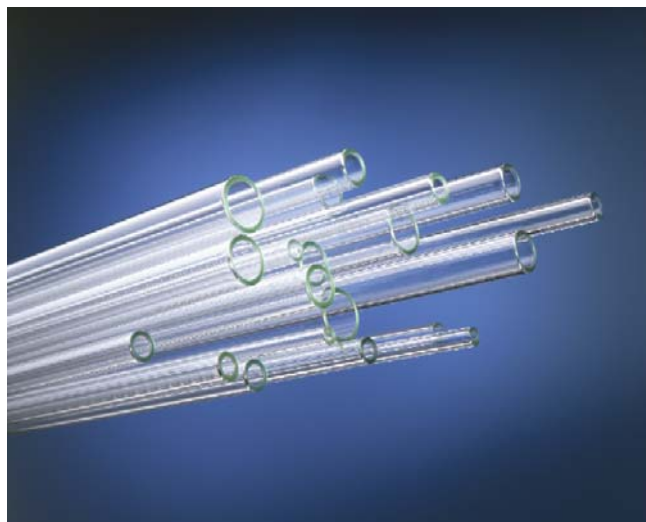


## THERMAL PERFORMANCE

SYLVANIA's lead and arsenic free borosilicate glass tubing is a low expansion glass ideal for high temperature performance and tungsten sealing applications.

## FULL SERVICE

SYLVANIA's extensive product offering includes both hard glass tubing and bulbs made from the same composition.



### Products

SYLVANIA has a broad range of products that service lighting as well as other special applications.

<i>Tubing Diameter (English)</i>	<i>Tubing Diameter (Metric)</i>	<i>Application</i>
.070 - .160"	1.78 – 4.07mm	➤ HID bead tubing for sealing ➤ Cold cathode fluorescent tubing
.161 - .300"	4.08 – 7.63mm	➤ Exhaust tubing for lighting ➤ Fuse tubing
.301 - .700"	7.64 – 17.79mm	➤ Flare tubing for lighting
.701 - .810"	17.80 – 20.57mm	➤ Special applications

<i>Rod Diameter (English)</i>	<i>Rod Diameter (Metric)</i>	<i>Application</i>
.130"	3.30 mm	➤ Internal lamp supports and special applications
.140"	3.56 mm	
.150"	3.81 mm	
.160"	4.06 mm	
.170"	4.32 mm	
.200"	5.08 mm	

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# TECHNICAL INFORMATION BULLETIN

## Process and Capabilities

SYLVANIA begins by melting batch materials in an oxygen-fired furnace. The temperature of the molten glass is then conditioned in one of the tank's electric forehearth until proper forming temperatures are reached. Tubing is then drawn using a velo process. SYLVANIA offers a broad range of tubing sizes and rod for a variety of applications.

## Composition

SYLVANIA's SG773 borosilicate glass is lead and arsenic free. The following are typical composition values. Actual values may vary to accommodate the melting process and maintain the controlled properties.

	SiO <sub>2</sub>	Na <sub>2</sub> O	K <sub>2</sub> O	BaO	B <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>
SG773	76	3	2	2	14	3

The following oxides are present as minor constituents: Li<sub>2</sub>O, Fe<sub>2</sub>O<sub>3</sub>, CeO<sub>2</sub>, TiO<sub>2</sub>.

## Glass Properties

SYLVANIA maintains the following controlled properties to provide a glass with consistent forming and sealing properties.

Controlled Property	Controlled Measure	Tolerance
Thermal Expansion (25 - 300°C)	39	± 1.5 x 10 <sup>-7</sup> cm/cm/ °C
Softening Point (10 <sup>7.6</sup> Poise)	773	± 5 °C

## Thermal Properties

SYLVANIA's borosilicate glass is used in applications where thermal shock resistance is needed. This makes it ideal for many applications.

Property	Typical Measure
Working Point (@ 10 <sup>4</sup> poise)	1164 °C
Annealing Point (@10 <sup>13</sup> poise)	547 °C
Strain Point (@10 <sup>14.6</sup> poise)	497 °C

Proper annealing of the glass after forming or sealing will prevent cracking and breakage due to residual forming stresses. The annealing point is the hot end of the annealing range. Glass must be cooled slowly within the annealing range to prevent permanent stresses from forming.

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## Mechanical Properties

The mechanical properties of borosilicate glass are as follows:

<i>Property</i>	<i>Typical Measure</i>
Young's Modulus	6.47 x 10 <sup>3</sup> kg/mm
Poisson's Ratio	0.19
Density	2.30 g/cm <sup>3</sup>

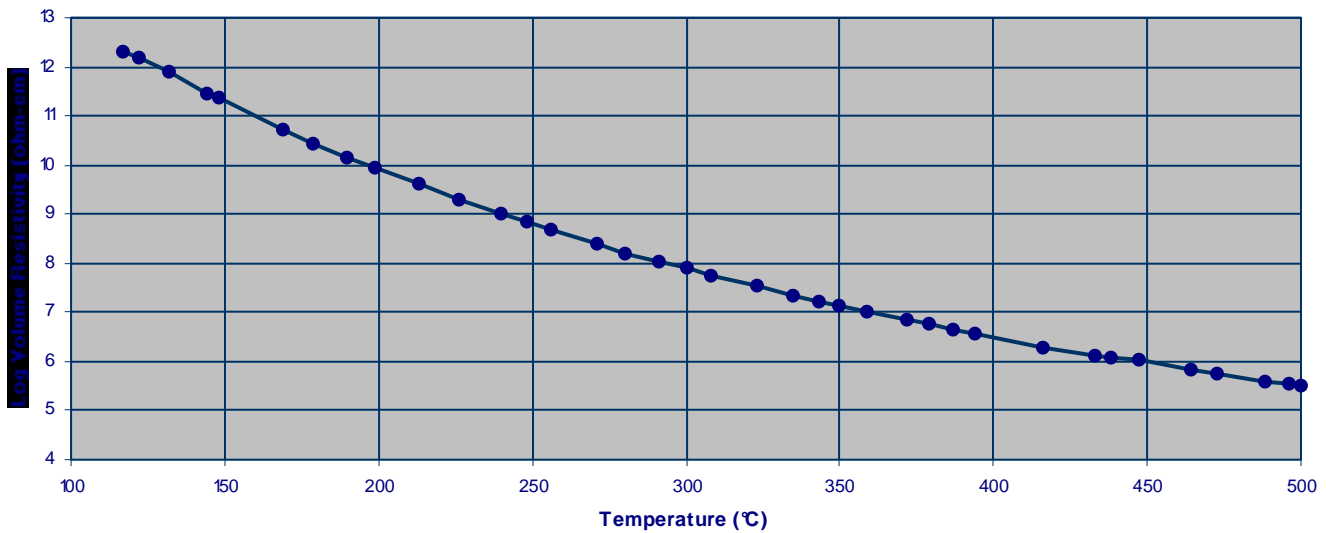
\*The design tensile strength is usually recommended as 1000psi.

## Electrical Properties

As with most glasses SG773 is an insulator at room temperature. As temperature increases resistivity drops as a result of the migration of conductive alkali ions in the glass. The change in resistivity from 250°C to 350°C is shown below:

<i>Property</i>	<i>Typical Measure</i>
Log <sub>10</sub> Volume Resistivity	
@ 250 °C	8.8 Ω-cm
@ 350 °C	7.1 Ω-cm

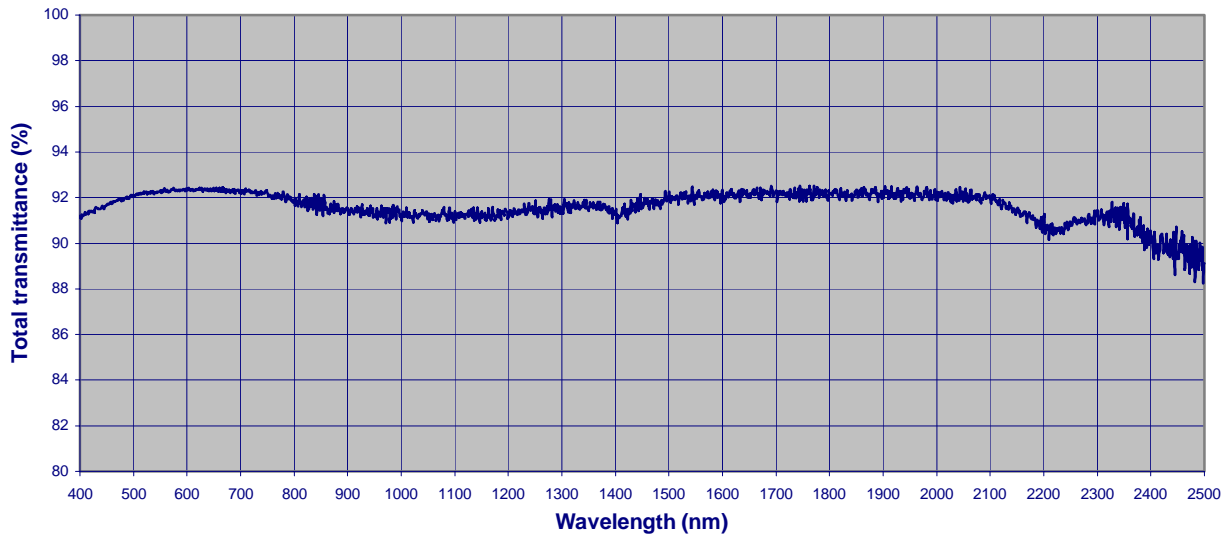
SG773 - DC Electrical Resistivity



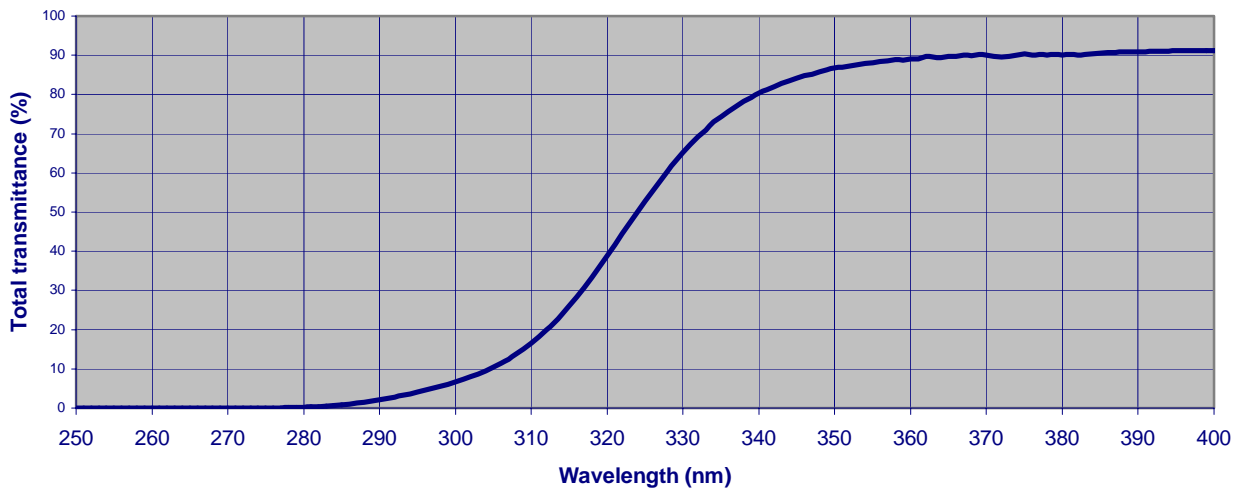
## Optical Transmission

Transmittance in the visible, ultraviolet (UV) and infrared (IR) wavelengths was established to optimize lumen output while minimizing UV radiation.

**SG773 Visible-Infrared Transmittance**



**SG773 Ultraviolet Transmittance**



\*Lamp operating conditions can alter the optical properties of glasses.

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# BOROSILICATE TUBING

## Optical Properties

The following properties can be used when studying SG773 glass.

<i>Property</i>	<i>Typical Measure</i>
<b>Index of Refraction</b>	1.479
<b>Birefringence Constant</b>	360 (nm/cm)/(kg/mm <sup>2</sup> )

The index of refraction can be used for ordering immersion oil for studying stresses in the wall of the glass. The birefringence constant can be used to convert a stress that has been measured in degrees retardation to kg/mm<sup>2</sup> or psi. The formula for this conversion is:

$$\text{Stress} = (\text{°R} \times L) / (C \times t)$$

Where            °R is the reading from the polarimeter in degrees  
                       L is the wavelength used in the polarimeter / 180°  
                       C is the birefringence constant  
                       t is the path length of the light in the glass (i.e. wall thickness)

## Forming Dimensions

After the tube drawing process, various measurements are taken by both operators and quality inspectors to ensure that specifications are met. The following is a general guideline of dimensions that are checked.

<i>Dimension</i>	<i>Measure</i>	<i>Gauging Technique</i>
<b>Outside Diameter</b>	Minimum / Maximum	Variable Indicator Gauge
<b>Out of Round</b>	Maximum	Calculated Measurement
<b>Wall Thickness</b>	Minimum / Maximum	Variable Indicator Gauge
<b>Wall Siding</b>	Maximum	Calculated Measurement
<b>Bow</b>	Maximum	≤.200" OD – Go / No Go Plug Gauges >.200" OD – Variable Indicator Gauge
<b>Length</b>	Minimum / Maximum	≤.300" OD – Go / No Go Length Gauge >.300" OD – Variable Indicator Gauge
<b>Glaze OD</b>	Maximum	Go / No Go Ring Gauge
<b>Glaze ID</b>	Minimum	Go / No Go Plug Gauge

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# TECHNICAL INFORMATION BULLETIN

## Visual Forming Criteria

The visual forming criteria are those that cannot be measured by gauging and are considered attribute data. To evaluate these criteria visual limit samples and/or definitions are established along with a sampling plan to ensure that non-conforming product is identified and contained.

## Glass Quality Criteria

Glass quality criteria have been developed to identify and define typical imperfections that can be present as a result of the borosilicate glass melting process. Most of these do not affect structural integrity, and are judged mainly due to the visual appearance of the glass. These criteria are controlled as attributes.

## Cutting

SYLVANIA offers standard long length tubing of 1220 mm. Long length tubing will be either rough-cut or trimmed and glazed depending upon the OD of the tubing. Tubing can also be cut to desired lengths offering tighter tolerances as needed.

	<b>OD (mm)</b>	<b>Length</b>	<b>Tolerance</b>
<b>Rough Cut</b>	<b>1.78 – 7.63mm</b>	Long Length – 1220mm	± 25.4 mm
<b>Trim &amp; Glaze</b>	<b>7.64 – 20.57mm</b>	Long Length – 1220mm	± 3.18 mm
<b>Cut Piece</b>	<b>All</b>	3.80 – 1220 mm	± 0.75 mm*

\*Tighter tolerances available upon request.

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# BOROSILICATE TUBING

## Packaging

SYLVANIA's standard packaging for long length borosilicate tubing is a tote pack configuration. Long length carton packs are available for smaller diameter tubing with order quantities less than 2200 kg. Cut pieces are packaged in smaller boxes and vary in size depending on OD and cut length.

	<b>OD (mm)</b>	<b>Packaging</b>	<b>Weight*</b>
<b>Long Length</b>	<b>1.78 – 7.63mm</b>	Tote Pack	1800 kg – 3300 kg
		Long Length Carton Pack	50 - 175 kg
<b>Long Length</b>	<b>7.64 – 20.57mm</b>	Tote Pack	1300 – 1800 kg
<b>Cut Piece</b>	<b>All</b>	Small Carton Pack	< 75 kg

\*Weights given are approximate as they vary depending on tubing size and fill volume.

\*\* Conversion: Weight in lbs = (Weight in kg / 2.2kg/lb)

## Quality Assurance

SYLVANIA controls the quality of the product throughout the entire process. Specifically for finished goods an electronic data system has been developed that provides a detailed inspection plan for both operators and quality inspectors. Variable data is monitored and/or controlled using both average and range limits. Attribute data is also controlled using a specified sampling plan.

<b>Process Step</b>	<b>Quality Assurance Measures</b>
<b>Incoming Raw Material</b>	➤ Certificate of Analysis from supplier
<b>Glass Properties</b>	➤ Regular monitoring of controlled glass properties
<b>Dimensional Forming Criteria</b>	➤ Regular dimensional checks
	➤ Statistical controls for critical dimensions
<b>Visual Forming Criteria</b>	➤ Regular sampling against visual forming criteria
<b>Glass Quality Criteria</b>	➤ Regular sampling against glass quality criteria

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**How to Order**

Requests for quotes and purchase orders are managed through our Marketing and Customer Service groups. Quotations can be made on a delivered basis allowing our customers to benefit from our negotiated freight rates.

<b>Information for Quoting and Ordering</b>	
<b>1. Product Type</b>	<ul style="list-style-type: none"> <li>➤ Indicate the product (s) of interest.</li> <li>➤ Product description should be: OD x Wall Thickness x Length</li> <li>➤ For a new product, provide any information concerning special tolerance requirements.</li> </ul>
<b>2. Quantity</b>	<ul style="list-style-type: none"> <li>➤ Provide requested quantity:                             <ul style="list-style-type: none"> <li>• Long length product is sold by weight.</li> <li>• Cut tubing is sold by number of pieces.</li> </ul> </li> <li>➤ Specialty types may require a minimum purchase quantity.</li> </ul>
<b>3. Delivery</b>	<ul style="list-style-type: none"> <li>➤ Specify shipping terms requested. SYLVANIA can provide the benefit of negotiated freight rates by quoting prices as delivered.</li> <li>➤ Specify desired delivery date.</li> </ul>

**Contact Us**

You can contact us at our headquarters or at any of our worldwide sales offices:

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