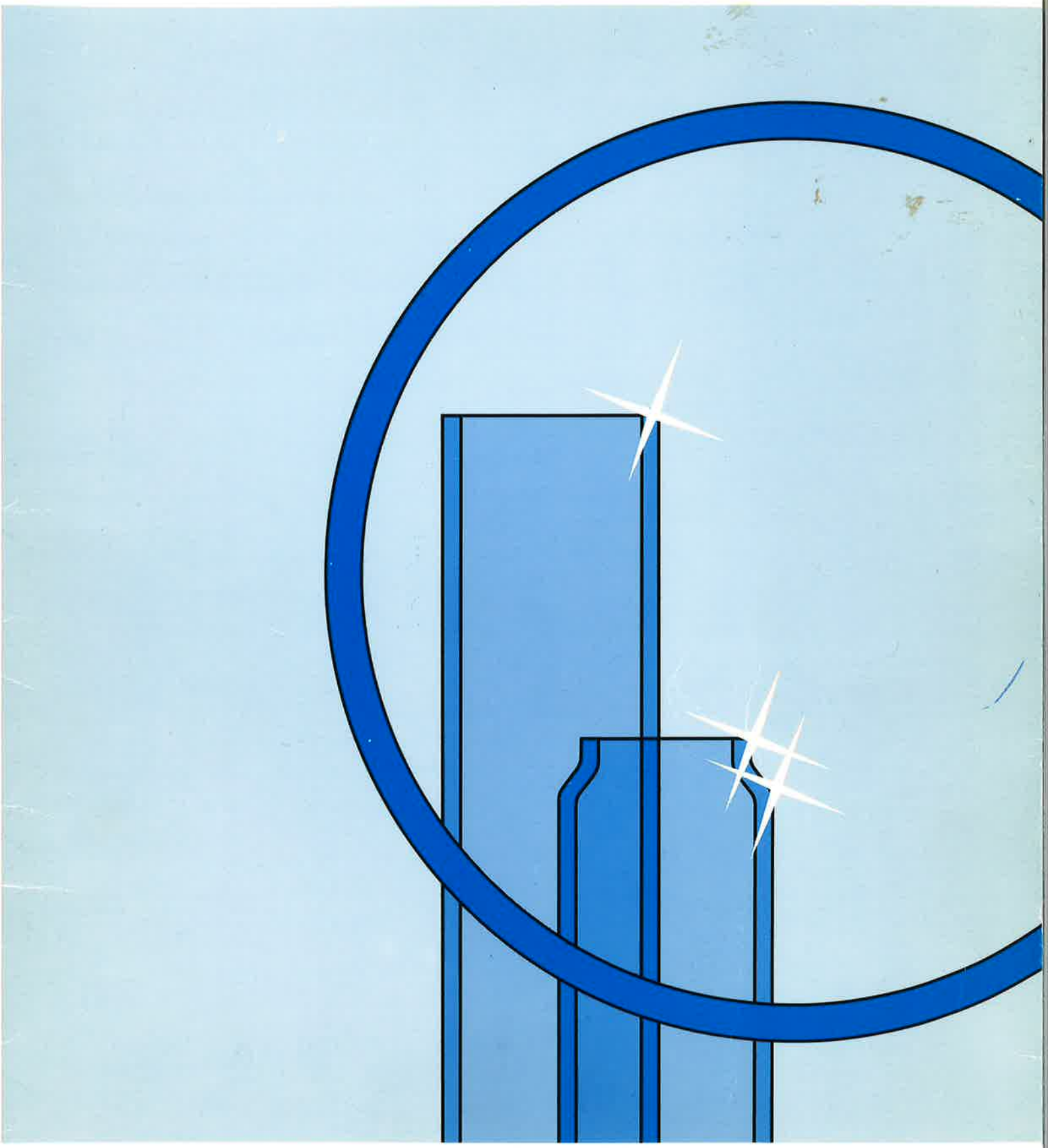
PHILIPS

Lighting

Glass



Philips quartz glasses

Contents

Philips quartz glasses

Section 1

Introduction

PH300/PH308

- PH300 and PH308 are clear fused silica glasses of very high purity: featuring more than 99.99% of SiO_2.
  Both glasses have the typical characteristics of vitreous silica glasses such as low thermal expansion, high viscosity and high electrical resistivity.
- PH300 glass can be supplied as tubing in the range between 5 mm and approx. 42 mm outside diameter. PH300 glass has a very good visual appearance and shows a low degree of visual defects. Main application areas are: high-pressure mercury discharge tubes and tungsten halogen envelopes.
  Vacuum baking of the PH300 quartz glass reduces the OH-content to the desired level; the following classes are available:

PH300/MD	OH-content	< 10 p.p.m.
PH300/ND	OH-content	< 5 p.p.m.
PH300/ED	OH-content	< 2 p.p.m.
PH300/SD	OH-content	≤ 0.5 p.p.m.

- PH308 tubing is available in the range between approx. 2 mm and 5 mm outside diameter. Main application areas are exhaust tubing for lamp production and thermo-couple tubing. PH308 exhaust tubing shows no open airlines, no ridges nor grooves on the outer surface, characteristics which are critical for lamp making.

PH303/PH304

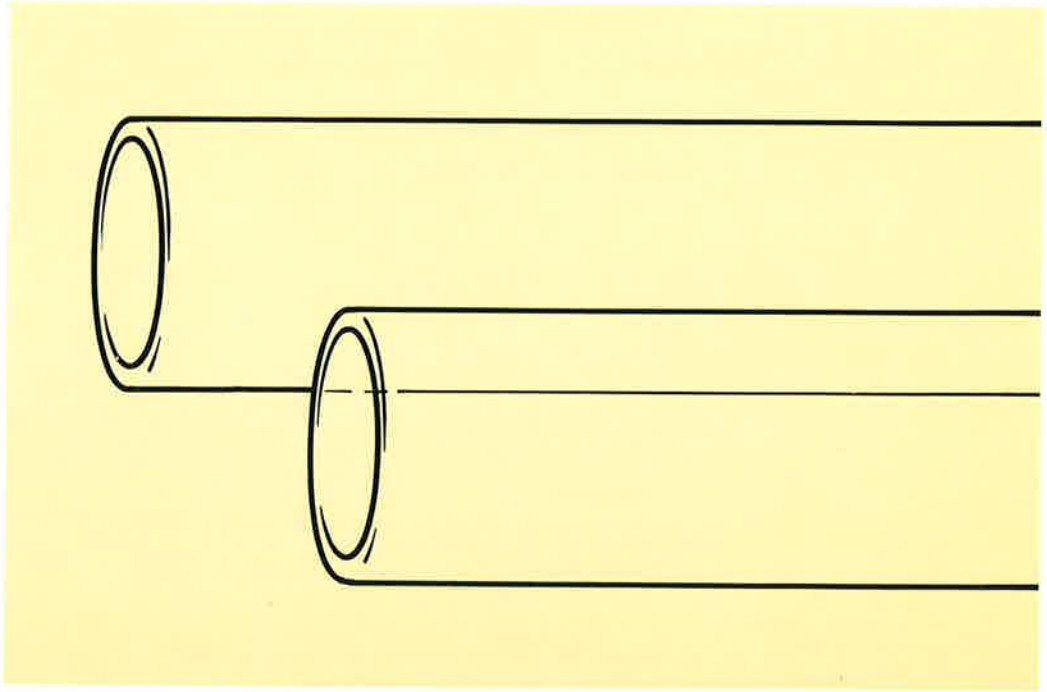
Both PH303 and PH304 are quartz glasses doped with TiO_2.
With the exception of the transmittance, they retain all the other properties of quartz glass, such as low expansion, high viscosity and the electrical characteristics.
The TiO_2 doping absorbs short-wave UV radiation, which encourages the production of ozone. PH303 and PH304 can therefore be described as "ozone-free" quartz glasses.
Both these glasses are used in gas-discharge lamps that are designed to emit UV-A and UV-B radiation, such as sun-tanning lamps, reprographic lamps and xenon flash lamps.
PH303 and PH304 glass tubing is available in the same diameter range as is PH300 glass.
By vacuum baking the same hydroxyl groups can be made:

PH303/MD	PH304/MD	OH-content	< 10 p.p.m.
PH303/ND	PH304/ND	OH-content	< 5 p.p.m.
PH303/ED	PH304/ED	OH-content	< 2 p.p.m.
PH303/SD	PH304/SD	OH-content	≤ 0.5 p.p.m.

Section 2

Glass Data

Pure quartz glass	PH300 PH308
Ozone-free quartz glass	PH303 PH304
Material data according to	GLN - X 03 - 300 GLN - X 03 - 303 GLN - X 03 - 304 GLN - X 03 - 308
Chemical composition	GLV 103 - 3 - 300 GLV 103 - 3 - 303 GLV 103 - 3 - 304 GLV 103 - 3 - 308



Description

Philips PH300 and PH308 are fused silica glasses, available as clear machine-drawn tubing.

Main application areas are:
- high pressure mercury vapour lamps
- halogen lamps
- exhaust tubes
- thermo-couple tubing

Technical data of Philips PH300/PH308 glass

Thermal properties

Coefficient of expansion	25-300°C	$°C^{-1}$ (x 10^{-6})	0.58
Transformation temperature		°C	approx. 1150
Conductivity	20°C	$W \cdot m^{-1} \cdot °C^{-1}$	1.4
Viscosity data			
Strain point	$10^{14.5}$dPa.s	°C	1110
Annealing point	10^{13} dPa.s	°C	1210
Softening point	$10^{7.6}$dPa.s	°C	1670
Working temperature	10^{4} dPa.s	°C	–

Mechanical properties

Density	20°C	$kg \cdot m^{-3}$(x10^3)	2.2
Young's modulus		GPa	73
Poisson's ratio			0.17

Electrical properties

Volume resistivity	$^{10}\log \rho$ 250°C	Ω·cm	–
	$^{10}\log \rho$ 350°C	Ω·cm	10
t_{k100}	10^8 Ω· cm	°C	–
Dielectric constant	at 20°C and 1 MHz		3.7
Loss tangent	at 20°C and 1 MHz	(x 10^{-4})	<2

Optical properties

Index of refraction $n_{.D}$.	at λ = 589.3 nm		1.459
Transmittance (thickness 1 mm) including surface losses			See graph

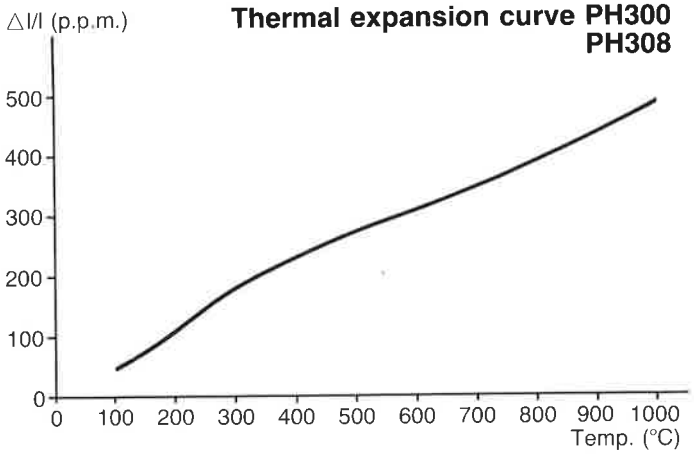
Chemical composition

SiO_2	min. 99.99%

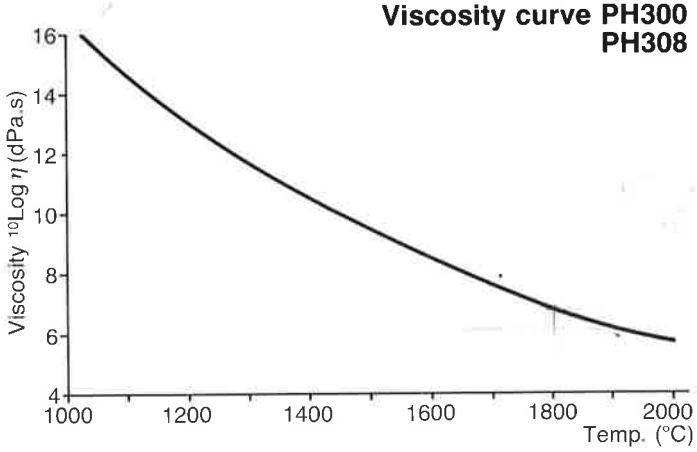
Impurities (Typical values)	p.p.m.	**Impurities** (Typical values)	p.p.m.
Li	1.5	Mn	< 0.1
K	1	Fe	0.7
Na	1	Co	< 0.1
Al	20	Ni	< 0.1
Ca	1	Mg	0.5
Cu	< 0.1	Zr	5
V	< 1	B	< 2
Cr	< 0.1	Ce	< 0.1
Ti	< 0.1		

β-**OH content**		p.p.m.
Unbaked	PH300/PH308	approx. 160
Vacuum baked	MD	< 10
	ND	< 5
	ED	< 2
	SD	≤ 0.5

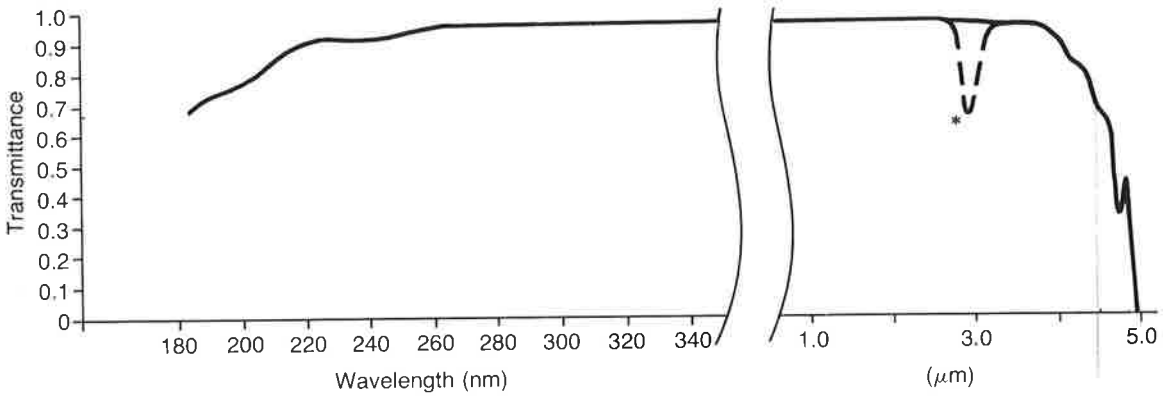
Thermal expansion curve PH300 PH308



Viscosity curve PH300 PH308



Transmittance PH300/PH308
(W.T. 1 mm: i.s.l.)



* Unbaked quality

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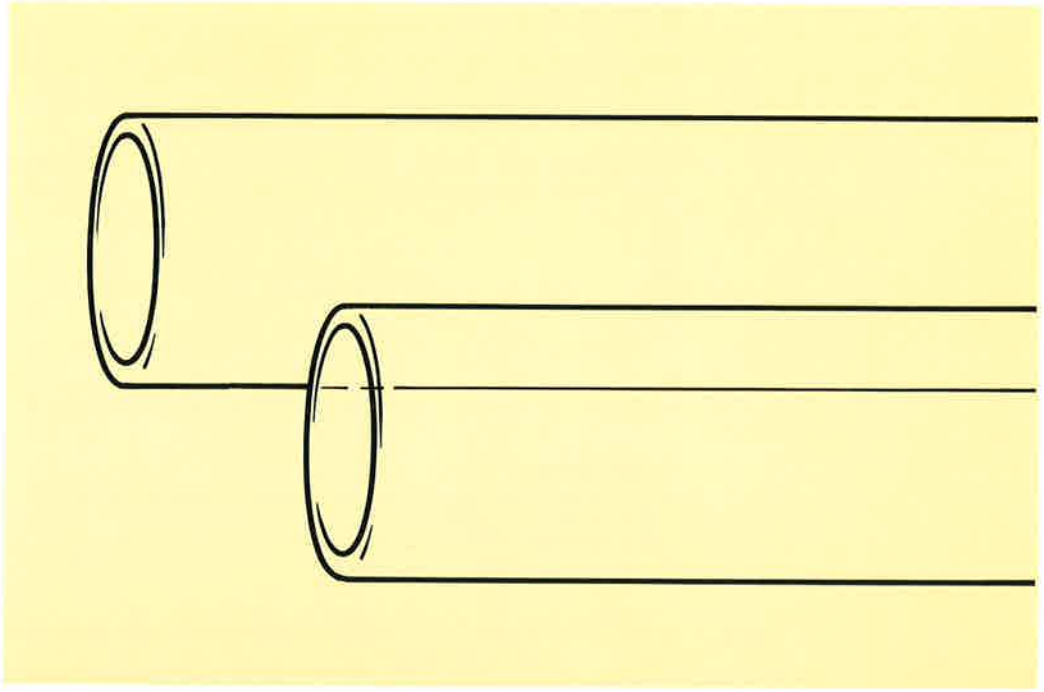


Description

Philips PH303 glass is a fused silica doped with TiO_2 (0.125% by weight), available as clear machine-drawn tubing.
The transmittance of PH303 glass is cut off at 230nm (at 20°C).
Main application areas are:
- sun-tanning lamps
- ozone-free reprographic lamps

Technical data of Philips PH303 glass

Thermal properties

Coefficient of expansion	25-300°C	$°C^{-1}$ (x 10^{-6})	0.58
Transformation temperature		°C	approx. 1150
Conductivity	20°C	$W \cdot m^{-1} \cdot °C^{-1}$	1.4
Viscosity data			
Strain point	$10^{14.5}$dPa.s	°C	1110
Annealing point	10^{13} dPa.s	°C	1210
Softening point	$10^{7.6}$dPa.s	°C	1670
Working temperature	10^{4} dPa.s	°C	–

Mechanical properties

Density	20°C	$kg \cdot m^{-3}$ (x10^3)	2.2
Young's modulus		GPa	73
Poisson's ratio			0.17

Electrical properties

Volume resistivity	$^{10}\log \rho$ 250°C	Ω·cm	–
	$^{10}\log \rho$ 350°C	Ω·cm	10
t_{k100}	10^8 Ω· cm	°C	–
Dielectric constant	at 20°C and 1 MHz		3.7
Loss tangent	at 20°C and 1 MHz	(x 10^{-4})	<2

Optical properties

Index of refraction n_D	at λ = 589.3 nm		1.459
Transmittance (thickness 1 mm) including surface losses			See graph

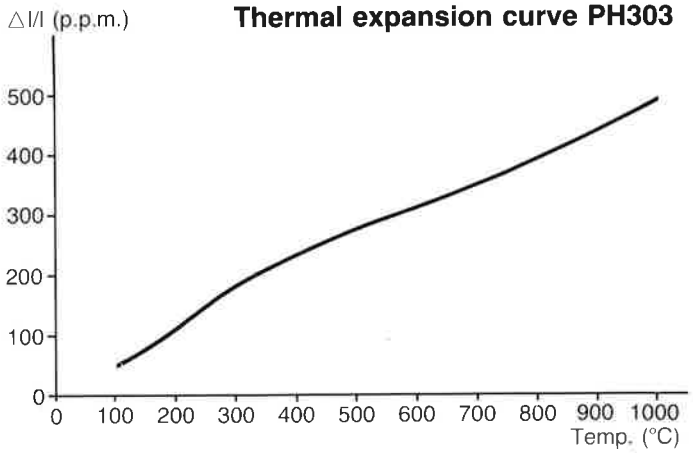
Chemical composition

SiO_2	min. 99.8%
TiO_2	approx. 0.125%

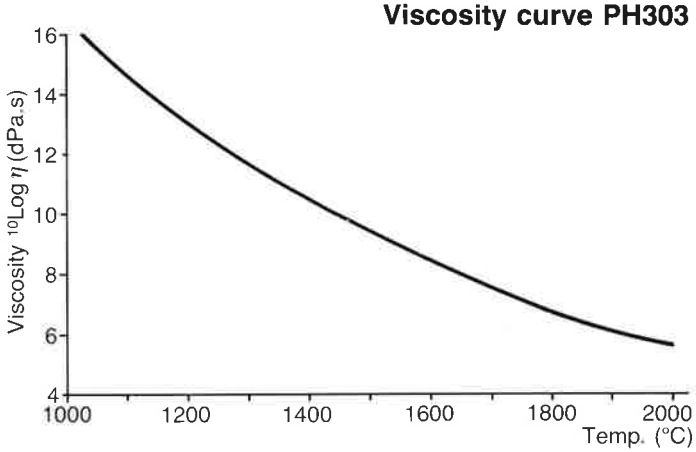
Impurities (Typical values)	p.p.m.	**Impurities** (Typical values)	p.p.m.
Li	1.5	Mn	< 0.1
K	1	Fe	0.7
Na	1	Co	< 0.1
Al	20	Ni	< 0.1
Ca	1	Mg	0.5
Cu	< 0.1	Zr	5
V	< 1	B	< 2
Cr	< 0.1	Ce	< 0.1

β-**OH content**		p.p.m.
Unbaked	PH303	approx. 160
Vacuum baked	MD	< 10
	ND	< 5
	ED	< 2
	SD	≤ 0.5

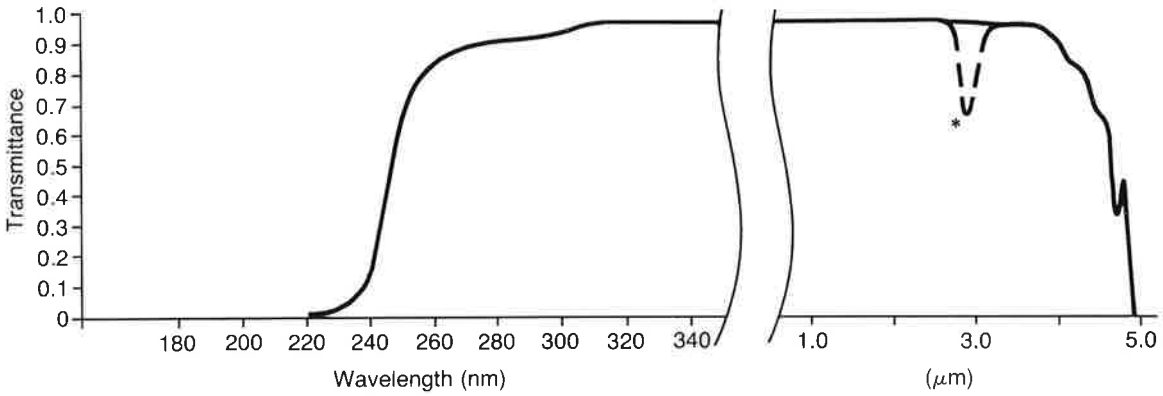
Thermal expansion curve PH303



Viscosity curve PH303



Transmittance PH303
(W.T. 1 mm: i.s.l.)



* Unbaked quality

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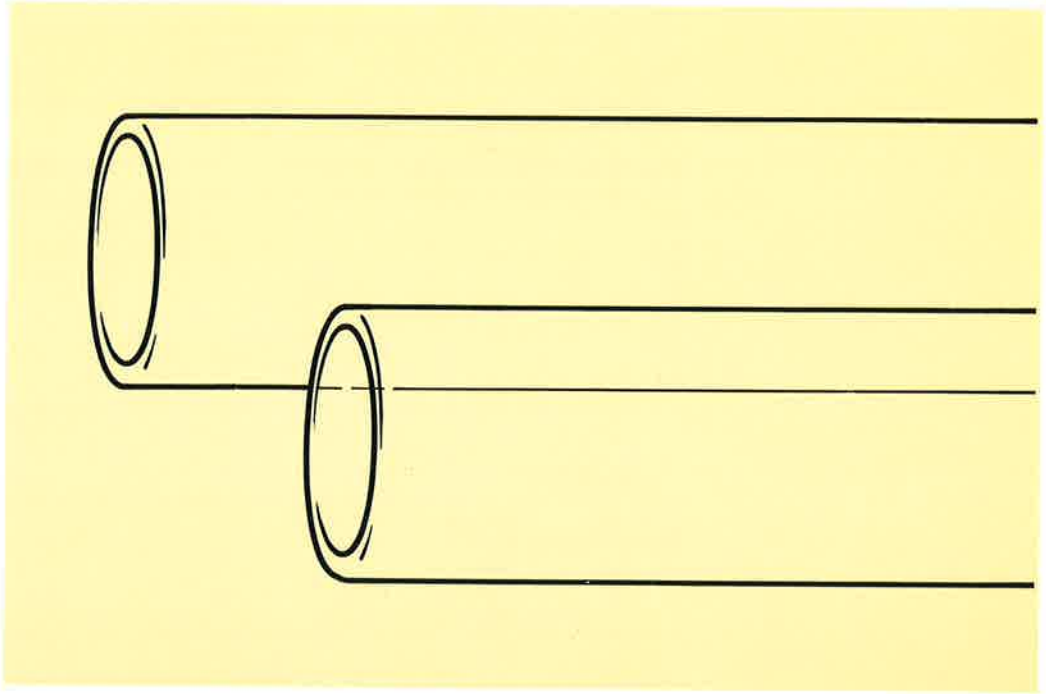


Introduction

Philips PH304 glass is a fused silica doped with TiO_2 (0.02% by weight), available as clear machine-drawn tubing.
The transmittance of PH304 glass is cut off at 220nm (at 20°C).
Main application areas are:
- ozone-free reprographic lamps
- high-pressure xenon discharge lamps
- industrial applications, such as hardening of lacquers and inks, and polymerisation of plastics.

Technical data of Philips PH304 glass

Thermal properties

Coefficient of expansion	25-300°C	$°C^{-1}$ (x 10^{-6})	0.58
Transformation temperature		°C	approx. 1150
Conductivity	20°C	$W \cdot m^{-1} \cdot °C^{-1}$	1.4
Viscosity data			
Strain point	$10^{14.5}$dPa.s	°C	1110
Annealing point	10^{13} dPa.s	°C	1210
Softening point	$10^{7.6}$dPa.s	°C	1670
Working temperature	10^{4} dPa.s	°C	–

Mechanical properties

Density	20°C	$kg \cdot m^{-3}$(x10^3)	2.2
Young's modulus		GPa	73
Poisson's ratio			0.17

Electrical properties

Volume resistivity	$^{10}\log\rho$ 250°C	Ω·cm	–
	$^{10}\log\rho$ 350°C	Ω·cm	10
t_{k100}	10^8 Ω· cm	°C	–
Dielectric constant	at 20°C and 1 MHz		3.7
Loss tangent	at 20°C and 1 MHz	(x 10^{-4})	<2

Optical properties

Index of refraction n_D	at λ = 589.3 nm		1.459
Transmittance (thickness 1 mm) including surface losses			See graph

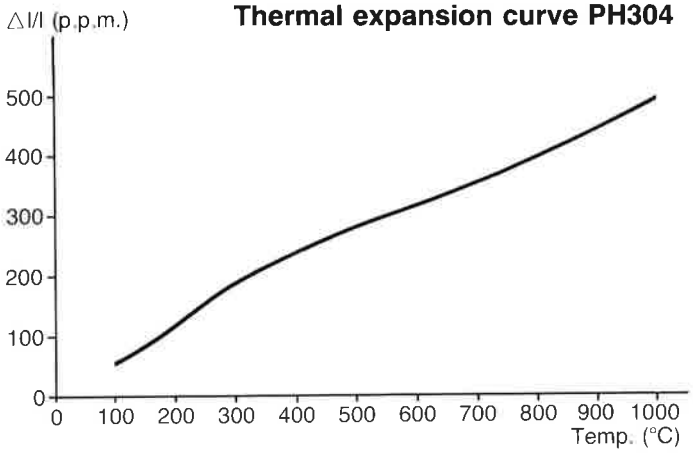
Chemical composition

SiO_2	min. 99.9%
TiO_2	0.02%

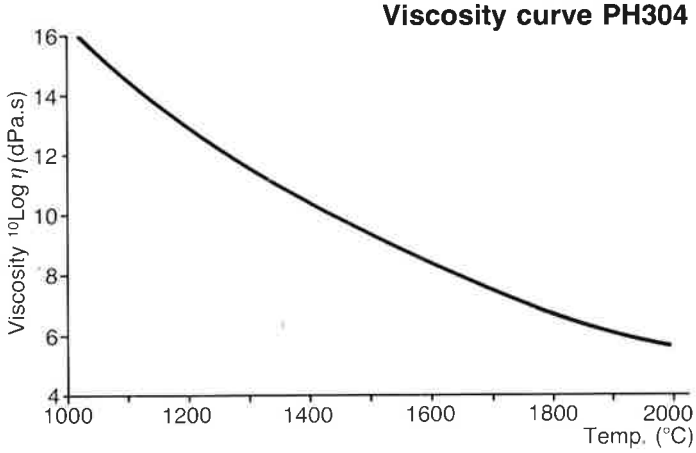
Impurities (Typical values)	p.p.m.	**Impurities** (Typical values)	p.p.m.
Li	1.5	Mn	< 0.1
K	1	Fe	0.7
Na	1	Co	< 0.1
Al	20	Ni	< 0.1
Ca	1	Mg	0.5
Cu	< 0.1	Zr	5
V	< 1	B	< 2
Cr	< 0.1	Ce	< 0.1

β-**OH content**		p.p.m.
Unbaked	PH304	approx. 160
Vacuum baked	MD	< 10
	ND	< 5
	ED	< 2
	SD	≤ 0.5

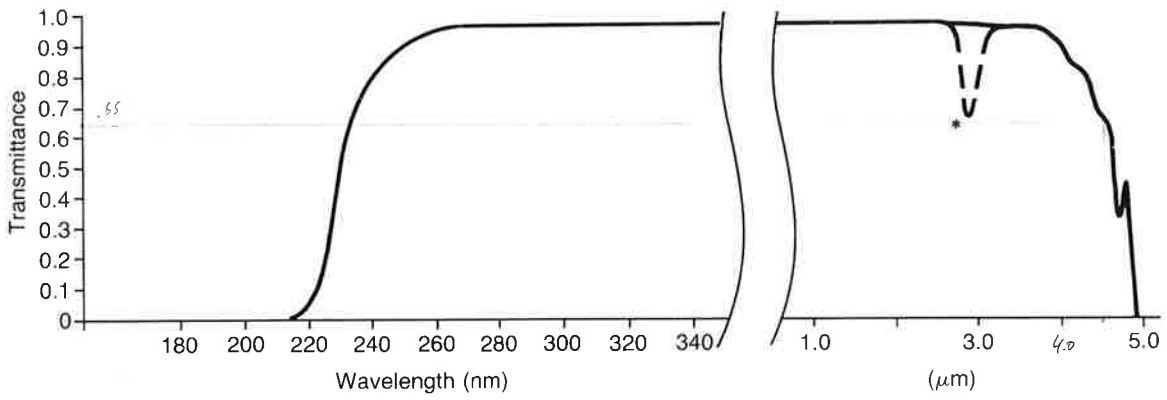
Thermal expansion curve PH304



Viscosity curve PH304



Transmittance PH304
(W.T. 1 mm: i.s.l.)



*Unbaked quality

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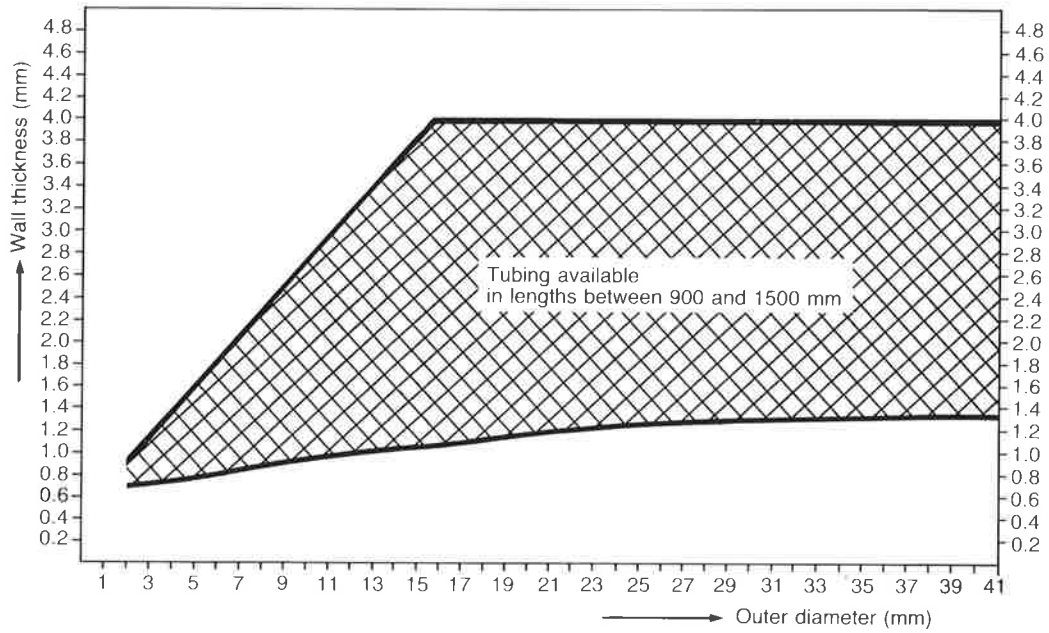
Section 3

Dimensional Specifications for Tubing

Rough-cut drawn tubing
The hatched part of the diagram below shows the combination of outside diameter and wall thickness which can be supplied as machine-drawn tubing.



TOLERANCES FOR QUARTZ GLASS TUBING

Outer diameter	:	+/− 3 % for OD ≤ 5 mm
Outer diameter	:	+/− 2 % for OD > 5 mm
Out of round	:	≤ 2 % for OD ≤ 5 mm
Out of round	:	≤ 1.5% for OD > 5 mm
Wall thickness	:	+/− 10 %
Siding of nominal wall	:	≤ 12 %
Bow	:	≤ 2 mm/m
Length	:	+/− 10 mm (rough cut)

If tighter tolerances are required, mutual agreement has to be reached.

Section 4

Inspection Procedures

1. **Sampling plans**
   According to
   a. MIL. STD. 414 or I.S.O./D.I.S. 3951
      "Inspection by variables"
   b. MIL. STD. 105 D or I.S.O./D.I.S. 2859
      "Inspection by attributes"

2. **Lot size**
   A lot is defined as all of the tubes of one single type per shipment. Minimum lot size is one standard packing unit.

3. **Sample size**
   a. "Inspection by variables".
      apply: general inspection level II.

   b. "Inspection by attributes".
      apply: general inspection level II.

4. **Dimensions**
   a. "Inspection by variables"
      As "Inspection by variables" is based upon estimated lot average ($\bar{x}$) and estimated lot standard deviation (s), this method provides substantially more information about the dimensional quality aspects than does "inspection by attributes".
      Philips Glass Division will apply "Inspection by variables" as a standard inspection method for all dimensional aspects, to assure outgoing quality.

   b. "Inspection by attributes" (go/no-go inspection) can be applied as an outgoing or incoming inspection method. This method gives fast information about whether products are within the permitted tolerances, and enables several defects to be brought together under one AQL percentage.
      AQL percentages given in section 5 for dimensions are meant for "Inspection by attributes".

5. **Visual aspects**
   Philips Glass Division will apply "Inspection by attributes".

6. **Classification of defects**
   Defects are classified as follows:
   a. Class I AQL 0.4%
      Defects which ultimately lead to a rejectable or unsafe end-product.
   b. Class II AQL 1.5% dimensions.
      AQL 1.0% visual aspects.
      Defects which are liable to cause the product to be rejected or to cause problems during further processing.
   c. Class III AQL 2.5%
      All other visual aspects; mostly aesthetic.

Section 5

Classification of Defects

Dimensions

Class I AQL 0.4%	Class II AQL 1.5%	Class III AQL 2.5%
001 – 002 –	021 Outside diameter 022 Out of round 023 Wall thickness 024 Siding 025 Length 026 Bow 027 Squareness of ends	041 Chipped ends 042 043

Visual PH300, PH303, PH304

Class I AQL 0.4%	Class II AQL 1.0%	Class III AQL 2.5%
101 Cracks/checks	121 Metal parts 122 Ridges/grooves 123 Airlines/voids 124 Crystallisation	141 Dirt/splinters

Visual PH308

Class I AQL 0.4%	Class II AQL 1.0 %	Class III AQL 2.5 %
101 Cracks/checks 122 Ridges/grooves Open airlines 141 Dirt/splinters		121 Metal 123 Airlines/voids

Physical
Density
Transmittance
ß-OH content
are checked once a day and must be within the Philips tolerances.

Note
Browning: PH300 tube-drawn quality (ß-OH content approx. 160 p.p.m.) may occasionally turn brownish or discolour if the glass is baked to ß-OH values below 1.5 p.p.m.
For ß-OH values above 1.5 p.p.m. no discoloration will occur.
The baked PH300 qualities MD, ND and ED will therefore not show discoloration.

Section 6

Inspection Criteria for Dimensions

1. **General**
   a) All tubing dimensions and tolerances specified in the graph in section 3 are understood to be "all points in".
   This means that the results of all measurements must be within the specified tolerances.
   b) Wherever disagreement exists between the general specifications and the individual tubing specifications, the latter shall prevail.

2. **Inspection criteria**

Defect 021 Outside diameter
Definition : each tubing outside diameter measured at right angles to the axis.
Limits : see individual tubing specifications.

Defect 022 Out of round
Definition : the maximum OD variation measured in a cross section at right angles to the axis.
Limits : see individual tubing specifications.

Defect 023 Wall thickness
Definition : each tubing wall thickness measured at right angles to the axis
Limits : see individual tubing specification.

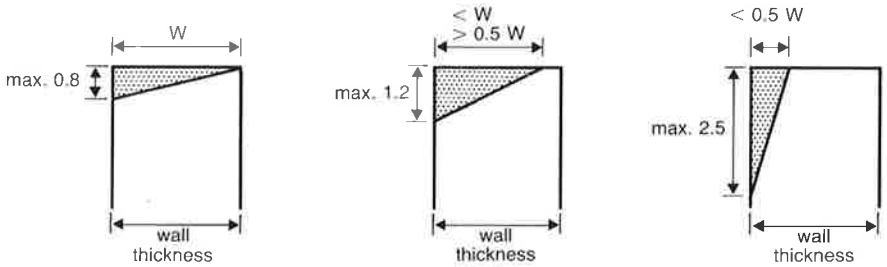
Defect 024 Siding
Definition : the maximum difference in wall thickness measured in a cross section at right angles to the axis.
Limits : see individual tubing specifications.

Defect 025 Length
Definition : the total length of the tube measured between two parallel plates at both extremities of the tube.
Limits : a) rough-cut tubing: see individual tubing specifications.
b) saw-cut tubing: see individual tubing specifications.

Defect 026 Bow
Definition : the maximum deviation, with respect to a straight line, measured between two points that are x mm apart (span).
Limits : a) see individual tubing specifications.
b) general limit: max. 2 mm/m.

Defect 027 Squareness of ends
Definition : deviation of the perpendicular plane of the cut end with respect to the axis of the tubing, including all irregularities.
Limits : a) rough-cut tubing: cutting irregularities shall be within half the length tolerance.
b) saw-cut tubing: see individual tubing specifications.

Defect 041 Chipped ends
Definition : glass particles chipped off from open ends of glass tubing.
Limits : a) rough-cut: max. length of V and/or skive chip: 10 mm.
b) saw-cut: see outlines (dimensions in mm).



Section 7

Inspection Criteria for Visual Aspects

Defect 101 Cracks, checks, bruises
Definition : a) Crack: a fissure through the wall of the tube.
b) Check: a fissure extending into the wall of the tube.
c) Bruise: a fissure which is usually half moon or of a similar configuration and which has no glass removed from the surface. It is irridescent under bright light and is caused by impact.
Limits : a) Rough-cut tubing:
1) Crack, check or bruise within distance of 10 mm from ends shall be disregarded.
2) Crack or check in tube body: reject all degrees.
3) Bruise in tube body: reject all degrees that show a definite check visible to the unaided eye within or extending from the bruise.
b) Saw-cut tubing:
1) Crack, check: reject all degrees.
2) Bruise: reject all degrees that show a definite check visible to the unaided eye within or extending from the bruise.

Defect 121 Metal parts
Definition : Metal particles embedded in the glass.
Limits : a) Reject all metal particles with dimensions (length + width)/2 > 0.5 mm.
b) Reject all tubing containing more than 2 metal particles with dimensions "(length + width)/2 < 0.5 mm".

Defect 122 Ridges/grooves
Definition : Sharp irregularities, extending in the axial direction of the tube, situated on the outer surface of the wall.
Limits : PH300, PH303, PH304: Reject all degrees that cause a bad legibility of standard letter type Times Corps 8/9, from a distance of 25 mm between letters and tube.
PH308: no ridges/grooves allowed.

Defect 123 Airlines/voids
Definition : Elongated gas inclusion or vacuum line in the wall of the tube.
Limits : **Width for PH300, PH303, PH304**

OD of tubing	max. width of void
5 - 13 mm	0.25 mm
13 - 25 mm	0.4 mm
25 - 40 mm	0.75 mm

Length and number of voids PH300, PH303, PH304

Nominal tube length (L) (mm)	Number of voids allowed		
	Length of void (mm)		
	> 15	> 100	> 250
L < 100	1	0	0
100 < L < 250	2	1	0
250 < L < 500	3	1	0
500 < L < 1200	5	1	0
1200 < L	7	2	0

Width for PH308
Max. width of void 0.15 mm.
Max. 3 voids in one cross-section, of which 1 void > 0.10 mm.
Open airlines: not allowed.

Defect 124 Crystallisation
Definition : Crystals brought about by devitrification of the glass.
Limits : Reject any degree readily visible with the unaided eye.

Defect 141 Dirt/splinters
Definition : a) Dirt: tubing with any extranous material on the surface, either inside or outside (dust, grease etc.).
b) Splinters: glass particles sticking to the inner or outer surface of the tubing.
Limits : Reject all degrees not removable with standard washing processes.

Section 8

Apparatus for Measurement

Dimensions

021	Tube OD	micrometer/dial caliper
022	Tube o.o.r.	micrometer/dial caliper
023	Wall thickness	micrometer/dial caliper
024	Siding	micrometer/dial caliper
025	Length	ruler
026	Bow	bow measuring assembly
027	Squareness of ends	dial caliper
028	Chipped ends	measuring magnifier

Visual aspects

101	Cracks, checks, bruises	light box + dark background
121	Metal particles	measuring magnifier
123	Airlines/voids	measuring magnifier

Physical aspects

Transmittance	spectrofotometer
ß-OH content	IR-spectrofotometer

Section 9

Packaging

Packaging must permit shipment with less than 2% of breakage. Excess of 2% will be the liability of either supplier or transportation company.
Packaging must be such that the product quality continues to meet the requirements during transportation and storage. Formation of standard packing units depends on product dimensions and will be subject of a study as soon as product specifications are known.

Section 10

Labelling

a) Each packing unit will bear a label stating:
   - code number;
   - glass type;
   - main product dimensions;
   - lot identification number;
   - quantity of products (number or kg);
   - number of production run;
   - date of inspection.

b) Each packing unit will bear a label stating:
   "GLASS - HANDLE WITH CARE" or similar international label indicating that the shipped unit contains glassware.

c) A quality certificate will be attached to each pallet unit.

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