TECHNICAL INFORMATION BULLETIN

BOROSILICATE BLOWNWARE

THERMAL RESISTANCE

SYLVANIA's lead and arsenic free borosilicate glass provides high thermal shock resistance making it ideal for HID Lighting applications.

FULL SERVICE

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

Products

Type	*Diameters (English)**	*Diameters (mm)*	*Shape Description*
A	23	73	Standard A-line shape
BD	17	54	Small elliptical with dimple
BRL	38	120	One piece PAR
BT	28, 36, 37, 46, 56	90, 116, 120, 146, 180	Standard elliptical with dome
E	17	54	Small elliptical without dimple
E	18, 25	57, 79	Elongated with graduated diameter
ED	17, 23.5, 28, 37	54, 75, 90, 120	Standard elliptical with dimple
ED	18	57	Elongated with shoulder and dimple
ET	18, 23.5	57, 75	Elongated with graduated diameter
ET	23.5	75	Elliptical with dome
P	25	79	Pear shape – Clear only
PS	40	125	Pear shape with neck – Clear only
R	40, 57, 60	125, 181, 190	Reflector shape – Clear / Red stain for R40
RD	40	125	Reflector with raised dimple - Clear
T	14.5, 16	46, 50	Standard Tubular

*English measure shown in eighth inch units

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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 forehearths until proper forming temperatures are reached. Bulbs are then blown into molds using discrete "gobs" of glass. Product capabilities are primarily determined by equipment and process limitations.

Product Dimension	Minimum Dimension	Maximum Dimension
Overall Length	170 mm	415 mm
Diameter	45 mm	250 mm

*Each new product request will be evaluated individually for process capability.
** Maximum overall length capability for dimple bulbs is shorter.

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	$\pm$ 1.5 x 10^{-7} cm/cm/ °C
Softening Point ($10^{7.6}$ Poise)	773	$\pm$ 5 °C

Thermal Properties

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

Property	Typical Measure
Working Point (@ 10^4 poise)	1164 °C
Annealing Point (@10^{13} poise)	547 °C
Strain Point (@$10^{14.6}$ 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:

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

*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:

Property	Typical Measure
Log_{10} Volume Resistivity	
@ 250 °C	8.8 Ω-cm
@ 350 °C	7.1 Ω-cm

Optical Properties

The following properties can be used when studying SG773 glass.

Property	Typical Measure
Index of Refraction	1.479
Birefringence Constant	360 (nm/cm)/(kg/mm^2)

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^2 or psi. The formula for this conversion is:

Stress = (°R x L) / (C x 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)

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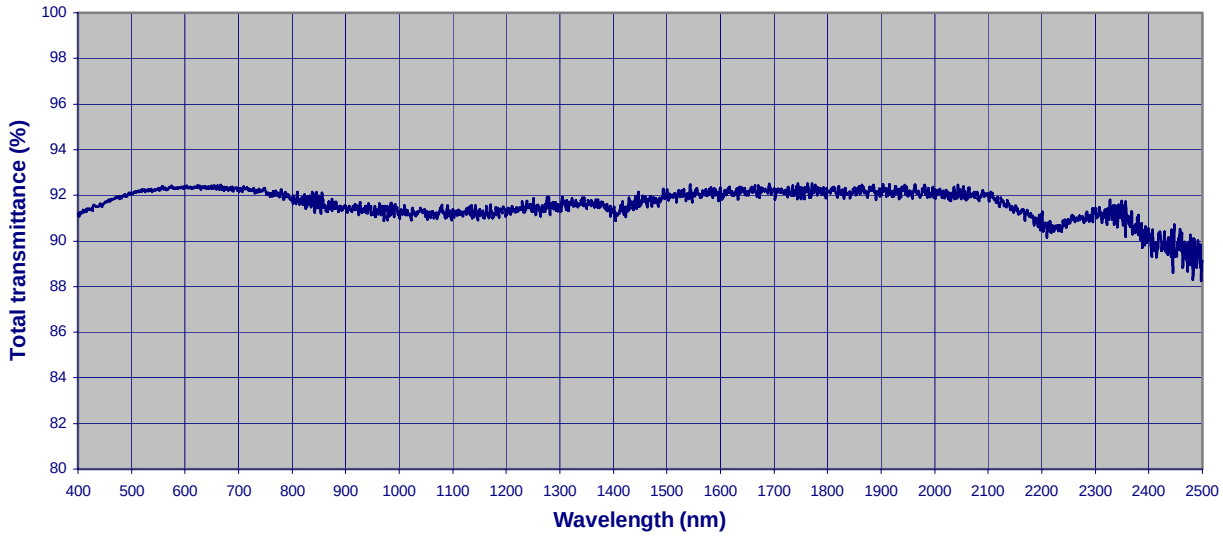
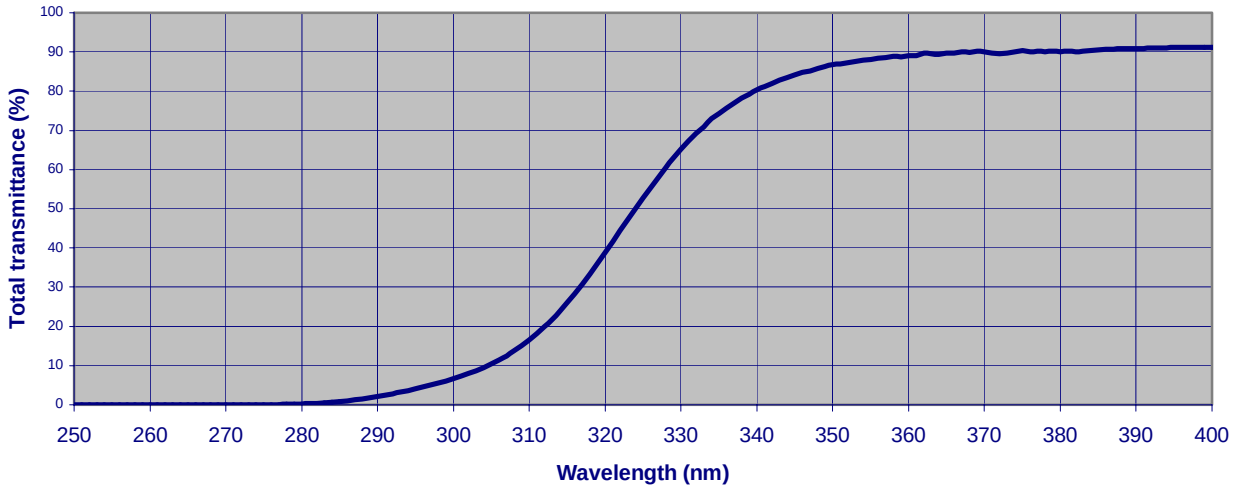
Transmission

SYLVANIA's lead and arsenic free glass was developed specifically for HID Lighting applications. 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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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_2	Na_2O	K_2O	BaO	B_2O_3	Al_2O_3
SG773	76	3	2	2	14	3

The following oxides are present as minor constituents: Li_2O, Fe_2O_3, CeO_2, TiO_2.

Forming Dimensions

After the forming process, various measurements are taken by both operators and quality inspectors to ensure that specifications are met for both bulb shape and wall thickness dimensions. The following is a general guideline of dimensions that are checked. Specific dimensions and tolerances may vary for each product based on shape differences and customer requirements.

Dimension	Measure	Gauging Technique
Body Diameter	Minimum / Maximum	Go-No Go Ring Gauge
Neck Outside Diameter	Maximum	Go-No Go U-Gauge
Neck Out of Round	Maximum	Variable Indicator Gauge
Neck Inside Diameter	Minimum	Go-No Go Plug Gauge
Flare Outside Diameter	Maximum	Go-No Go Ring Gauge
Flare Inside Diameter	Minimum	Go-No Go Plug Gauge
Eccentric Flare	Maximum	Go-No Go Plug & Ring Gauge
Bulb Overall Length	Minimum / Maximum	Go-No Go Height Gauge
Dome ID	Minimum	Go-No Go Plug Gauge
Dimple Length	Minimum / Maximum	Variable Indicator Gauge
Neck Wall Thickness	Minimum / Maximum	Variable Indicator Gauge
Neck Wall Siding (=max. – min.)	Maximum	Calculated Measurement
Top Wall Thickness	Minimum	Variable Indicator Gauge
Side Wall Thickness	Minimum	Variable Indicator Gauge

* Note: Flare / moil of bulb is not removed in finished product.

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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 for each bulb type 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.

Packaging

SYLVANIA has both a domestic returnable pack and a one-way export pack. Carton quantities vary for each bulb type to optimize shipping density, while maintaining a manageable weight of 25kg or less. The following is a sample list of carton quantities and 40' container quantities of some of the types available for export.

Bulb Type (metric)	*Pieces per carton*	*Pieces per 40' Container*
BD17 (54)	160	66,240
BRL38 (120)	84	34,272
BT36 (116)	30	20,160
BT56 (180)	12	6,048
ED23.5 (75)	96	38,400
ED28 (90)	42	42,000
ED37 (120)	30	20,160
R40 (125)	84	31,500
T14.5 (46) x 292mm	56	43,008
T14.5 (46) x 265mm	56	48,384
T14.5 (46) x 220mm	56	59,136

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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.

Process Step	*Quality Assurance Measures*
Incoming Raw Material	➢ Certificate of Analysis from supplier
Glass Properties	➢ Regular monitoring of controlled glass properties
Dimensional Forming Criteria	➢ Regular dimensional checks for shape and wall thickness ➢ Statistical controls for critical dimensions
Visual Forming Criteria	➢ Regular sampling against visual forming criteria
Glass Quality Criteria	➢ Regular sampling against glass quality criteria

How to Order

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

Information for Quoting and Ordering	
1. Product Type	➢ Indicate the product(s) of interest from list on page 1. ➢ For a new product, provide drawing or specification if available. ➢ New products require design, development and testing before issuing final quotation.
2. Quantity	➢ Provide requested quantity. ➢ Specialty types may require a minimum purchase quantity.
3. Delivery	➢ Specify shipping terms requested. SYLVANIA can provide the benefit of negotiated freight rates by quoting delivered prices. ➢ Specify desired delivery date.

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