 0,25	0,7-1,3	± 0,15	1250	± 10	ends unfirepolished
10,0-14,0	± 0,35	0,9-1,8	± 0,2	1250	± 10	ends unfirepolished
14,0-20,0	± 0,5	1,2-1,8	± 0,25	1250	± 10	ends unfirepolished
20,0-28,0	± 1,0	1,4-2,0	± 0,35	1250	± 10	ends unfirepolished
Precut tubing:						
3,0-4,0	± 0,1	0,5-0,7	± 0,10	60-90	± 0,5	ends firepolished
4,0-4,8	± 0,15	0,7-1,2	± 0,15	90-200	± 1,0	ends firepolished
Rods with unit lengths:						
4,0-5,8	± 0,2			1250	± 10	ends unfirepolished
Precut rods						
4,0-5,8	± 0,2			14-60	± 0,4	ends unfirepolished
Different dimensions and tolerances can be considered upon request.						

Glass

Types

OVISIL®

OVISIL® quartz glass consists up to 99,9% of silicic acid. It is a particular viscous and hard glass. Its good optical transmission ranging from ultraviolet to close infrared as well as its high transformation and softening temperatures together with its thermal stress factor make OVISIL® quartz glass more suitable for the manufacture of light sources subjected to high loads than any other type of material. QVISIL® quartz glass is able to withstand permanent loads of up to 1000°C provided its surface is free of impurities, especially alkaline compounds (e.g. perspiration from fingers) otherwise devitrification with consequent opaqueness and less mechanical strength can be expected.

Physical and chemical properties

Linear coefficient of thermal expansion 0... 1000°C	[10 ⁻⁶ K ⁻¹]	0,54	Temperature at electrical resistivity		
Young's Modulus	[GPa]	66	10 ⁵ Ω cm	[°C]	1000
Poisson factor	[1]	0,17	10 ⁶ Ω cm		800
Density	[gcm ⁻³]	2,2	10 ⁸ Ω cm		510
Thermal stress resistance for 8 N mm ⁻²	[K]	370	10 ¹⁰ Ω cm		350
Transformation temperature	[°C]	1100	10 ¹² Ω cm		240
Temperature at 10 ¹³ (annealing point)		1150	Dielectric constant with 10 ⁶ Hz and 20°C	[1]	3,7
viscosity [dPa · s] 10 ^{7,6} (softening point)	[°C]	1665	Dielectric loss factor with 10 ⁶ Hz and 20°C	[10 ⁻⁴]	<1
10 ⁷ ..10 ⁵ (processing range)		1750-2200	stress-optical constant	[10 ⁻⁶ mm ² N ⁻¹]	3,54
Devitrification range	[°C]	1000-1700	Optical refraction coefficient at λ =	587,6 nm	1,459
Maximum operational temperature continuously with periodical cooling	[°C]	1000	Coefficient of thermal conductivity at 1000°C	[Wm ⁻¹ K ⁻¹]	2,7
continuously with periodical cooling not below 300°C	[°C]	1200			
for shorts periods only	[°C]	1300			

Glass

Types

OVISIL®

Chemical composition

Quartz glass (silica glass) consists up to 99,9% of silicic acid (SiO_2).
OVISIL® contains approximately the following impurities in ppm:

Lithium	1	Molybdenum	< 1
Sodium	3	Manganese	2
Potassium	3	Iron	3
Aluminium	25	Cobalt	< 1
Calcium	3	Nickel	< 1
Copper	< 1	Magnesium	2
Titanium	2	Zircon	2
Vanadium	< 1	Boron	< 1
Chromium	0,3		

OH-contents: Type 451 (unfired) ca. 120 ppm
Type 452 (vacuum-fired) 2 ppm

Glass

Types

OVISIL®

Application:

For burner and exhaust tubing in high-pressure discharge lamps used for street- and indoor illumination, floodlighting and cosmetic purposes;

for burner and exhaust tubing in UV-radiation lamps, e.g. germicidal lamps;

for the tubular bulbs of tungsten-halogen lamps, e.g. projector lamps, headlamps for motorcars, photographic lamps etc.

OVISIL® quartz glass can be sealed to tungsten wire by using our intermediate sealing glasses 441/440/439.

Modes of supply

OVISIL® tubing is mechanically drawn in an OSRAM GMBH BERLIN · MÜNCHEN developed process from a melt made pure fine quartz sand. This tubing distinguishes itself due to its greater homogeneity and can be processed better than tubing made of quartz rock crystals. OVISIL® tubing is available in 2 qualities.

Type 451, unfired with approx. 120 ppm OH
Type 452, vacuum-fired < 5 ppm OH

as well as with UV-decreasing additives of TiO₂

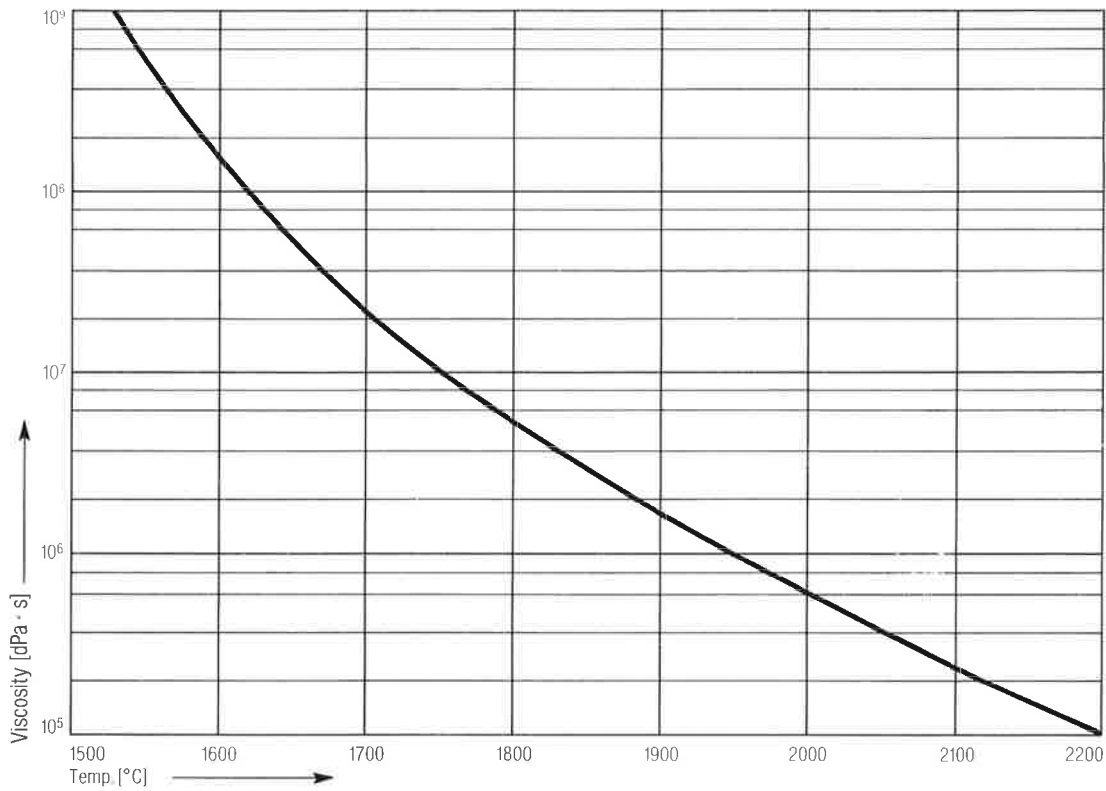
Type 461, unfired
Type 462, vacuum-fired

Glass

Types

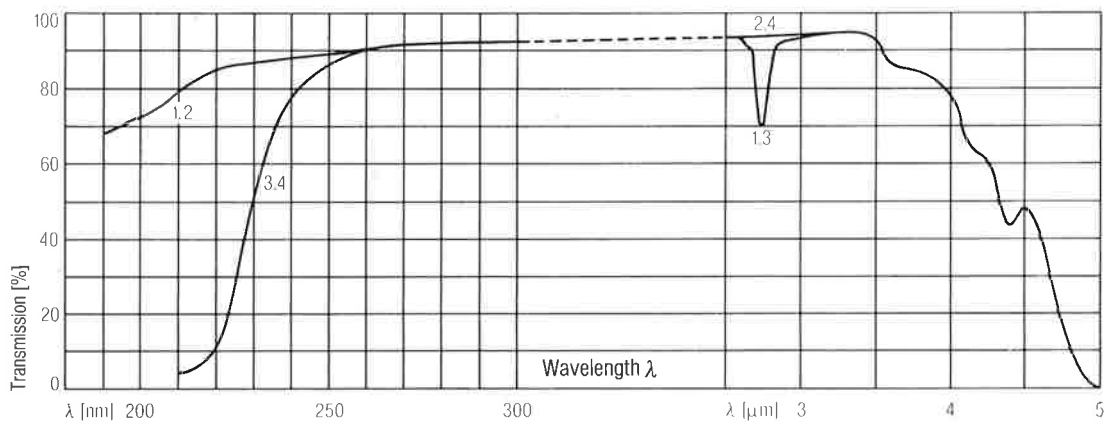
OVISIL®

Viscosity of quartz glass in the temperature range 1500° C–2200° C



Ultraviolet and Infrared transmission of OVISIL®, wall thickness 1 mm

1. Type 451
2. Type 452
3. Type 461 with 0,00 weight % TiO₂
4. Type 462 with 0,02 weight % TiO₂



Glass

Types

OVISIL®

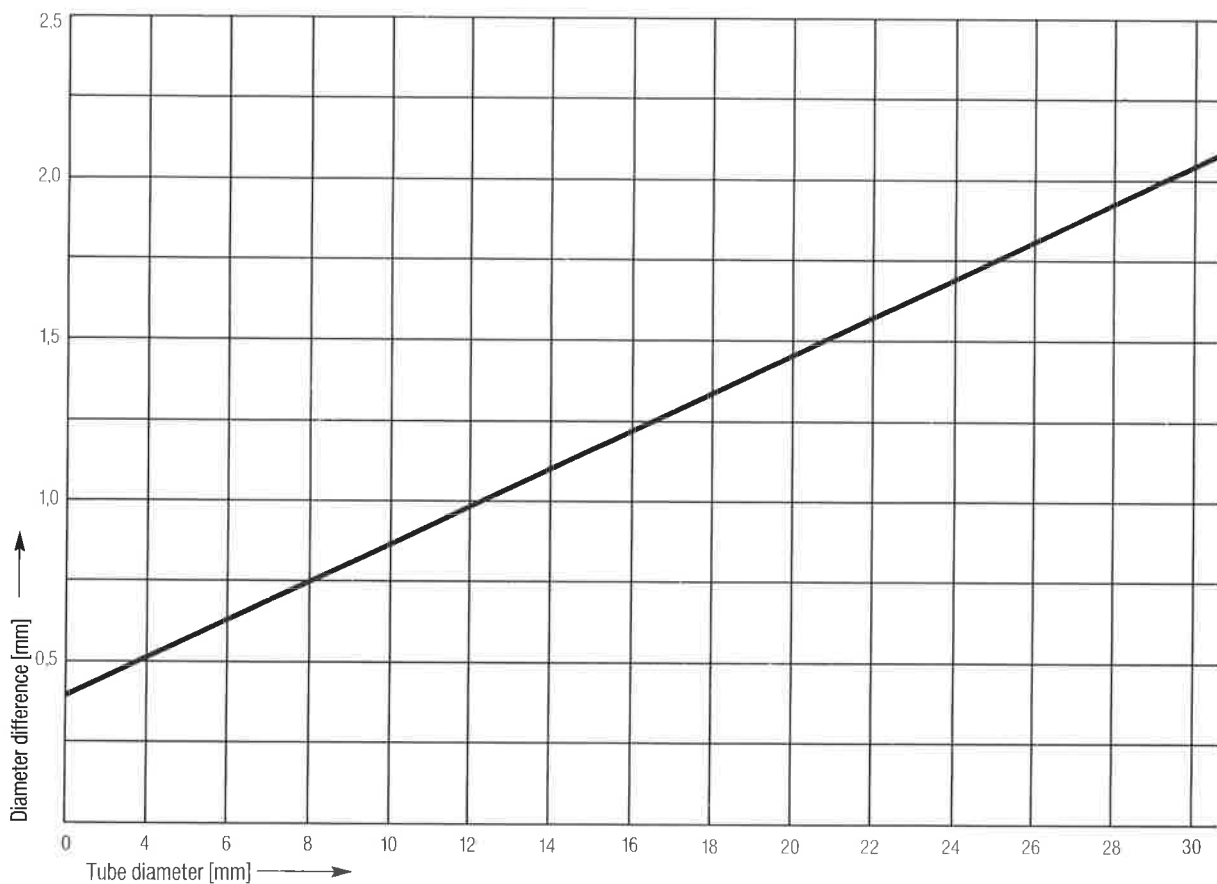
Dimensions

Length of tubing

OVISIL® can be supplied with any desired length between 10 and 1240 mm. Differing lengths need prior agreement.

Diameter

The tubing is manufactured with outside diameters between 3,5 and a maximum of 30 mm as its gauging is based on the outside diameter, inside diameter or its wall thickness. Guiding data for the required diameter tolerances which depend on the average outside diameter of our unit dimensions, are shown in the following curve. Differing dimensions require prior agreement.



Glass

Types

OVISIL®

Garding according to weight

Tubing shorter than 150 mm and with a diameter of up to a maximum of 25 mm can be graded according to weight if so desired.

It is guaranteed that our quality conditions on which all deliveries are based, will be strictly met by the application of statistical quality control tests as stated in the OSRAM GMBH BERLIN · MÜNCHEN specifications of acceptance.

Cutting quality

For the manufacture of precut quartz glass tubing three cutting methods are possible:

coarse cut for unit lengths of 1240 mm if the tubing is to be processed for smaller unit lengths;

fine cut for precut tubing (for this purpose the tubing is cut dry or wet, depending in the required quality);

dry cut for outside diameters ranging from 3,5 -15,0 mm and length > 50 mm;

wet cut for outside diameters ranging from 3,5 - 30,0 mm and length of 10 - 1240 mm.

Fire polishing

For the manufacture of quartz glass exhaust tubing it is possible to have one end fire - polished if so desired.

Glass

Types

OVISIL®

Wall thickness

Guiding data for the average wall thickness which depend on the outside diameter are shown in the following diagram.

The permissible wall thickness tolerance must be at least 0,3 mm.

Dimensions differing from these guiding data can be considered upon request.

