Glass

Types

Physical and chemical properties

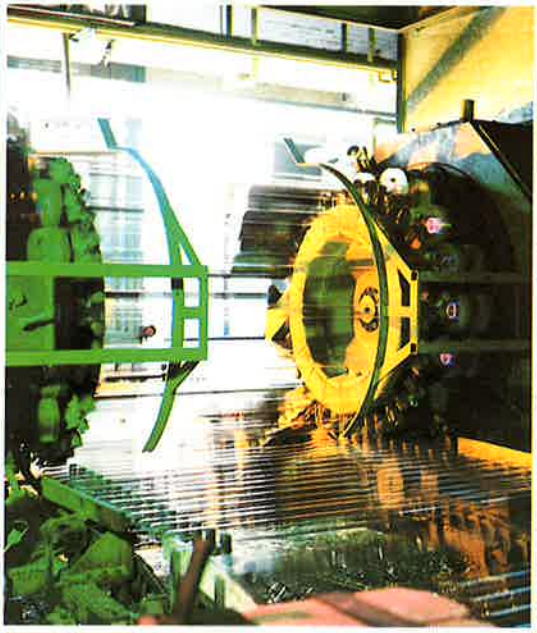
Sealing properties

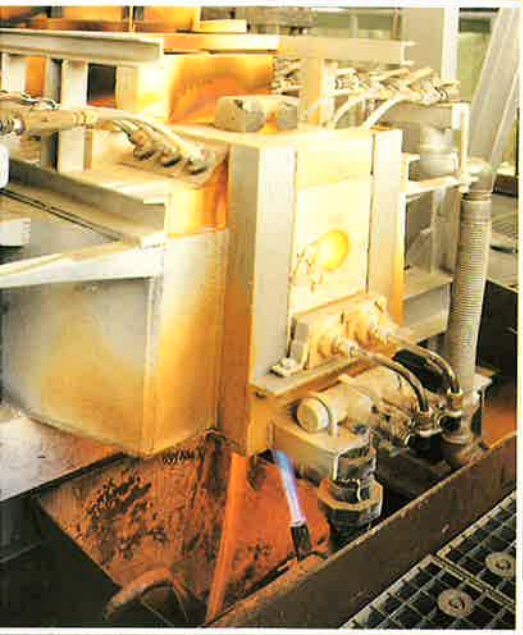
Application

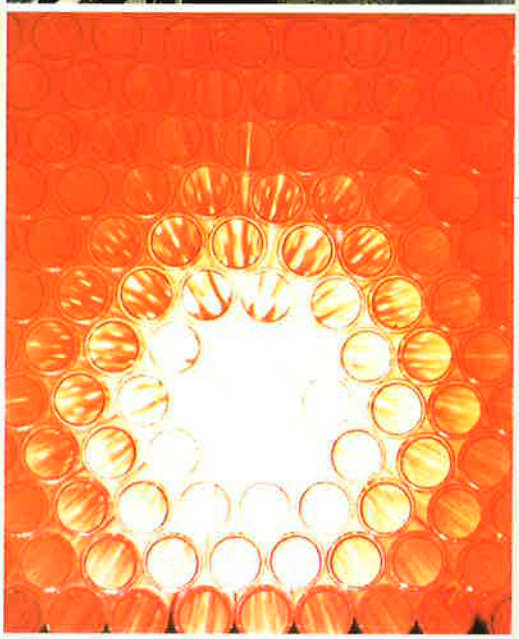
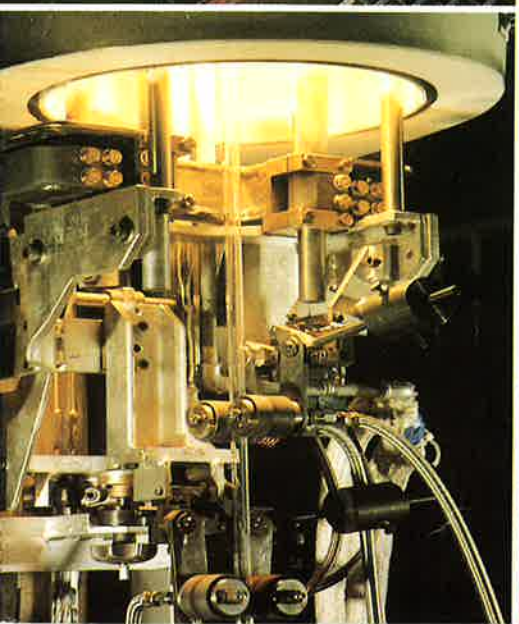
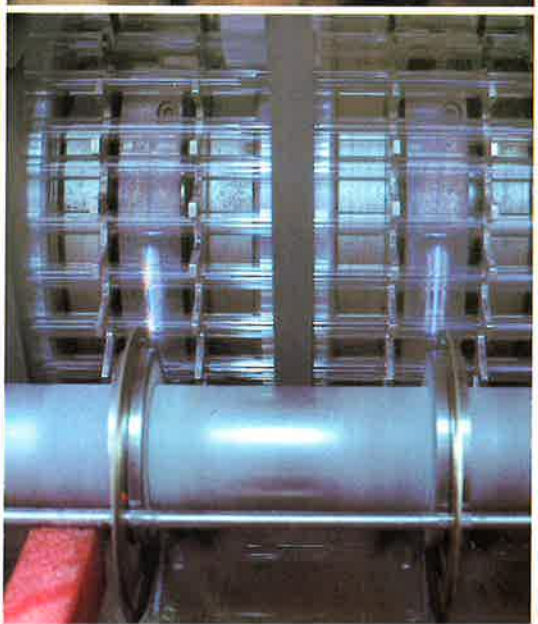
Modes of supply

OSRAM

Glasses




Glass

For many years OSRAM has manufactured 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;
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 descreased transmission in the visible and invisible spectral range.

OSRAM is an expert in manufacturing of glass with special properties, therefore most demands from our customer can be met.

Glass

Summary of types

Glass 127

Glass 127 is a lead glass containing 20 %PbO which softens at relatively low temperature levels. It has good sealing properties with metals having a similiar thermal expansion. 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 302

Glass 302 is a lead glass containing approx. 40 %PbO which softens at relatively low temperatures. It has good sealing properties with metals having a similiar thermal expansion. Glass 302 is used by OSRAM exclusively for the manufacture of glass beads

Glasses 439, 440 and 441

These glasses are alkaline earth alumina borosilicate glasses and are used as rod-shaped graded sealed glasses for the sealing of tungsten rods into quartz glass.

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 x $10^{-6}K^{-1}$.

OVISIL®

OVISIL® -quartz glass type is manufactured as pure and doped quartz glasses. According to the kind of doping, the properties differ from the quartz glass 451, 452 and 454 S with 99.9 %SiO_2 content. Correspondingly, doped quartz glasses are produced, quartz glass 455 and 456 with lower viscosity values, and quartz glasses 461, 462, 464 S, 471, 472, 474 S with restricted UV-transmission. Different processing varies the hydroxyl content OH^- between 2 and 150 ppm. A special acid processing of the tubings (index „S") gives the optimum in transparency.

All the OVISIL®-Glasses have high viscosities of the melts. Their good resp. controlled UV- and IR-Transparencies, their high transition- and softening temperatures and the very high thermal stress resistence give them a good qualification for high wattage Lamp production. They are suited for endurances up to 900-1000 °C, if their surfaces are free of contaminations, esp. finger sweat. Otherwise cristallization may occur, in combination of lowered mechanical strength.

Physical and chemical properties of glass

Linear expansion coefficient α [$10^{-6} K^{-1}$].

The values measured as per DIN 523 28 between 20 °C and 300°C and between 20 °C and transformation temperature 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 $\sigma = 8 N/mm^2$. 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 at 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 tg [° 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 characeristic values, defined in ISO 7884:
a) at $10^{14,7}$ dPas (strainpoint)
b) at $10^{13,2}$ dPas (annealing point)
c) at $10^{7,6}$ dPas (softening point)
d) at 10^{4} dPas (working point)

They correspond with the viscosities during which
a) stress in the glass is relieved within a few houres,
b) stress in the glass is relieved within a few minutes,
c) deformations become evident within a few minutes,
d) many machinical or manual processes can be carried out.

The values are measured in stabilized state. Viscosity values in time-temperature balance are shown in the diagramms.

Physical and chemical properties of glass

Electrical resistivity ϱ_D in solid state.

The values are given in °C at 10^4; 10^8; 10^{12} Ωcm and in Ω cm at 250 and 350 °C.

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 10^3 dPas. 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 tg δ.

Both values are shown for 20 °C and 1 MHz.

Stress-optical constant C [10^{-6} mm^2 /N]
at room temperature and wavelength 540 nm.

This gives the relative wavelength retardation in nm/cm
with a sample load of 0,1 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 127

Glass 127 is a lead glass containing approx. 20% PbO. which softens at relatively low temperature levels. It has good sealing properties with metals having a similiar 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 propertis

Linear coeffizient			
off thermal expansion 20 . . . 300° C		[10^{-6} K^{-1}]	9,6
20 . . . tg			10,2
Young's Modulus		[GPa]	61
Poisson factor		[1]	0,22
Density		[gcm^{-3}]	2,80
Thermal stress resistance			
for 8 N mm^{-2}		[K]	21
Surface tension		[mN · m^{-1}]	246
Transformation temperature		[°C]	440
Temperature at	$10^{14,7}$ (strain point)	[°C]	418
viscosity [dPa · s]	$10^{13,2}$ (annealing point)	[°C]	448
	$10^{7,6}$ (softening point)	[°C]	648
	10^{4} (working point)	[°C]	1001

Temperature [°C] at	10^{12} Ω cm		132
electrical resistivity	10^{8} Ω cm ≙ t_{K100}		284
	10^{4} Ω cm		558
electrical resistivity			
at 10^{3} dPa · s viscosity	[Ω cm]		12,6
at 250 °C			5.10^{8}
at 350 °C			7.10^{6}
Dielectric constant	20 °C	[1]	6,6
at 1 MHz and			
Dielectric loss factor	20 °C	[10^{-3}]	3,7
at 1 MHz and			
stress-optical constant			
and 540 nm	[$10^{-6}$$mm^{2}$$N^{-1}$]		2,9
Optical refraction			
coefficient at	λ = 587,6 nm	[1]	1,53
Chemical	water		4
solubility [class]	acid		2
per DIN in	alkali		3

Sealing properties:

Glass 127 can be sealed to

OSRAM-glass type 905 as well as other soft glasses
e.g. bulb glass manufactured by Emgo, Lommel (Belgium)

copper-clad wire (OSRAM 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.

Application:

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

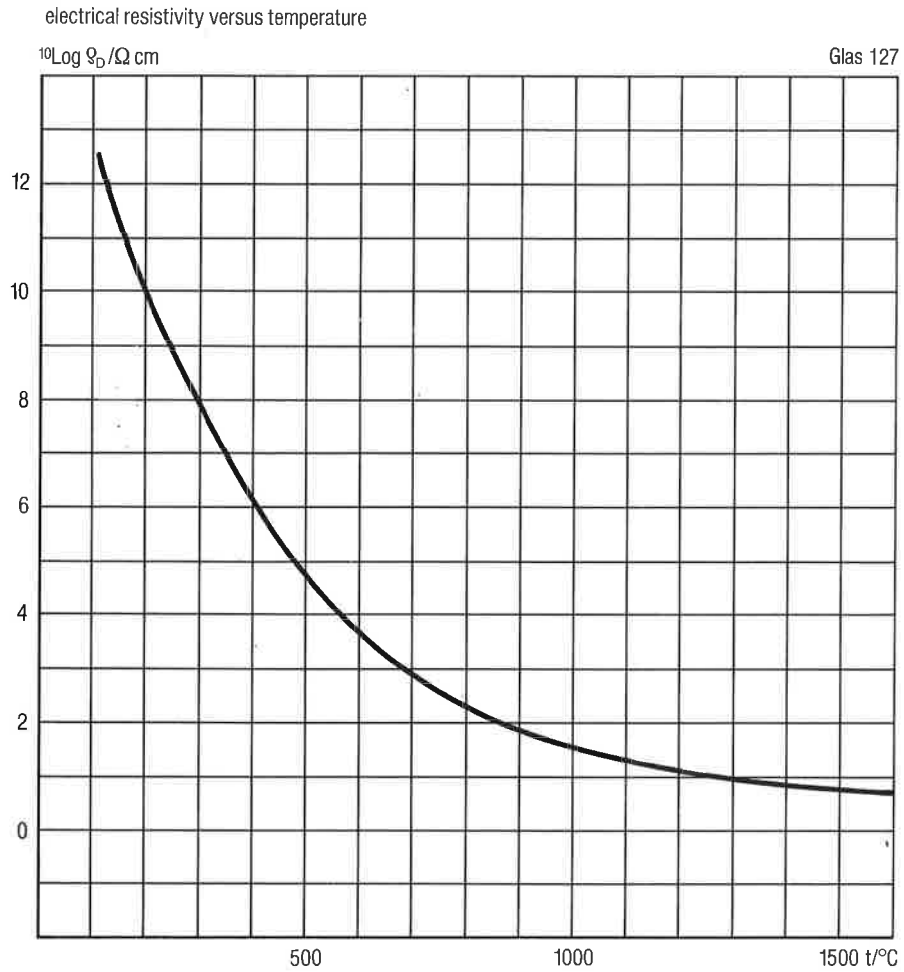
bulbs of miniature lamps, flashbulbs etc.

parts used by the radio and electronic industry .

Types

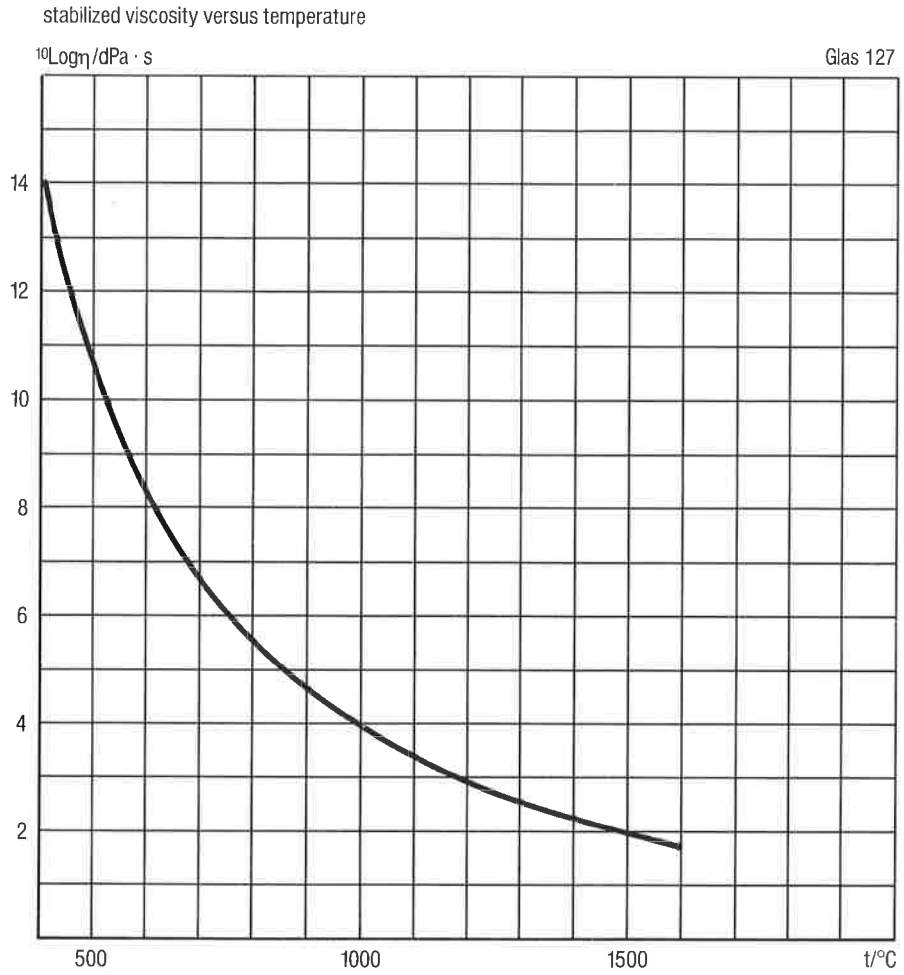
Glass 127

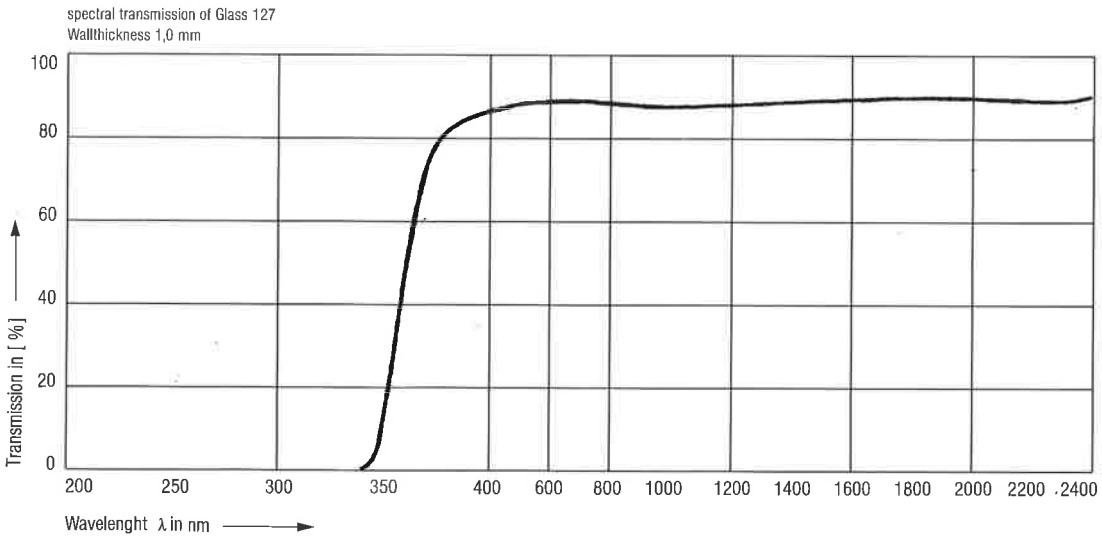
Curve of electrical resistivity as a function of temperature



Types

Glass 127
Curves of stabilized viscosity as a function of temperature and of spectral transmission.





Types

Outside diameter range mm	Tolerance mm	Wall thickness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 127						
Modes of supply						
Glass 127 is continuously melted in furnaces and is available as tubing, rods and sintered glass powder.						
The following dimensions are in constant supply.						
Tubing with unit lengths:						
1,9 - 5,5	± 0,10	0,45 - 0,55	± 0,05	1240	± 10	ends unfirepolished
3,4 - 9,1	± 0,10	0,65 - 0,75	± 0,05	1240	± 10	ends unfirepolished
4,9 - 11,85	± 0,10	0,85 - 0,95	± 0,05	1240	± 10	ends firepolished
6,3 - 11,85	± 0,10	0,95 - 1,05	± 0,05	1240	± 10	ends firepolished
4,85 - 11,85	± 0,15	0,45 - 0,95	± 0,05	1240	± 10	ends firepolished
6,35 - 12,15	± 0,15	0,95 - 1,15	±0,05	1240	± 10	ends firepolished
8,2 - 16,5	± 0,20	0,60 - 1,20	±0,10	1240	± 10	ends firepolished
13,1 - 19,5	±0,25	0,70 - 1,40	±0,10	1240	±10	ends firepolished
Different dimensions and tolenances can be considered upon request.						
Precut tubing:						
1,9 - 2,1	± 0,1	0,45 - 0,55	± 0,05	14 - 30	± 0,3	ends unfirepolished
				60 - 90	±0,5	ends unfirepolished
				60 - 90	± 0,5	ends unfirepolished
2,3 - 5,5	± 0,1	0,45 - 0,55	± 0,05	50 - 125	± 0,5	ends firepolished
2,9 - 6,6	± 0,1	0,65 - 0,75	± 0,05	38 - 125	± 0,5	ends firepolished
				126 - 198	± 1,0	ends firepolished
4,7 - 6,6	± 0,1	0,85 - 0,95	± 0,05	42 - 105	± 0,5	ends firepolished
6,6 - 7,2	± 0,1	1,125	± 0,075	74 - 105	± 0,5	ends firepolished
8,65	± 0,15	1,05	± 0,05	88	± 0,5	ends firepolished
Different dimensions and tolerances can be considered upon request.						

Types

Outside diameter range mm	Tolerance mm	Wall thick-ness mm	Tolerance mm	Length mm	Tolerance mm	Remarks
Glass 127						
Rods with unit lengths						
1,85 - 3,95	± 0,15			1240	± 10	ends unfirepolished
4,25	± 0,25			1240	± 10	ends unfirepolished
4,75	± 0,25			1240	± 10	ends unfirepolished
5,75	± 0,25			1240	± 10	ends unfirepolished
Different dimensions and tolerances can be considered upon request.						
Precut rods						
2,35 - 3,75	± 0,15			14 - 46	± 0,4	ends unfirepolished
2,55 - 3,95	± 0,15			47 - 75	± 0,5	ends unfirepolished
3,15	± 0,15			10,3 - 27	± 0,3	ends unfirepolished
4,75	± 0,25			69	± 0,8	ends unfirepolished
Different dimensions and tolerances can be considered upon request.						

Glass

Types

Glass 302

Glass 302 is a lead glass containing approx. 40 % PbO which softens at relatively low temperatures. It has good sealing properties with metals having similar expansion coefficient

Physical and chemical properties

Linear coefficient of thermal expansion 20 . . . 300° C		[10^{-6} K^{-1}]	10,3
20 . . . tg			10,8
Young's Modulus		[GPa]	61
Poisson-factor		[1]	0,25
Density		[gcm^{-3}]	3,45
Thermal stress resistance for 8 N mm^{-2}		[K]	19
Surface tension		[mN · m^{-1}]	230
Transformation temperature		[°C]	418
Temperature at viscosity [dPa · s]	$10^{14,7}$ (strain point)	[°C]	371
	$10^{13,2}$ (annealing point)		404
	$10^{7,6}$ (softening point)		555
	10^{4} (working point)		838

Temperature (°C] bei spezif. electrical resistivity	10^{12} Ω cm		96
	10^{8} Ω cm ≙ t_{K100}		236
	10^{4} Ω cm		490
electrical resistivity at 10^{3} dPa · s			12,5
at 250 °C			5.10^{7}
at 350 °C	[Ω cm]		1.10^{6}
Dielectric constant at 1 MHz and	20 °C	[1]	–
Dielectric loss factor at 1 MHz and	20 °C	[10^{-3}]	–
stress-optical constant at 540 nm	[$10^{-6}mm^{2}N^{-1}$]		3,1
Optical refraction coefficient at λ =	587,6 nm	[1]	1,57
Chemical solubility [class] per DIN in	water		3
	acid		3
	alkali		3

Glass to metal seal:

Glass 302 suitable for sealing:
with Dumet wire (OSRAM F-wire)

Sealing with OSRAM glasses is unusual.

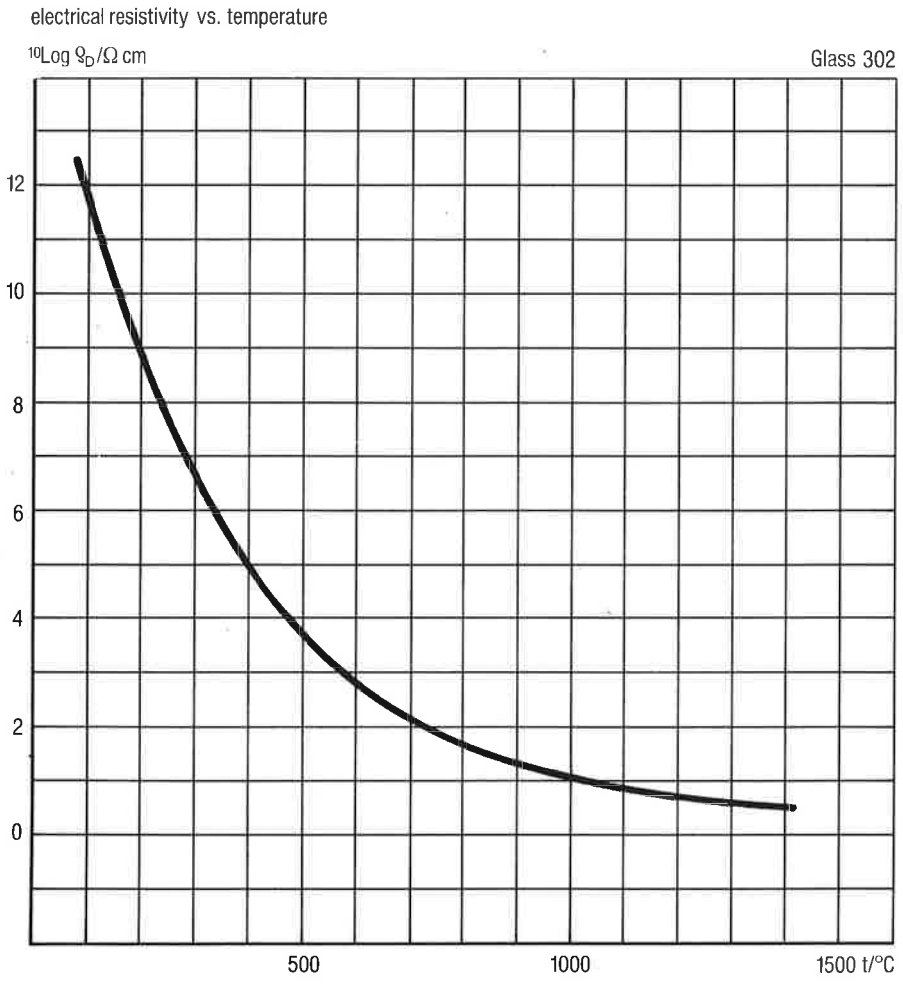
Application:

Glass 302 is used by OSRAM exclusively for the manufacture of sintered glass parts of glass powder agglomerate, e. g. for miniature lamps.

Types

Glass 302

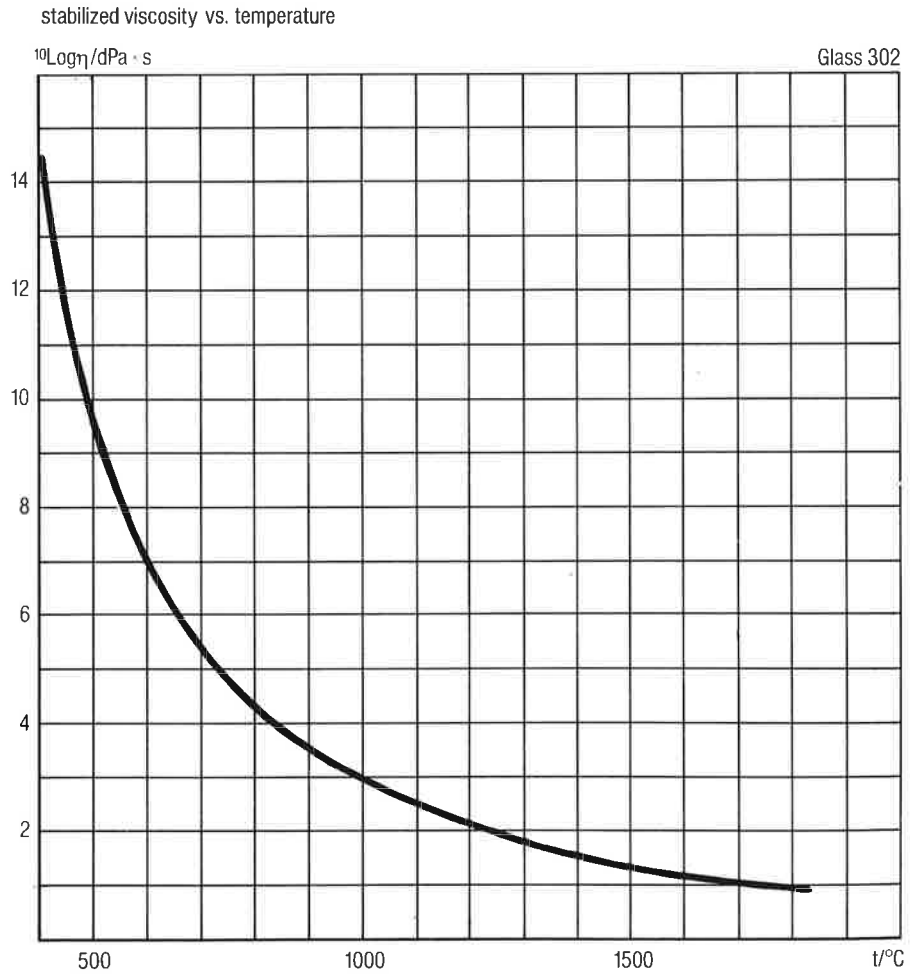
Curve of electrical resistivity as a function of temperature



Types

Glass 302

Curve of stabilized viscosity as a function of temperature



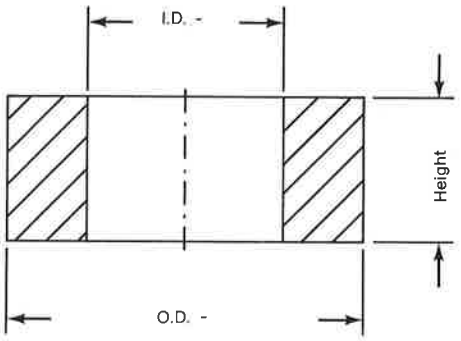
Glass

Types

Glass 127 and 302

Modes of supply:

Pressed and sintered rings, so called glass beads use made of glass powder



The following dimensions are in constant supply:

O.D. mm	Tolerance mm	I.D. mm	Tolerance mm	Height mm	Tolerance mm	Glass
3,35	± 0,15	2,15	± 0,15	1,45	± 0,15	127 and 302
3,45	± 0,15	2,25	± 0,15	2,50	± 0,20	302
3,75	± 0,15	2,45	± 0,15	1,45	± 0,15	127
3,75	± 0,15	2,45	± 0,15	1,80	± 0,15	302
3,75	± 0,15	2,45	± 0,15	2,50	± 0,20	302
4,55	± 0,15	2,75	± 0,15	1,80	± 0,15	127

Other dimensions and tolerances upon request.

Manufacture of different coloring is possible.

Types

Glass 439

Glass 439 is an alkaline earth alumina borosilicate glass and is used as rod-shaped graded sealed glass for the sealing of tungsten rods into quartz glass.

Physical and chemical properties:

Linear coefficient of thermal expansion 20 . . . 300° C		[10^{-6} K^{-1}]	2,3
Young's Modulus		[GPa]	
Poisson factor		[1]	
Density		[gcm^{-3}]	2,19
Thermal stress resistance for 8 N mm^{-2}		[K]	
Surface tension		[mN · m^{-1}]	
Transformation temperature		[°C]	660
Temperature at viscosity [dPa · s]	10^{10}	[°C]	900
	$10^{7,6}$ (softening point)	[°C]	1090
	10^{4} (working point)	[°C]	1615

Temperature [°C] at electrical resistivity	10^{12} Ω cm	
	10^{8} Ω cm ≙ t_{K100}	
	10^{4} Ω cm	
electrical resistivity at 10^{3} dPa · s viscosity		[Ω cm]
Dielectric constant at 1 MHz and	20 °C	[1]
Dielectric loss factor at 1 MHz and	20 °C	[10^{-3}]
stress-optical constant at 540 nm		[$10^{-6}mm^{2}N^{-1}$]
Optical refraction coefficient at	λ = 587,6 nm	[1]
Chemical solubility class per DIN	water	
	acid	
	in alkali	

Modes of supply

The following dimensions are in constant supply.

Rods with unit Lengths

Outside diameter range mm	Length mm mm
2,0 - 2,5	200 - < 350
2,25 - 2,75	200 - 350
2,3 - 2,7	350 - 370

Different dimensions and tolerances can be considered upon request.

Glass

Types

Glass 440

Glass 440 is an alkaline earth-alumina-borosilicate glass and is used as rod-shaped graded sealed glass for the sealing of tungsten rods into quartz glass.

Physical and chemical properties:

Linear coefficient of thermal expansion 20 . . . 300° C			[10^{-6} K^{-1}]	1,8	Temperature [°C] at electrical resistivity	10^{12} Ω cm 10^{8} Ω cm ≙ t_{K100} 10^{4} Ω cm
Young's Modulus			[GPa]		electrical resistivity at 10^{3} dPa · s viscosity	[Ω cm]
Poisson factor			[1]			
Density			[gcm^{-3}]	2,19	Dielectric constant at 1 MHz and	20 °C [1]
Thermal stress resistance for 8 N mm^{-2}			[K]		Dielectric loss factor at 1 MHz and	20 °C [10^{-3}]
Surface tension			[mN · m^{-1}]		stress-optical constant at 540 nm	[$10^{-6}$$mm^{2}$$N^{-1}$]
Transformation temperature			[°C]	730		
Temperature at viscosity [dPa · s]	10^{10}		[°C]	969	Optical refraction coefficient at	λ = 587,6 nm [1]
	$10^{7,6}$	(softening point)	[°C]	1173		
	10^{4}	(working point)	[°C]	1759	Chemical solubility class per DIN	water acid in alkali

Modes of supply

The following dimensions are in constant supply.

Rods with unit Lengths

Outside diameter range mm	Length mm
2,0 - 2,5	200 - < 350
2,0 - 2,5	200 - 370

Different dimensions and tolerances can be considered upon request.

Glass

Types

Glass 441

Glass 441 is an alkaline earth-alumina-borosilicate glass and is used as rod-shaped graded sealed glass for the sealing of tungsten rods into quartz glass.

Physical and chemical properties:

Linear coefficient of thermal expansion 20 . . . 300° C			[10^{-6} K^{-1}]	1,3	Temperature [°C] at electrical resistivity	10^{12} Ω cm 10^{8} Ω cm ≙ t_{K100} 10^{4} Ω cm	
Young's Modulus			[GPa]		electrical resistivity at 10^{3} dPa · s viscosity		[Ω cm]
Poisson factor			[1]		Dielectric constant at 1 MHz and	20 °C	[1]
Density			[gcm^{-3}]	2,18	Dielectric loss factor at 1 MHz and	20 °C	[10^{-3}]
Thermal stress resistance for 8 N mm^{-2}			[K]		stress-optical constant at 540 nm		[$10^{-6}mm^{2}N^{-1}$]
Surface tension			[mN · m^{-1}]		Optical refraction coefficient at	λ = 587,6 nm	[1]
Transformation temperature			[°C]	800	Chemical solubility class per DIN	water acid in alkali	
Temperature at viscosity [dPa · s]	10^{10}		[°C]	1059			
	$10^{7,6}$	(softening point)	[°C]	1237			
	10^{4}	(working point)	[°C]	1887			

Modes of supply

The following dimensions are in constant supply.

Rods with unit Lengths

Outside diameter range mm	Length mm
2,0 - 2,5	200 - < 350
2,0 - 2,5	200 - 370

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 x 10^{-6} K^{-1}.

Physical and chemical properties

Linear coefficient of thermal expansion 20 . . . 300° C		[10^{-6} K^{-1}]	9.8
20 . . . tg			10,7
Young's Modulus		[GPa]	70
Poisson-factor		[1]	0,23
Density		[gcm^{-3}]	2,48
Thermal stress resistance for 8 N mm^{-2}		[K]	18
Surface tension		[$mN \cdot m^{-1}$]	325
Transformation temperature		[°C]	505
Temperature at viscosity [dPa · s]	$10^{14,7}$ (strain point)		486
	$10^{13,2}$ (annealing point)		514
	$10^{7,6}$ (softening point)	[°C]	700
	10^{4} (working point)		1016

Temperature (°C) at electrical resistivity	10^{12} Ω cm		38
	10^{8} Ω cm ≙ t_{K100}		163
	10^{4} Ω cm		458
electrical resistivity at 10^{3} dPa · s	[Ω cm]		6.5^{5}
at 250 °C			2.10^{6}
at 350 °C			1.10^{5}
Dielectric constant at 1 MHz and	20 °C	[1]	7,2
Dielectric loss factor at 1 MHz and	20 °C	[10^{-3}]	10
stress-optical constant at 540 nm	[$10^{-6}mm^{2}N^{-1}$]		3,0
Optical refraction coefficient at λ =	587,6 nm	[1]	1,51
Chemical solubility [class] per DIN in	water		4
	acid		1
	alkali		2

Sealing properties:

Glass 905 can be sealed to:

glass type 127 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:

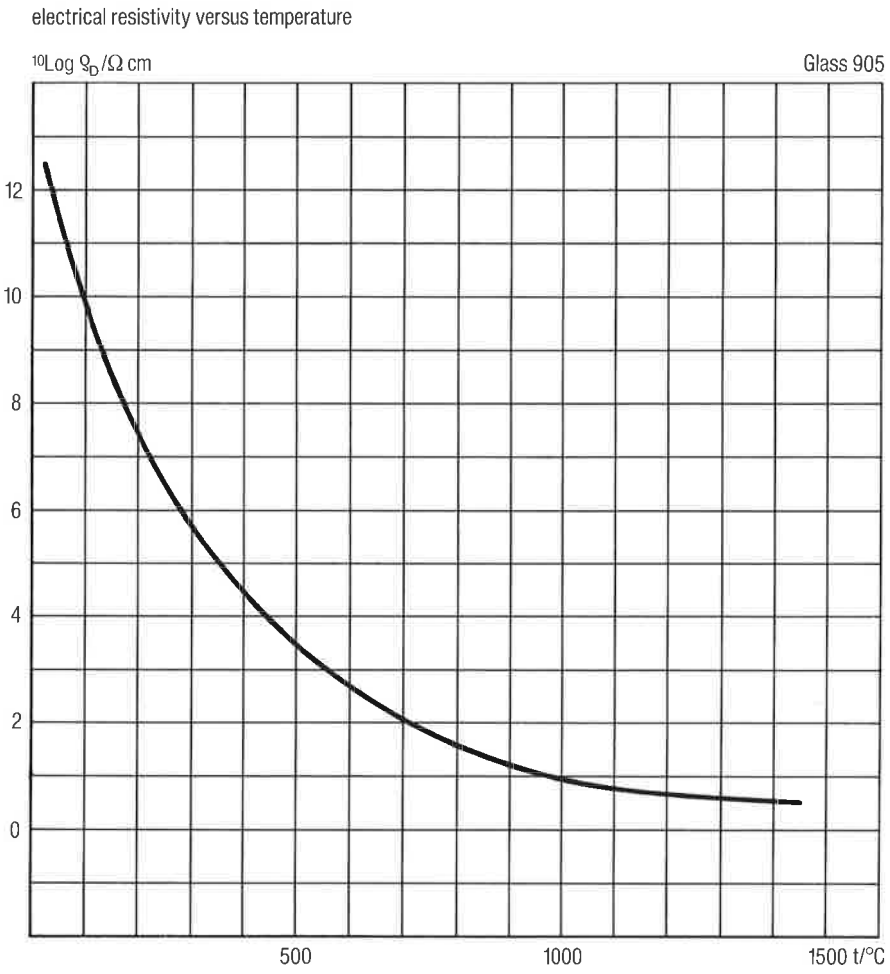
General purpose glass for the manufacture of bulbs for the electric lamp industry, especially tubular bulbs for fluorescent lamps (see Spectral transmission curve).

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

Types

Glass 905

Curve of electrical resistivity as a function of temperature

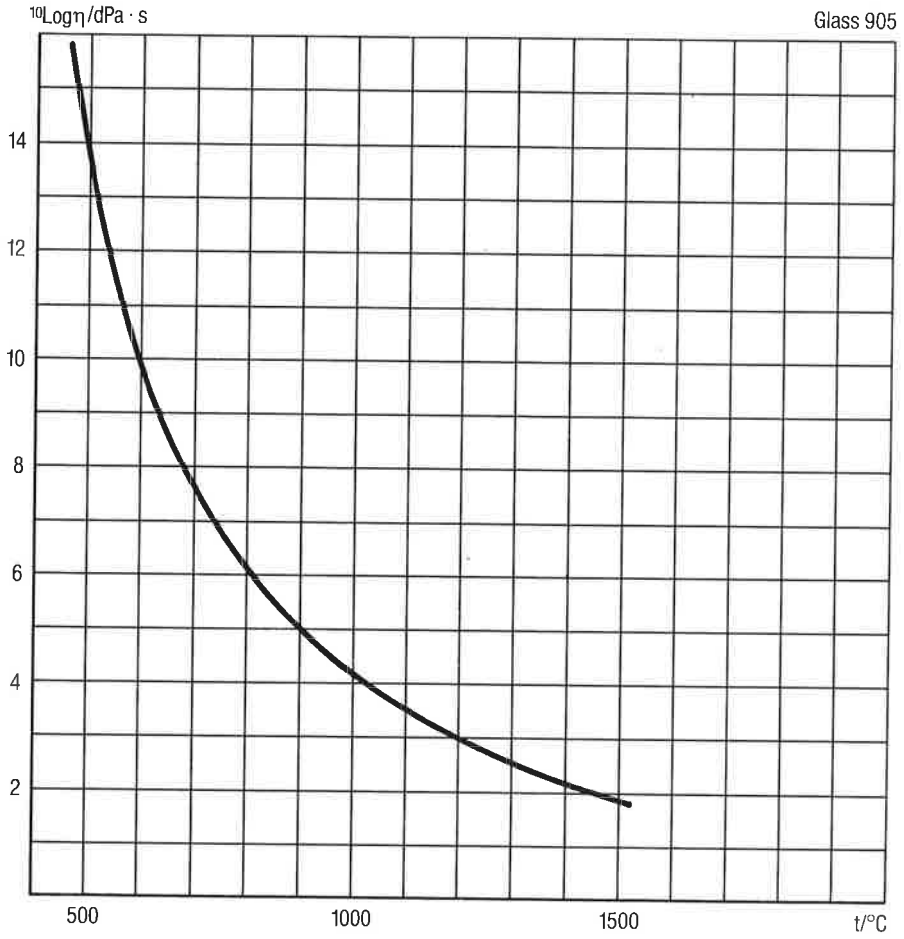


Types

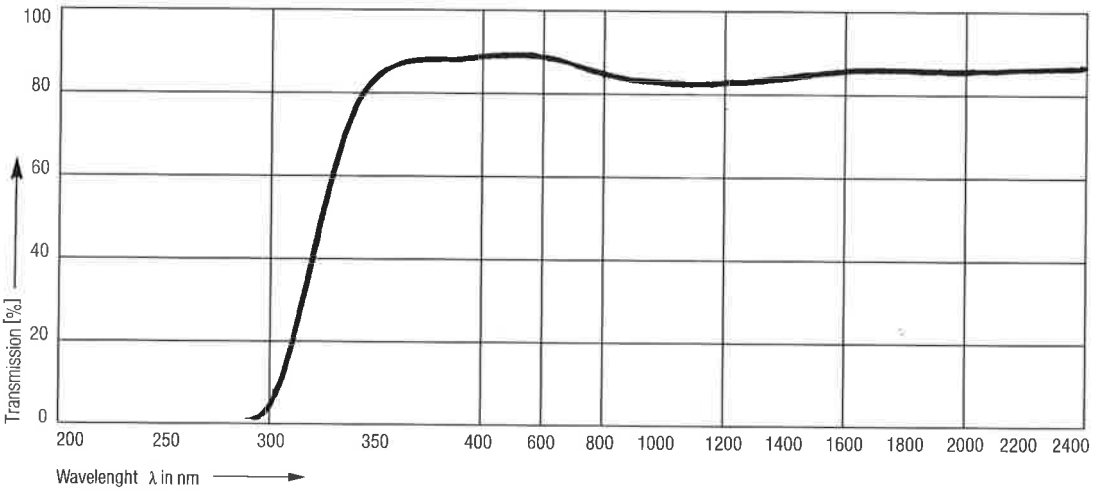
Glass 905

Curves of stabilized viscosity as a function of temperature and of spectral transmission.

stabilized viscosity versus temperature



spectral transmission of Glass 905
Wallthickness 1,0 mm



Glass

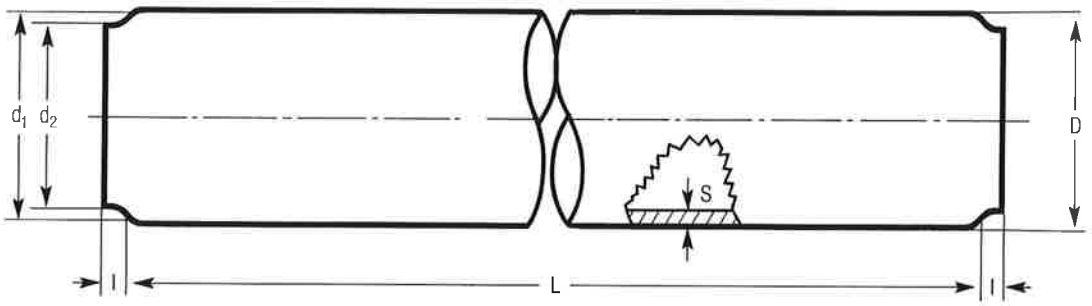
Types

Outside diameter range mm	Tolerance mm	Wall thick-ness 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 - 51,0	± 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.

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 - 571,0	4,1 - 5,3	24,0	21,0 - 21,8
25,0 - 26,0	0,70 - 0,85	872,2 - 873,0	4,1 - 5,3	24,0	21,0 - 21,8
25,0 - 26,0	0,70 - 0,85	1179,8 - 1180,6	4,1 - 5,3	24,0	21,0 - 21,8
25,0 - 26,0	0,70 - 0,85	1480,5 - 1481,3	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	569,6 - 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	949,8 - 950,8	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1027,0 - 1028,0	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1179,3 - 1180, 3	4,1 - 5,3	35,0	30,9 - 31,7
36,2 - 37,5	0,70 - 0,84	1480,5 - 1481,5	4,1 - 5,3	35,0	30,9 - 31,7



1) Total length = L + 2 × l

Types

OVISIL® 451/452/454 S/461/462/464 S/471/472/474 S

These OVISIL® -quartz glasses consist up to 99.9 %of silicic acid. They are particular viscous and high melting. Because of their high transition -and softening temperatures as well as their thermal stress factors they are suited of the manufacture of highly light sources. The glasses 451, 452, and 454 S are not doped: 461, 462, 464 S, contain 0,02 %TiO_2; 471, 472, 474 S 0.125 %TiO_2 for the control of the spectral transmission in the UV-C region.
The gasses are able to withstand permanent loads up to 1000 °C, provided their surfaces are free of impurities, especially alkaline compounds (e.g. perspirations from fingers.) Otherwise devitrification with consequent opaqueness and lower mechanical strength can be expected..

Physical and chemical properties

Linear coefficient of thermal expansion 0 . . . 1000° C	[10^{-6} K^{-1}]		0,54
Young's Modulus	[GPa]		66
Poisson factor	[1]		0,17
Density	[gcm^{-3}]		2,2
Thermal stress resistance for 8 N mm^{-2}	[K]		370
Transformation temperature	[°C]	≈	1200
Temperature at viscosity [dPa · s] ¹) $10^{14,7}$ (strain point)	[°C]		1167
$10^{13,2}$ (annealing point)	[°C]		1255
$10^{7,6}$ (softening point)	[°C]		1760
10^{4} (working point)	[°C]		1990
Devitrification range	[°C]		1000-1700
Maximum operational temperature continuously with periodical cooling	[°C]		1000
continuously with periodical cooling not below 300 °C	[°C]		1200
for short periods only	[°C]		1300

Temperature at electrical resistivity		
10^{2} Ω cm	[°C]	2200
10^{4} Ω cm	[°C]	1660
10^{6} Ω cm	[°C]	1000
10^{8} Ω cm	[°C]	510
10^{12} Ω cm	[°C]	240
Dielectric constant with 10^{6} Hz and 20 °C	[1]	3,7
Dielectric loss factor with 10^{6}Hz and 20 °C	[10^{-4}]	< 1
stress-optical constant 540 nm	[$10^{-6}mm^{2}N^{-1}$]	3,54
Optical refraction Coefficient at	λ = 587,6 nm [1]	1,459
Coefficient of thermal conductivity at 1000°C	[$Wm^{-1}K^{-1}$]	2,7

Chemical composition

OVISIL®-quartz glasses 451, 452, 454 S, contain approx the following impurities (ppm):

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

The OVISIL® -quartz glasses 461, 462, 464 S additionally are doped with 0,02 %TiO_2, the glasses 471, 472, 474 S with 0.125 %TiO_2.

Standard values for OH contents being removable by annealing (ppm = 10^{-6})

Type 451 (not annealed) appr. 150	Type 461 (not annealed) appr. 140	Type 471 (not annealed) appr. 140
Type 452 (vac.annealed) < 4	Type 462 (vac.annealed) < 4	Type 472 (vac. annealed) < 4
Type 454 S (vac. annealed) < 2	Type 464 S (vac. annealed) < 2	Type 474 S (vac. annealed) < 2

No change of these data by acid processing (Index „S").

Types

OVISIL® 455 and 456

The glasses OVISIL® 455 and 456 are quartz glasses doped with colorless metal oxides. They have appr. 200 K lower processing temperatures and appr. 100 K lower working temperatures as compared to pure quartz glasses. All other mechanical and electrical properties are similar to the undoped glasses. In particular, they can be sealed almost tension free with those glasses.

2 different glasses are available:

Type 455, not annealed, with approx. 75 ppm OH
Type 456, vacuum annealed, with < 4 ppm OH

Third parties may own patents in various countries relating to the processing or the use of OVISIL® quartz glass of the types 455 and 456, and also to further applications in lamps therefrom. However, OSRAM assumes no responsibility or liability for any allegations of patent infrigement incurred by the manufacture of lamps and by the use of these quartz glasses. The purchaser assumes full and sole risk of any allocations of patent infrigements.

Physical and chemical properties

Linear coefficient of thermal expansion 0 . . . 1000° C			[10^{-6} K^{-1}]	0,54
Young's Modulus			[GPa]	66
Poisson factor			[1]	0,17
Density			[gcm^{-3}]	2,2
Thermal stress resistance for 8 N mm^{-2}			[K]	370
Transformation temperature			[°C]	≈ 1050
Temperature at viscosity [dPa · s] [1]	$10^{14,7}$	(strain point)	[°C]	992
	$10^{13,2}$	(annealing point)		1062
	$10^{7,6}$	(softening point)		1545
	10^{4}	(working point)		1825
Devitrifracation range		[°C]		900-1500
Maximum operational temperature continuously with periodical cooling			[°C]	900
continuously with periodical cooling not below 300 °C			[°C]	1000
for short periods only			[°C]	1100

Temperature at electrical resistivity		
10^{2} Ω cm	[°C]	
10^{4} Ω cm	[°C]	
10^{6} Ω cm	[°C]	
10^{8} Ω cm	[°C]	
10^{12} Ω cm	[°C]	
Dielectric constant with 10^{6} Hz and 20 °C	[1]	3,7
Dielectric loss factor with 10^{6}Hz and 20 °C	[10^{-4}]	< 1
stress-optical constant 540 nm	[$10^{-6}mm^{2}N^{-1}$]	3,54
optical refraction coefficient at $\lambda =$	587,6 nm [1]	1,459
Coefficient of thermal conductivity at 1000°C	[$Wm^{-1}K^{-1}$]	2,7

Nr.	doping	Composition		Viscosities			Spectral Transmission			
		TiO_2-contents	OH -contents	$10^{14.7}$dPas	$10^{7.6}$dPas	10^{6}dPas	dec. Absorption coefficient			
							200	254	313	365 nm
OVISIL®		[weight %]	[10^{-6}]	[°C]	[°C]	[°C]	[mm^{-1}]			
451	–	–	approx. 150	1167	1760	1990	0.11	0.02	≈ 0	≈ 0
452	–	–	< 4	1167	1760	1990	0.10	0.02	≈ 0	≈ 0
454 S	–	–	< 2	1167	1760	1990	0.10	0.02	≈ 0	≈ 0
455	+	–	approx. 75	992	1545	1825	0.28	0.03	0.01	≈ 0
456	+	–	< 4	992	1545	1825	0.21	0.04	0.01	≈ 0
461	–	0.02	approx. 140	1167	1760	1990	1.7	0.02	0.01	≈ 0
462	–	0.02	< 4	1167	1760	1990	1.7	0.03	0.01	≈ 0
464 S	–	0.02	< 2	1167	1760	1990	1.7	0.03	0.01	≈ 0
471	–	0.125	approx. 140	1167	1760	1990	> 1.7	0.08	0.02	≈ 0
472	–	0.125	< 4	1167	1760	1990	> 1.7	0.08	0.02	≈ 0
474 S	–	0.125	< 2	1167	1760	1990	> 1.7	0.08	0.02	≈ 0

S = acid processed surfaces

OVISIL® types processing (silica glasses)

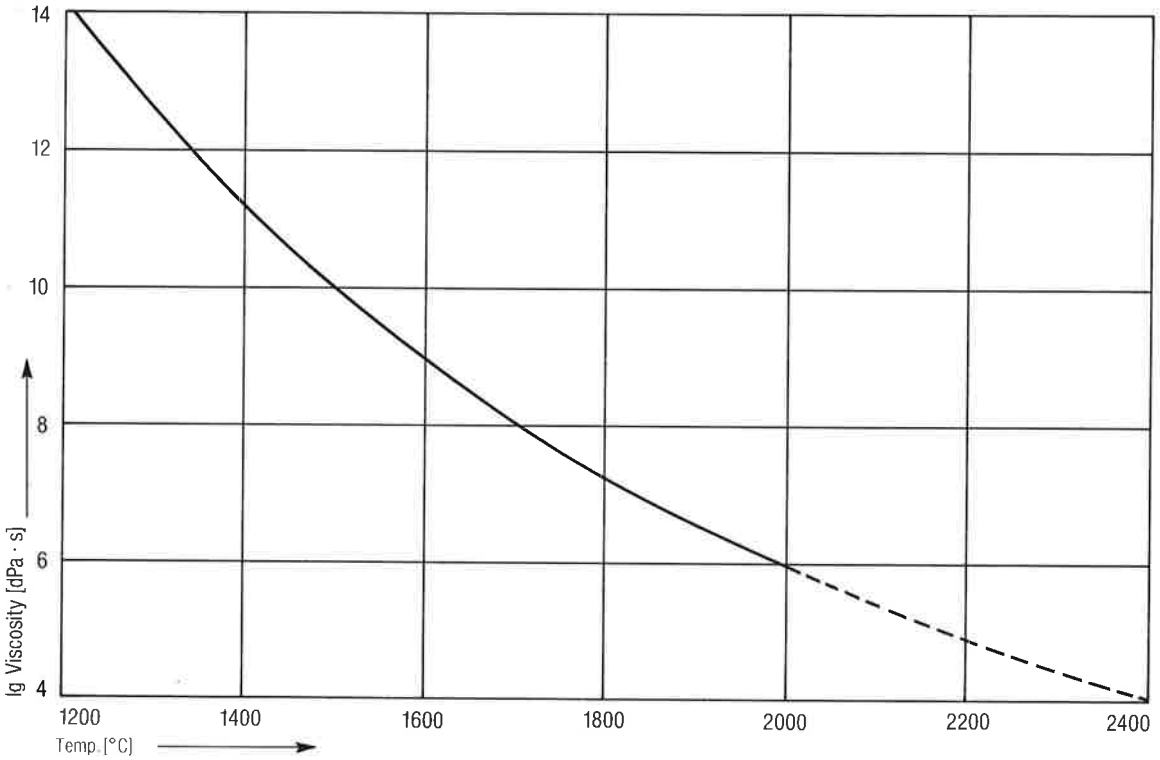
	Iota-Sand → melting	Iota-Sand + Glass 510 → melting	Iota-Sand + 200ppm TiO_2 → melting	Iota-Sand + 1250ppm TiO_2 → melting	tube drawing	Acid processing	vacuum annealing appr. 4h	vacuum annealing appr. 40h	packing
Ovisil® 451	●				●				●
Ovisil® 452	●				●		●		●
Ovisil® 452 S	●				●	●	●		●
Ovisil® 454 S	●				●	●		●	●
Ovisil® 455		●			●				●
Ovisil® 456		●			●		●		●
Ovisil® 461			●		●				●
Ovisil® 462			●		●		●		●
Ovisil® 462 S			●		●	●	●		●
Ovisil® 464 S			●		●	●		●	●
Ovisil® 471				●	●				●
Ovisil® 472				●	●		●		●
Ovisil® 472 S				●	●	●	●		●
Ovisil® 474				●	●	●		●	●

S = acid processed surfaces

Types

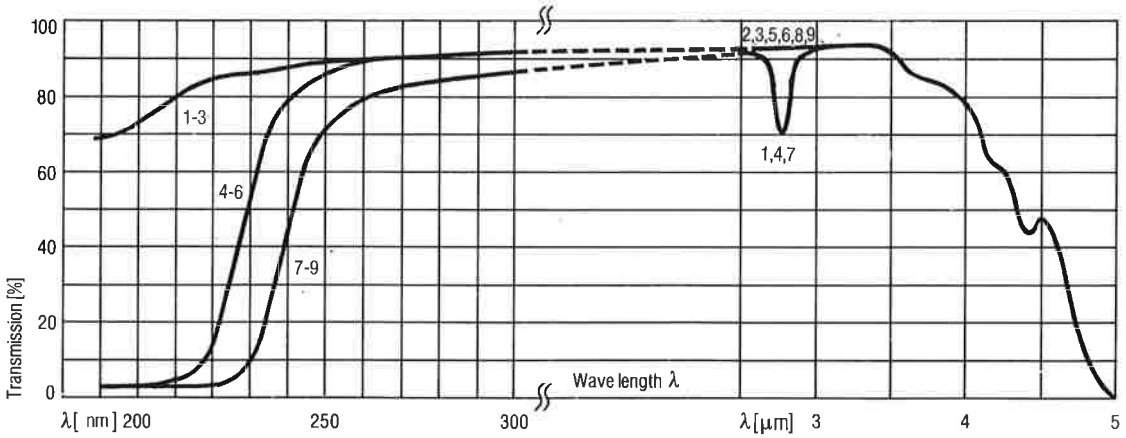
OVISIL®451 / 452 / 454 S / 461 / 462 / 464 S / 471 / 472 / 474 S

Viscosity



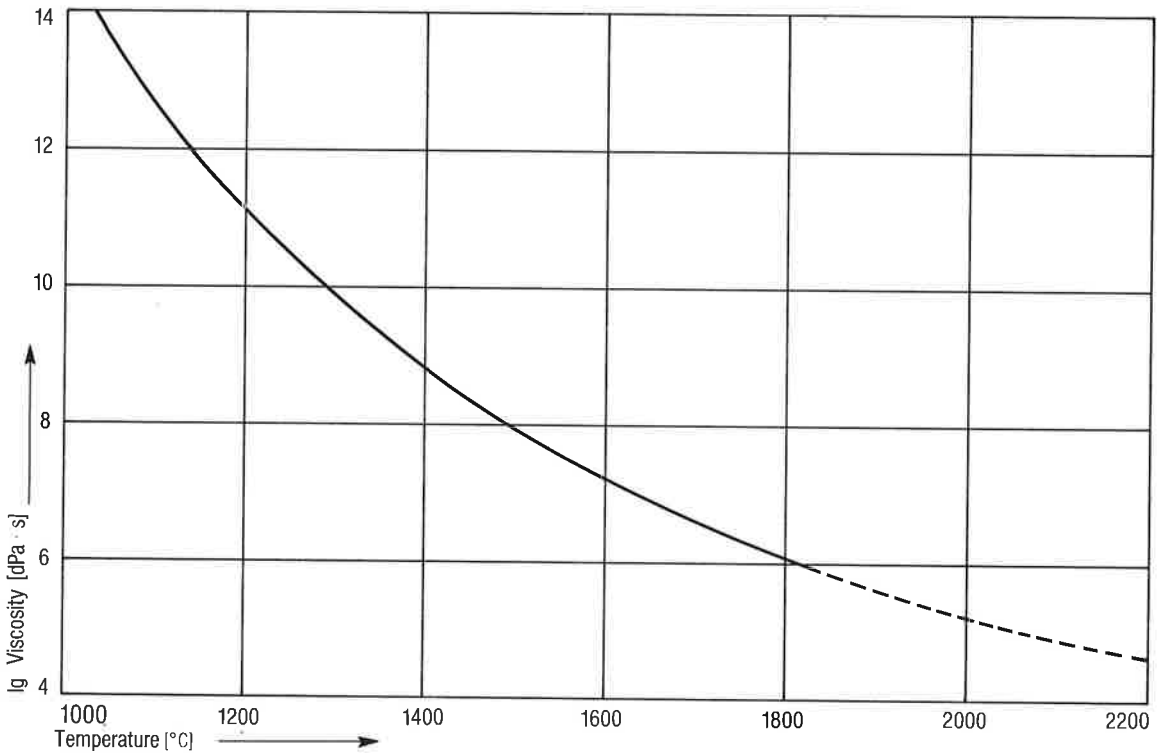
UV- and IR-Transmission of OVISIL®at 1 mm wall thickness

1. Type, 451 appr. 150 ppm OH
2. Type 452, < 4 ppm OH
3. Type 454 S, < 2 ppm OH
4. Type 461 with 0,02 weight % TiO_2, ≈140 ppm OH
5. Type 462 with 0,02 weight % TiO_2, < 4 ppm OH
6. Type 464 S with 0,02 weight % TiO_2, < 2 ppm OH
7. Type 471 with 0,125 weight % TiO_2, ≈ 140 ppm OH
8. Type 472 with 0,125 weight % TiO_2, < 4 ppm OH
9. Type 474 S with 0,125 weight % TiO_2, < 2 ppm OH



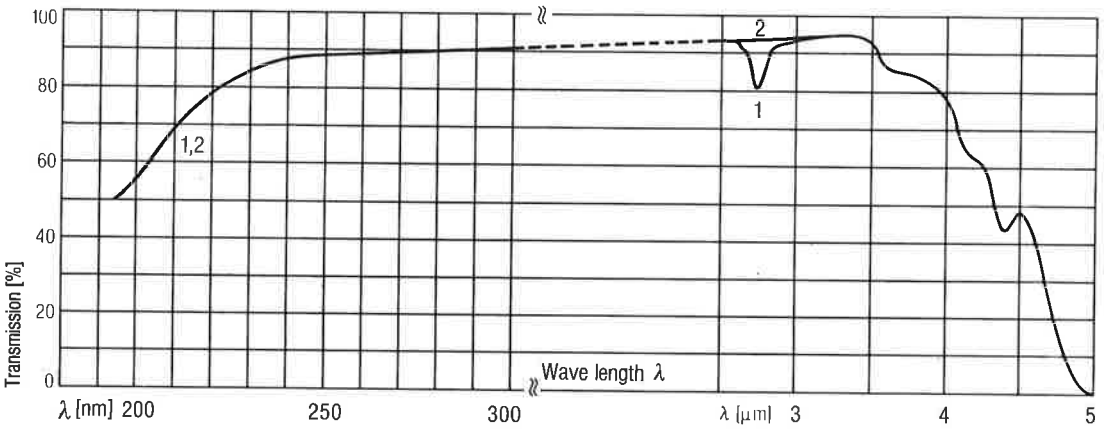
Types

OVISIL® 455 and 456
Viscosity



UV- and IR-transmission of OVISIL® 455 and 456 at 1 mm wall thickness.

1. Type 455
2. Type 456



Types

OVISIL®451 / 452 / 454 S

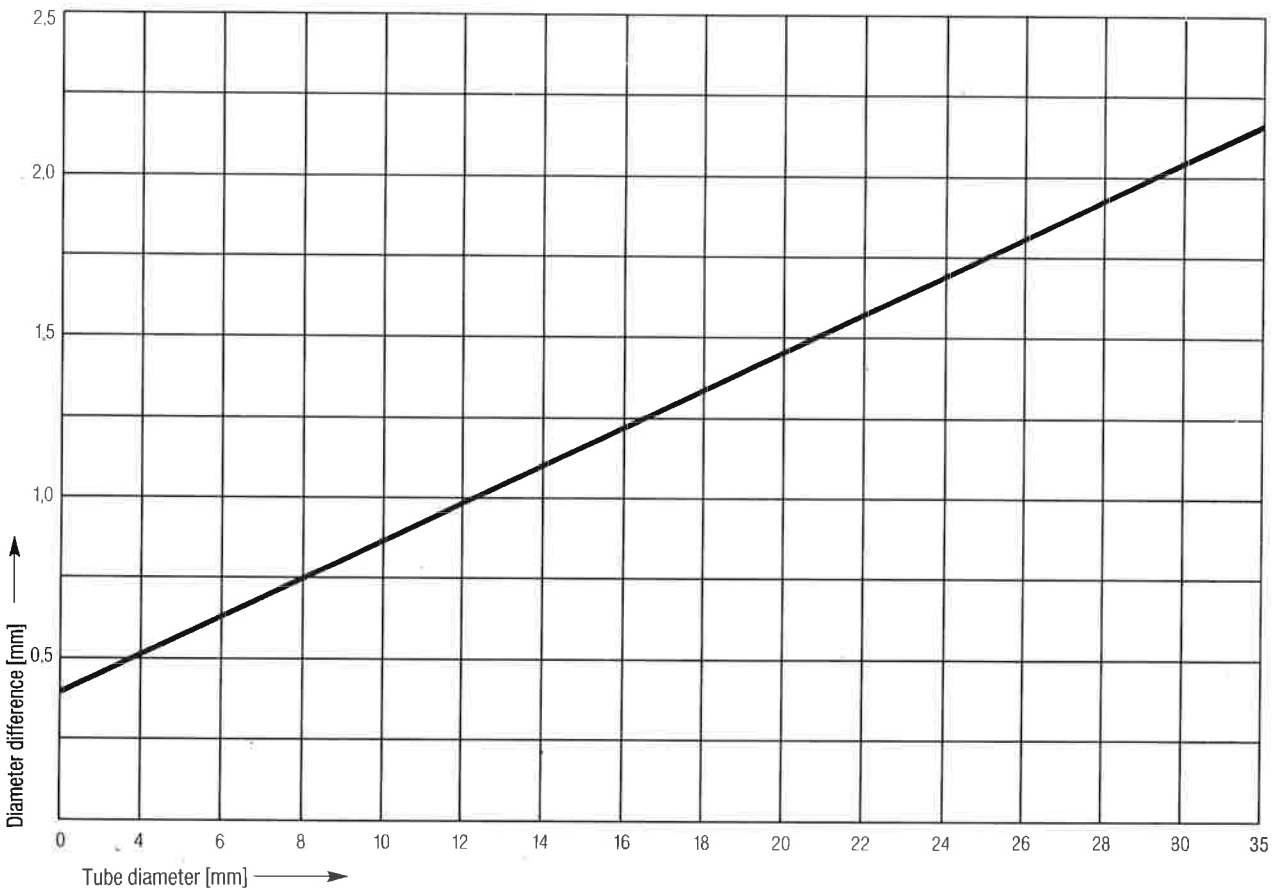
Dimensions

Length of tubing

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

Diameter

The tubing is manufactured with outside diameters between 3,5 and a maximum of 35 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.



Available dimensions for OVISIL® -Glass 455/456/461/462/464 S/471/472/474 S upon request.

Types

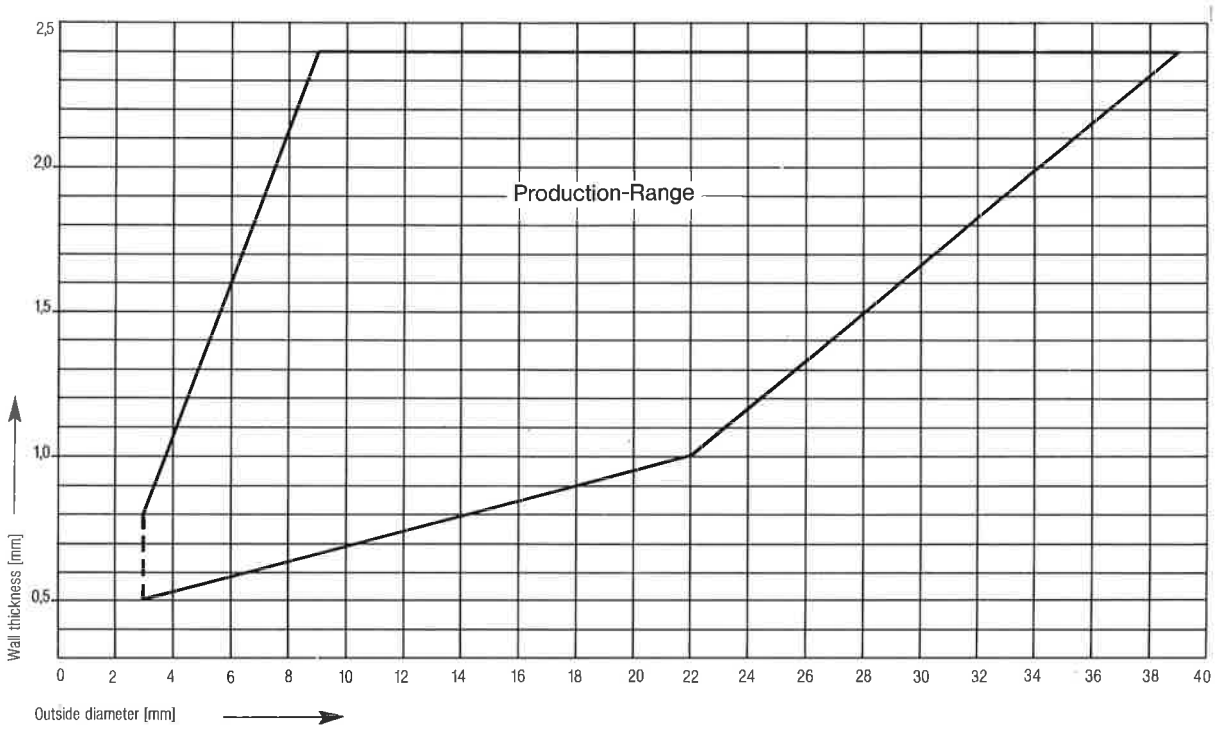
OVISIL® 451/452/454 S

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.



Available dimensions for OVISIL® -glass 455/456/461/462/464S/471/472/474S upon request.

Types

OVISIL® 451, 452, 454 S, 461, 462, 464 S

Application:

Used for burners and exhaust tubes in high pressure discharge lamps for street and indoor applications, floodlighting and cosmetic applications.

Used for arc- and exhaust tubes in UV-lamps, e.g. germicidal lamps. For halogene incandescent lamps bulbs, e.g. projection lamps, automobile headlamps and photographic lamps.

OVISIL® 471, 472, 474 S

Application:

Burners for therapeutic and reprography high and low pressure discharge lamps

OVISIL® 455, 456

Application:

Used for burners and exhaust tubes in high pressure discharge lamps for street and indoor applications, floodlighting and cosmetic applications.

Used for halogene incandescent lamp bulbs, e.g. projection lamps automobile headlamps and photographic lamps. Glass rods for mount assembly.

Availability:

OSRAM OVISIL® tubing is made of pure fine sand and is machine drawn, applying a proprietary process for manufacturing. The distinguished feature in the high homogeneity.

OVISIL® Tubing and Rods are available in several qualities.

Type 451, not annealed, with approx. 150 ppm OH
Type 452, vacuum annealed with < 4 ppm
Type 454 S, vacuum annealed with < 2 ppm OH
with UV reducing additives of TiO_2

Type 455, not annealed, with approx. 75 ppm OH
Type 456, vacuum annealed, with < 4 ppm OH

Type 461, not annealed, with approx. 140 ppm OH
Type 462, vacuum annealed, with < 4 ppm OH
Type 464, vacuum annealed, with < 2 ppm OH

Type 471, not annealed, with approx. 140 ppm OH
Type 472, vacuum annealed, with < 4 ppm OH
Type 474,S vacuum annealed, with < 2 ppm OH

All OVISIL® glasses can be sealed to tungsten wires- and rods by using OSRAM sealing glasses 441/440/439.

The sectional planes of the cut quartz tubing discolor differently due to the vacuum annealing process. However, the transmission properties are not essentialy affected.

Acid processed surfaces ameliorate the optical transparency (e.g. 452 S, 454 S, 462 S, 464 S, 472 S, 474 S).

Third parties may own patents in various countries relating to the processing or the use of OVISIL® quartz glass of the types 455 and 456, and also to further applications in lamps therefrom. However, OSRAM assumes no responsibility or liability for any allegations of patent infringement incurred by the manufacture of lamps and by the use of these quartz glasses. The purchaser assumes full and sole risk of any allocations of patent infringements.

Glass

Types

Outside diameter range mm		Length mm	Tolerance mm	Remarks
Glass OVISIL®				
Modes of supply				
The following dimensions are in constant supply				
Rods with unit lengths (OVISIL® 451/452)				
2,20 - 2,85	± 0,30	1000 - 1240	± 10	ends unfirepolished
Precut rods (OVISIL® 451/452)				
2,20 - 2,85	± 0,30	9,8 - 15,0	± 0,4	ends unfirepolished

Different dimensions of OVISIL® -rods 455/456/461/462 can be considered upon request.

Types

OVISIL ®

Cutting quality

For the manufacture of precut quartz glass tubing five 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 on the required quality):

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

Laser cut for outside diameters from 5,8 to 25,3 mm and lengths from 50 - 136 mm:

wet cut for outside diameters ranging from 3,5 - 30,0 mm and lengths of 10 - 1240 mm $\pm$ 10 mm

Fire polishing

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

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