36th Edition

Electronic Glass Materials Technical Reference Guide

Neg GLASS FOR FUTURE
Nippon Electric Glass

Glossary

Strain point
A temperature at which internal stress in glass is removed in several hours. Below this temperature thermal stress is not substantially generated, so this would be the standard temperature for heat resistance.

Annealing point
A temperature at which internal stress in glass is removed in several minutes. This would be the standard temperature for annealing.

Transformation point
A temperature at which the inclination of the thermal expansion curve suddenly changes. This corresponds to the transformation of glass from solid state to liquid state.

Deformation point
A temperature at which thermal expansion is not any more detected in the measurement because of softening of glass. It appears as a peak of the expansion curve.

Softening point
A temperature at which glass deforms noticeably by its own weight. There are two measurement methods, fiber elongation method and differential thermal analysis (DTA). The measurements from both methods do not coincide.
Softening point for powder glass is usually measured with DTA.

Working point
A temperature at which viscosity of the glass is 10^4dPa·s. It is a standard temperature for glass forming such as tubing and pressing.

Glass flowing point
A temperature at which viscosity of the glass is 10^5dPa·s. Glass becomes soft enough to flow and spread.

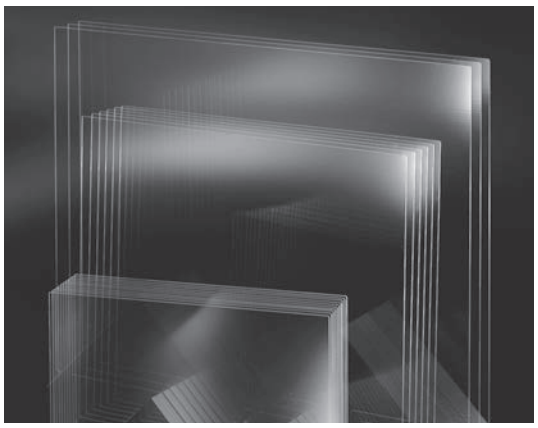
Sealing temperature/Firing temperature
Processing temperature suitable for sealing or firing.

Contents / Electronic Glass Materials

Alkali-free Glass Substrate

Ref. No. 2210-01E

OA-11



OA-11 is used as a substrate for liquid crystal displays and OLED displays, as well as a substrate for the formation of various thin films. OA-11 has particularly low deformation and deflection of gravity properties.
The substrate is both very thin and highly useful.
The high dimensional stability of this glass substrate allows it to withstand high-temperature processes, which makes it suitable for use in the LTPS and IGZO high-quality, next-generation displays.

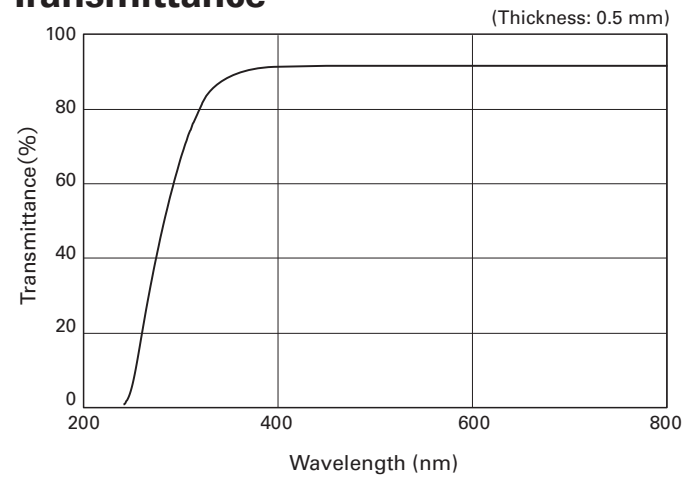
Features

1. **Smooth surface**
   Glass substrates formed using overflow technology exhibit flat precision surfaces.
2. **Alkali-free**
   With a maximum alkali oxide content of 0.1%, this product does not degrade the thin-film characteristics of amorphous or polycrystalline silicon.
3. **Thermal dimensional stability**
   A high strain point and a low thermal expansion coefficient give OA-11 high thermal dimensional stability during TFT forming process and other heat treatment processes.
4. **Chemically stable surface**
   Inert to treating agents used in the semiconductor process and the TFT forming process, so surfaces retain pristine quality.
5. **Environmentally friendly glass**
   This environmentally friendly glass does not contain environmentally hazardous substances, such as As and Sb.

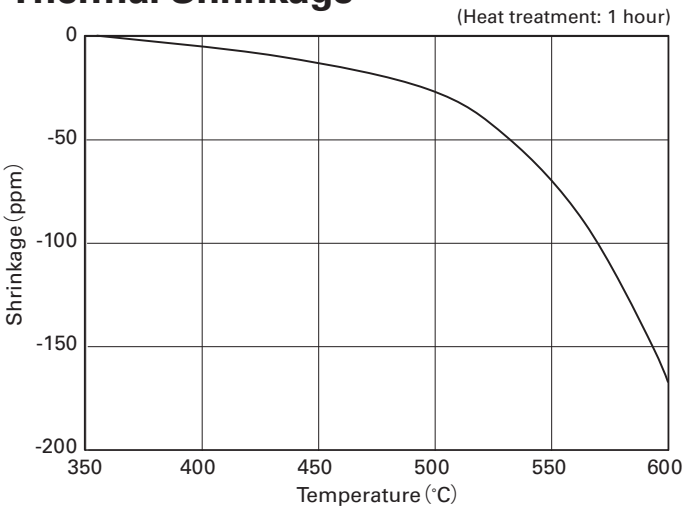
Properties

Properties/Glass Code			**OA-11**
Density		$\times 10^3$kg/m^3	2.52
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	37
Strain point		°C	685
Young's modulus		GPa	78
Poisson's ratio			0.2
Vickers hardness	Hv		620
Volume resistivity Log ρ	350°C	Ω·cm	13.0
Dielectric constant	1MHz, RT		5.6
tan δ	1MHz, RT		0.001
Light transmittance	λ =550nm	%	92
Refractive index (n_d)	587.6nm		1.53
Chemical durability	10% HCl (80°C-60min)		No visual change
	63 BHF (20°C-3min)		No visual change
Alkali oxide content		wt %	0.1 max.
As, Sb content		wt %	Less than 0.1

Transmittance



Thermal Shrinkage



Flatness

Subjects	Specifications	Remarks
Waviness	0.06μm max.	Standard length 20mm (SEMI D15-1296)
Surface Roughness	Ra: 0.2nm	AFM

Only on the pattern surface

Dimensions

(mm)

Length			
L_1		L_2	
Center	Tolerance	Center	Tolerance
370	± 0.2	470	± 0.3
550	± 0.35	650	± 0.4
730	± 0.5	920	± 0.6
1100	± 0.7	1300	± 0.8
1500	± 1.0	1850	± 1.2
1950	± 1.4	2250	± 1.6
2200	± 1.6	2500	± 1.7
2940	± 2.0	3370	± 2.2

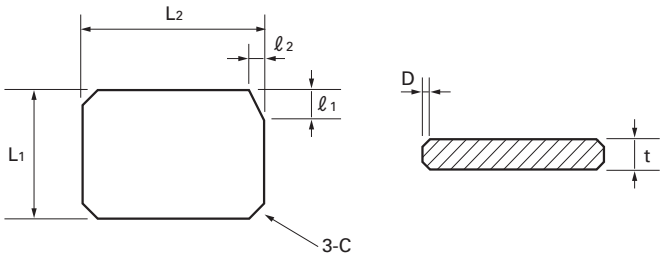
Consult us for other dimensions.

(mm)

Thickness	
t	
Center	Tolerance
0.50	± 0.05
0.40	± 0.04
0.30	± 0.03

Corner Cut		Orientation Corner 1-C		Chamfering
3-C		ℓ_1	ℓ_2	D
Center	Tolerance	Center	Tolerance	Simple Round Shape
1.5	± 1.0	4.0	± 1.0	0.05-0.55

Consult us for other shapes.



Surface Defects (Scratch, Dirt)

None observed in surface inspection carried out using oblique illuminations as shown in the following table.

Grade A	Grade B
10000 lx	1500 lx

Only on the pattern surface

Processing Defects
(Peripheral Chipping and Cracking)

Size of Defects (mm)	Maximum Number Allowed
> 1.0	None
≦ 1.0	Disregard

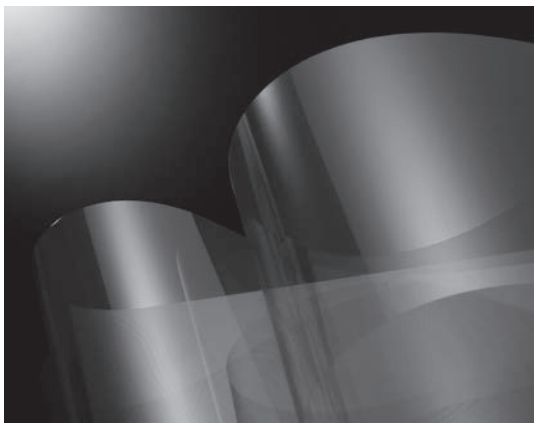
There were no sign of chips nor cracks developing in the glass.
Inspection conditions: Surface inspection at 1500 lux.

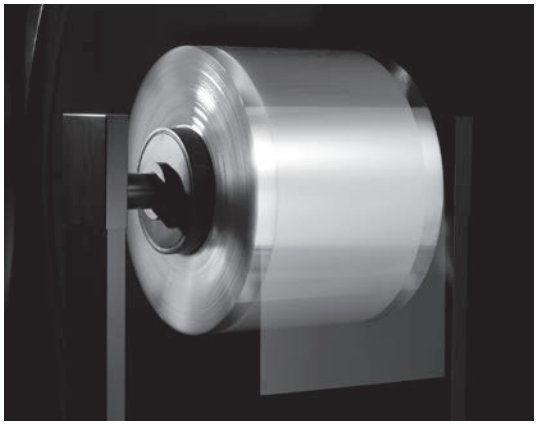
Ultra-thin Glass

Ref. No. 2210-02E

G-Leaf™

Ultra-thin glass G-Leaf™, which is under 0.2mm (200μm) thick, is a superior material formed by overflow technology. G-Leaf™ maintains the advantageous functions and reliability of glass in a film state and can therefore be applied using the roll-to-roll process. G-Leaf™ is a next-generation material that holds excellent potential for applications such as electronics, energy-related products, medical-use products, and lighting.





Rolled-up form

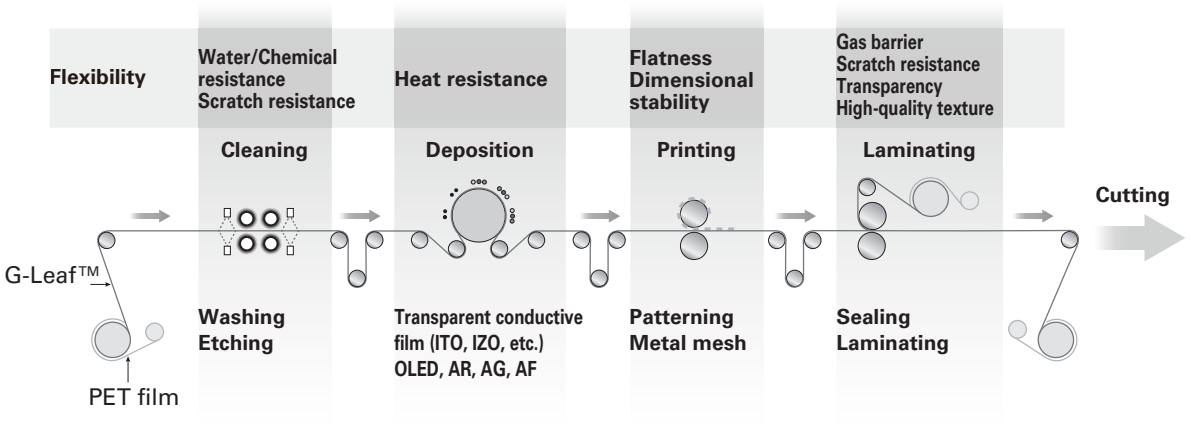
Features

- Excellent properties of glass
  - Optical properties
  - Weather resistance
  - Heat resistance
  - Gas barrier properties
  - Electrical insulation
  - Chemical durability
- Properties of overflow technology
  - Surface flatness
  - Surface smoothness
- Features unique to thin sheet forming
  - Flexibility
  - Workability
  - Lightweight
- Environmentally friendly glass that does not contain As or Sb

G-Leaf™ allows for the reduction of energy and environmental burdens at all stages of its production, from raw materials to delivery.

Roll-to-Roll manufacturing process for flexible devices using G-Leaf™

G-Leaf™, with both its glass features and flexibility, makes it possible to manufacture high-quality flexible devices with the high-productivity roll-to-roll process.



Applications

- Flexible solar cell
- Flexible display
- Flexible lighting
- Touch sensor
- Electronic paper
- Thin film battery

Thermal Properties

With its high heat resistance, low thermal expansion, and low thermal shrinkage, G-Leaf™ offers superior thermal dimensional stability.

Strain point		˚C	650
Annealing point		˚C	705
Softening point		˚C	940
Coefficient of thermal expansion	30-380˚C	× 10^{-7}/K	38

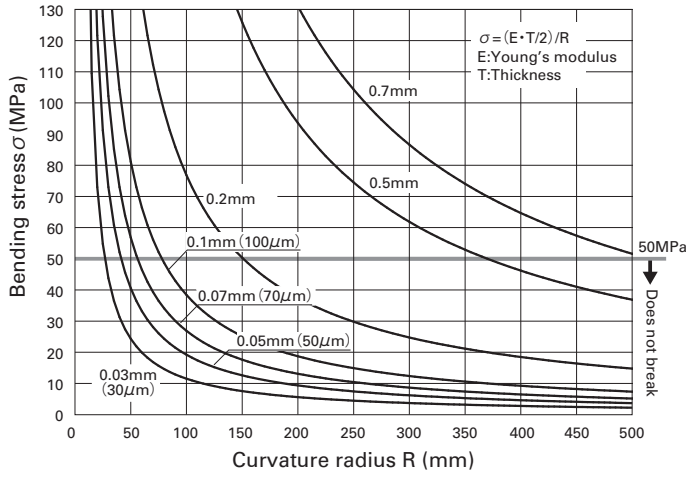
Mechanical Properties

G-Leaf™ is characterized by high elasticity and high hardness.

Density	× 10^3kg/m^3	2.46
Young's modulus	GPa	73
Poisson's ratio		0.2
Vickers hardness	Hv	600

Flexibility

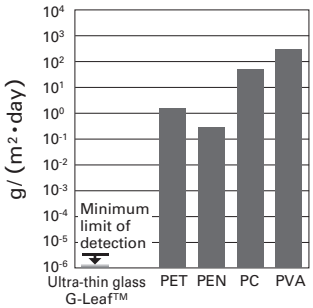
G-Leaf™ is also available in rolled-up forms.



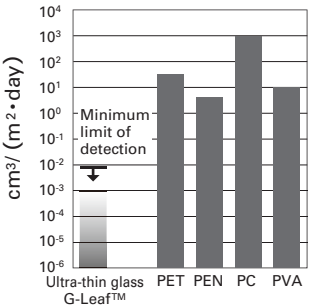
* Glass breakage depends on defects located on edges and/or surfaces of glass substrates. In the above figure, 50MPa is considered to be the boundary between "broken" and "not broken" conditions.

Gas Barrier Properties

Water vapor permeation rate



Oxygen transmittance rate



* Both the water vapor permeation rate and oxygen transmittance rate are lower than minimum limit of detection.

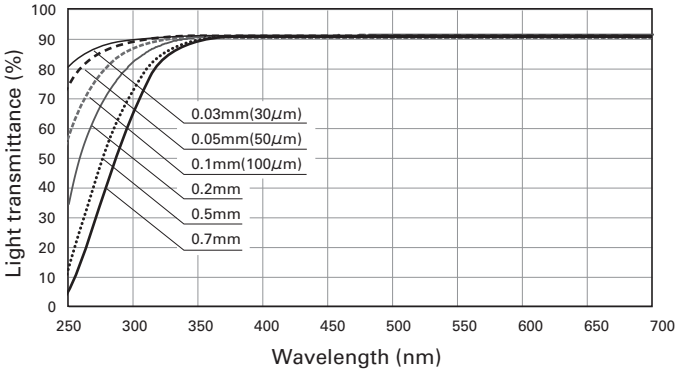
Electrical Properties

Volume resistivity Log ρ	350˚C	Ω・cm	12.0
Dielectric constant	1MHz, 25˚C		5.3
tan δ	1MHz, 25˚C		0.001

Optical Properties

G-Leaf™ has high light transmittance.

Light transmittance	λ=550nm	%	92
Refractive index (n_d)	λ=587.6nm		1.52



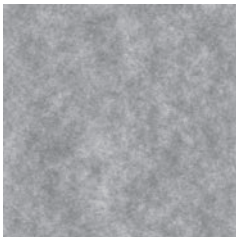
Chemical Properties

G-Leaf™ has high chemical durability. It is an ecological material and does not contain any substances that impose burdens on the environment.

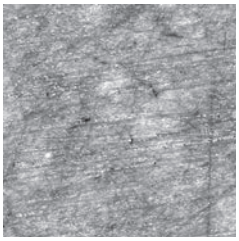
Chemical durability	10% HCl (80˚C-60min)		No visual change
	63 BHF (20˚C-3min)		No visual change
Alkali content		wt %	0.1 max.
As, Sb content		wt %	less than 0.1

Surface Quality (AFM Image)

Formed by overflow technology, the product has an extremely smooth and flat surface.



G-Leaf™
Non-polished surface formed by overflow technology
Ra = 0.2nm



Polished surface
Ra=0.5nm

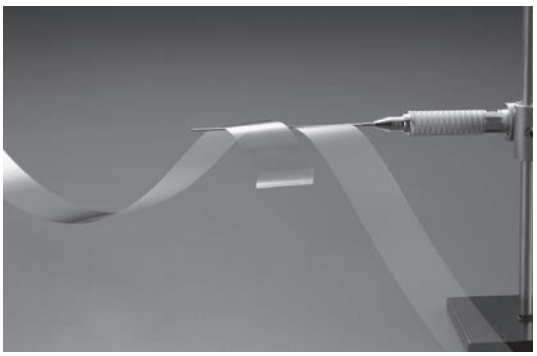
Dimensions

Thickness	
Center	Tolerance
0.2mm(200μm)	± 10%
0.1mm(100μm)	
0.07mm(70μm)	
0.05mm(50μm)	
0.03mm(30μm)	

Both rolled-up forms and sheets are available.
Please consult us regarding thickness, size, and shape.
Laminated adhesive film with G-Leaf™ is available in order to facilitate its handling.

Glass-ribbon

Glass-ribbon is so thin that it can be bent or rolled up like resin film. The glass surface is unpolished, but it is extremely flat and smooth. Glass-ribbon is characterized by rounded edges on both sides, as shown in the bottom photo. This enables enhanced durability in the face of bending and twisting pressure.

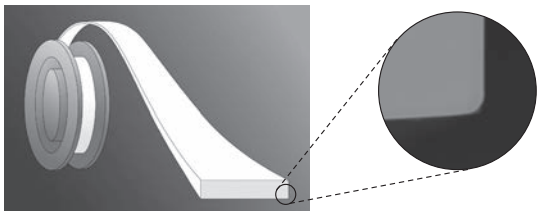


Features

● Super thin ● High flexibility ● High reliability

Properties

Glass Material		A	D	T
Coefficient of thermal expansion	$\times 10^{-7}$/K	66	38	100
Softening point	˚C	740	940	760
Dielectric constant	1MHz, 25˚C	6.5	5.3	7.7
Refractive index (n_d)		1.51	1.52	1.52
Young's modulus	GPa	77	73	75



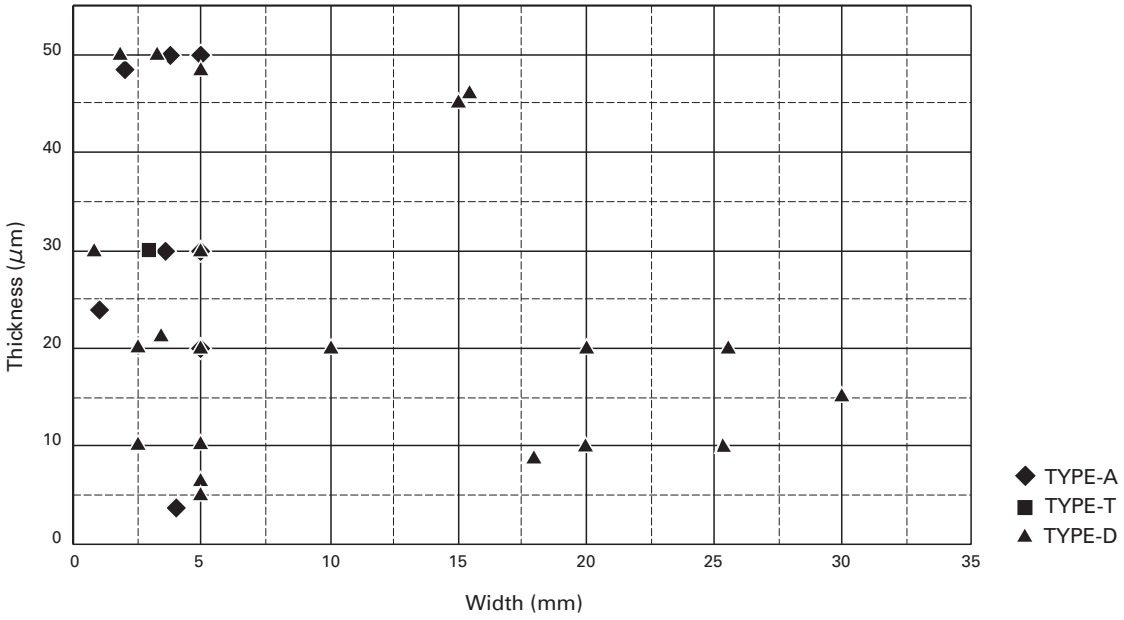
SEM image of enlarged edge

Dimensions

Thickness	4μm-50μm	Thickness tolerance : ± 0.002mm with thickness of 0.010mm and over ± 0.001mm with thickness under 0.010mm
Width	0.5mm-30mm	Width tolerance : ± 0.5mm with width of 10mm and over ± 0.1mm with width under 10mm
Aspect ratio (width/thickness)	Up to 3000	
Length	Up to 100m	

We are able to accommodate individual requests.

Sample Lineup

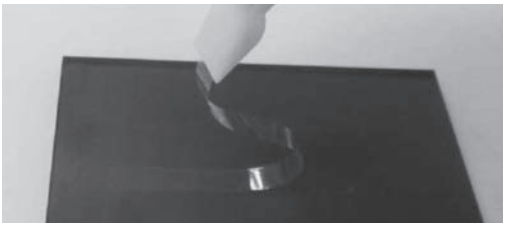


Applications

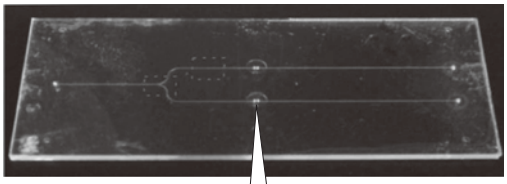
Microchip for Micro Total Analysis System

Glass-ribbon has been adopted for microchip stop valves of the Micro Total Analysis System that was developed by RIKEN. Glass-ribbon is extremely thin (4-6μm) and can be created in precisely required sizes. RIKEN has highly appreciated Glass-ribbon and has adopted it as a suitable material for valves to control solution flows.

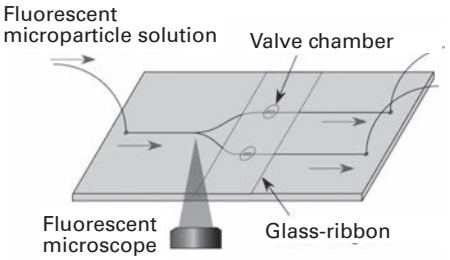
Glass-ribbon



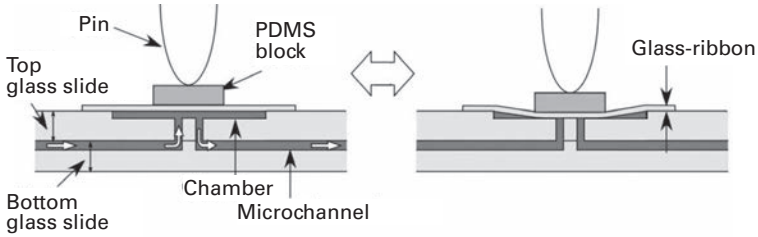
A fabricated all-glass-based microchip



Design and observation method of a prototype chip for valve demonstration



Cross-sectional view showing the working principle of the valve



Patentee : RIKEN Patent : JP Patent No. 6172711; US Patent No. 9073054

Reference

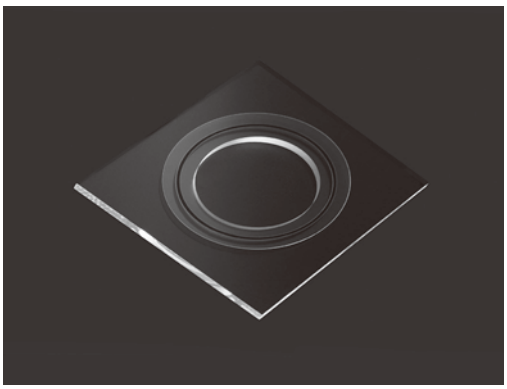
"Electric actuating valves incorporated into an all glass-based microchip exploiting the flexibility of ultra-thin glass"
Tanaka RSC Advances, 3(26), 10213-10220 (2013)

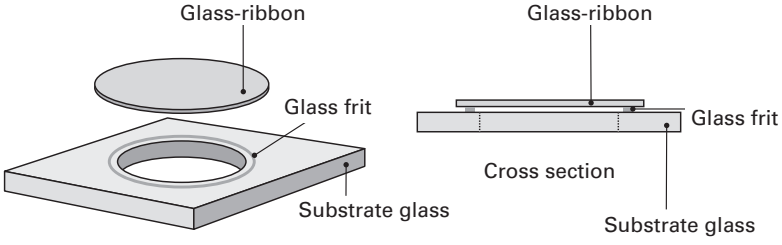
Images courtesy of RIKEN

Diaphragm

As a development item, Glass-ribbon or ultra-thin glass can be sealed with glass frit by laser-sealing technology for potential use as a diaphragm.
It has excellent hermetic properties compared to resin seal.

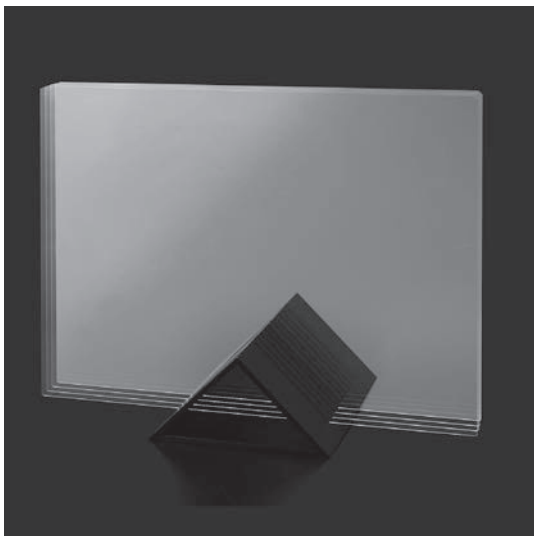
- Thickness of the sealed glass: 50μm or less
- Thickness of the substrate glass: 0.5mm or less





OA-20

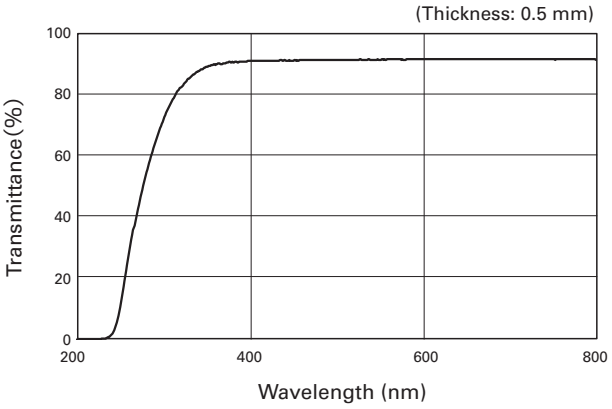
OA-20 is glass substrate for use in displays. It is most suitable for high-definition displays via oxide TFT (IGZO) and OLED displays, as well as in-vehicle displays that require high rigidity. OA-20 is available in large substrates of G8.5 and above. We believe it will contribute greatly to the development of next-generation high-performance displays.



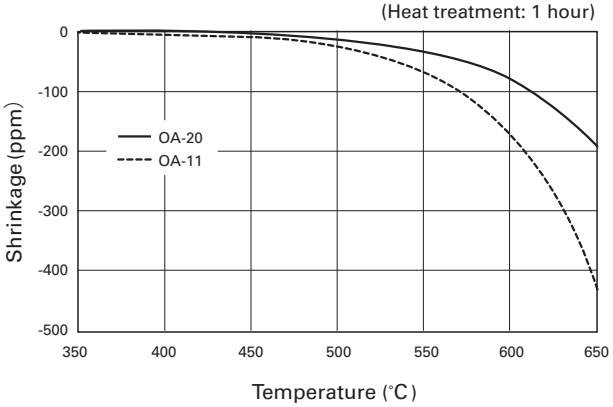
Features

1. **Low thermal compaction**
   Excellent thermal dimensional stability in the IGZO process and the high-temperature OLED display manufacturing process
2. **High Young's modulus**
   Minimal sag
3. **Superior optical properties**
   High light transmittance
4. **Smooth surface**
   A significantly smooth surface is derived from the overflow process.
5. **Upsizing**
   Large sizes of G8.5 or greater are offered.

Transmittance



Thermal Shrinkage



Properties

Properties/Glass Code			**OA-20**
Strain point		°C	725
Young's modulus		GPa	83
Density		$\times 10^3$kg/m^3	2.55
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	37
Poisson's ratio			0.2
Vickers hardness	Hv		670
Volume resistivity log ρ	350°C	Ω・cm	13.0
Dielectric constant	1MHz, RT		5.7
tan δ	1MHz, RT		0.001
Light transmittance	λ = 550nm	%	91
Refractive index (n_d)	587.6nm		1.53
Chemical durability	10% HCl (80°C-60min)		No visual change
	63 BHF (20°C-3min)		No visual change
Alkali oxide content		wt%	0.1 max.
As, Sb content		wt%	Less than 0.1

OA-31

OA-31 is low thermal compaction glass that was developed as a glass substrate for LTPS display in smartphones and other mobile devices. The ratio of glass shrinkage caused by heat treatment was greatly reduced compared with conventional products. OA-31 has a significantly smooth surface and offers uniformity of thickness achieved through the overflow process. It is most suitable as a glass substrate for next-generation displays and carriers for flexible OLED displays.

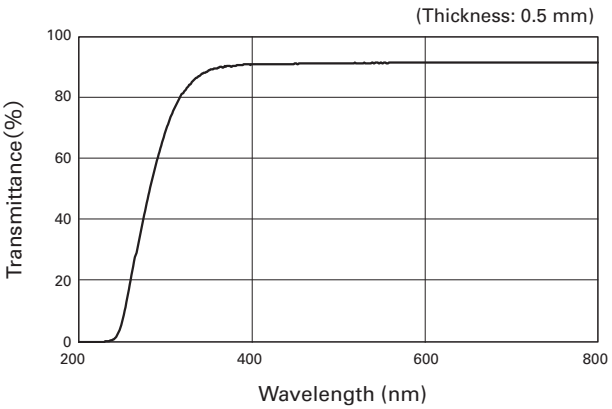
Features

1. **Low thermal compaction**
   Excellent thermal dimensional stability in extremely high-temperature processing such as LTPS process
2. **High Young's modulus**
   Minimal sag
3. **Superior optical properties**
   High light transmittance
4. **Smooth surface**
   A significantly smooth surface is derived from the overflow process.
5. **Small thickness deviation**
   Uniformity of thickness is derived from the overflow process.

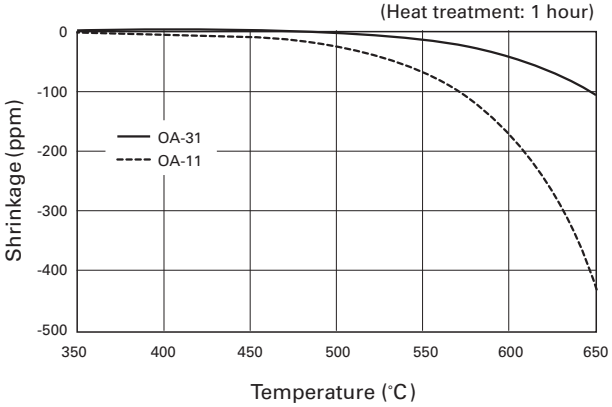
Properties

Properties/Glass Code			**OA-31**
Strain point		°C	750
Young's modulus		GPa	83
Density		$\times 10^3$kg/m^3	2.64
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	39
Poisson's ratio			0.25
Vickers hardness	Hv		680
Volume resistivity log ρ	350°C	Ω・cm	13.2
Dielectric constant	1MHz, RT		5.9
tan δ	1MHz, RT		0.002
Light transmittance	λ = 550nm	%	91
Refractive index (n_d)	587.6nm		1.53
Chemical durability	10% HCl (80°C-60min)		No visual change
	63 BHF (20°C-3min)		No visual change
Alkali oxide content		wt%	0.1 max.
As, Sb content		wt%	Less than 0.1

Transmittance



Thermal Shrinkage



High Refractive Index Glass Substrate

Ref. No. 2210-06E

HX-1

HX-1 is an alkali-free glass substrate with high refractive index available in large sizes. It also has unique properties such as high thermal expansion and high dielectric constant compared to conventional alkali-free glass.

Features

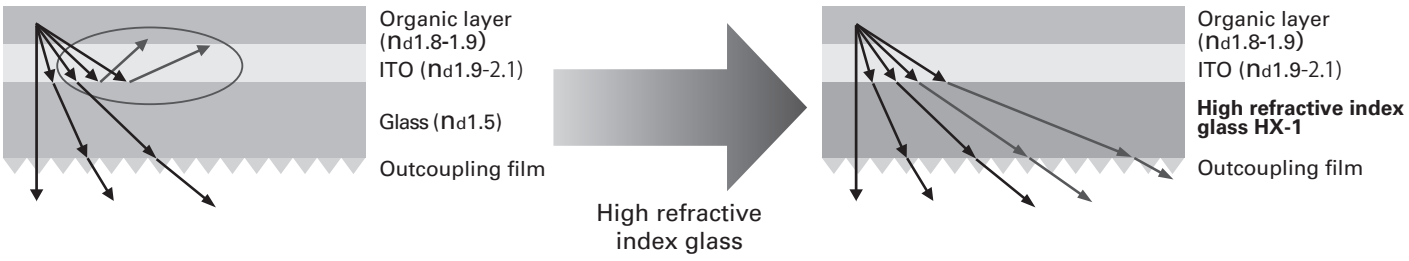
- High refractive index (n_d 1.63)
- High productivity
- High chemical durability
- High dielectric constant
- High thermal expansion non-alkali glass

Properties

Properties/Glass Code			HX-1
Refractive index (n_d)			1.63
Density		$\times 10^3$ kg/m^3	3.38
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	71
Strain point		°C	640
Dielectric constant	1MHz, 25°C		8.3

Example of OLED Lighting Application

With HX-1, OLED lighting efficiency can be improved by simply replacing a conventional glass substrate.



High Refractive Index Glass for Augmented/Mixed Reality

Wide viewing angle and clear vision can be realized with our high refractive index and high transmitting glass.

Light guide plate for smart glass

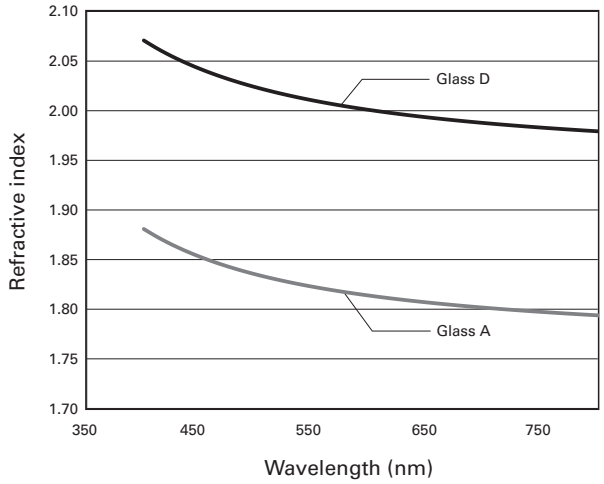
Features

- High refractive index; n_d is 1.8 or more.
- Hight transmittance for clear vision

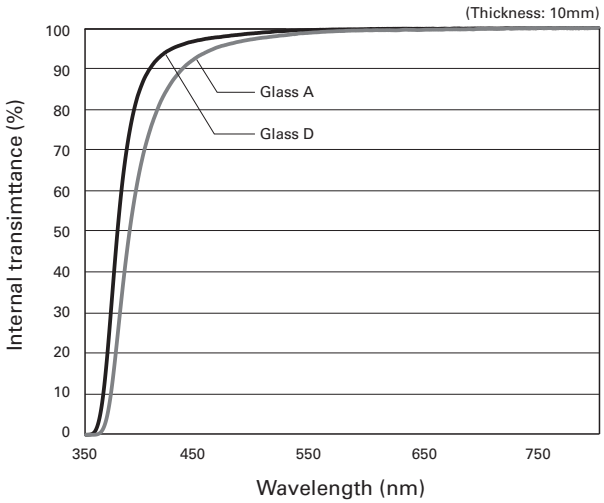
Properties

Properties/Glass Code			Glass D	Glass A
Refractive index (n_d)			2.0	1.8
Abbe's number			29	25
Internal transmittance	t = 10mm, 500nm	%	98	97
Density		$\times 10^3$kg/m^3	5.1	3.3
Coefficient of thermal expansion	30-300°C	$\times 10^{-7}$/K	8.5	8.6

Refractive Index



Internal Transmittance

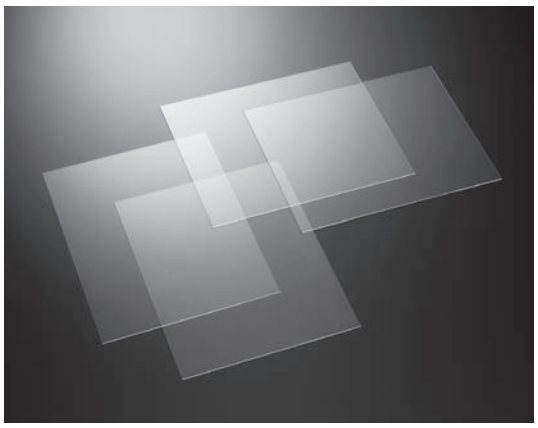


Glass for Chemical Strengthening

Ref. No. 2210-08E

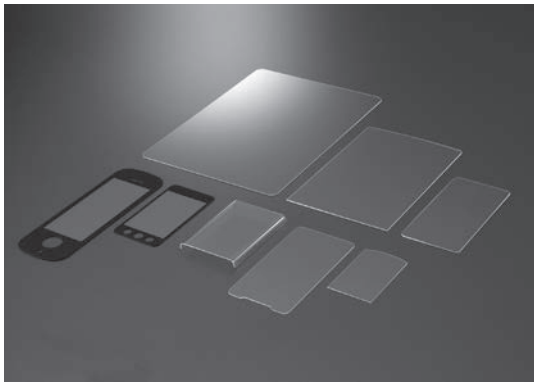
Dinorex™

Dinorex™ is glass for chemical strengthening developed for use as cover glass for mobile handsets such as smartphones and tablets, onboard vehicle displays, and other new applications. Dinorex™ protects such devices from impact shocks and scratches.



Features

- **Dinorex™ T2X-1**
  - · Superior chemical strengthening properties (High CS, Deep DOL)
  - · High productivity
  - · High transmittance
- **Dinorex™ T2X-7**
  - · Original chemical strengthening technology (DIOX)
  - · High drop strength on rough surfaces
  - · Optimized for 3D molding



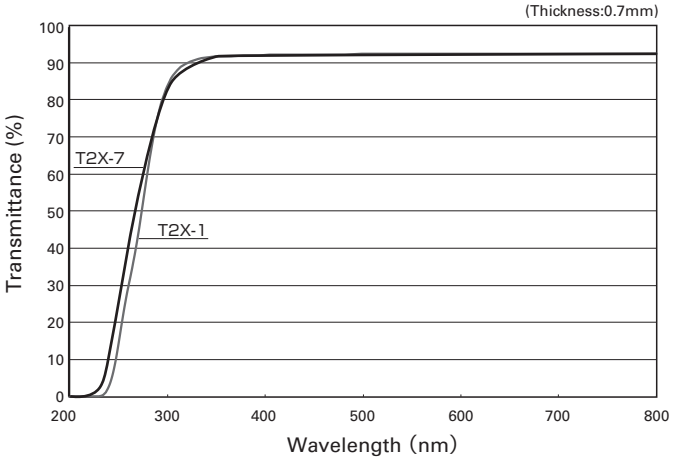
Dinorex™ in various processed forms

Properties

Properties/Glass Code			T2X-1	T2X-7
Density		× 10^3kg/m^3	2.45	2.40
Strain point		°C	560	590
Annealing point		°C	610	640
Softening point		°C	860	910
Coefficient of thermal expansion	30-380°C	× 10^{-7}/K	91	74
Young's modulus		GPa	70	76
Shear modulus		GPa	29	31
Poisson's ratio		—	0.2	0.2
Vickers hardness (unstrengthened)	Hv (0.2)	—	590	590
Vickers hardness (strengthened)	Hv (0.2)	—	670	640
Fracture toughness		MPa・$m^{0.5}$	0.68	0.76
Dielectric constant	1MHz, 25°C	—	7.7	6.7
tan δ	1MHz, 25°C	—	<0.03	0.01
Volume resistivity Log ρ	150°C	Ω・cm	7.1	7.7
Photo-elastic constant		nm/cm/MPa	29.5	29
Light transmittance	t=0.7mm, 550nm	%	>91.5	>91.5
Refractive Index nd	587.6nm	—	1.50	1.50
Specific heat	25°C	J/kg・K	810	820
Thermal conductivity	25°C	W/m・K	1.1	1.1
Alkali elution	JIS R3502	mg	0.1	0.1

Consult us regarding dimensions.

Transmittance



Refractive Index

Optical properties refractive index	T2X-1	T2X-7
n_h (404.7nm)	1.52	1.52
n_g (435.8nm)	1.51	1.51
n_F (486.1nm)	1.51	1.51
n_e (546.1nm)	1.51	1.50
n_d (587.6nm)	1.50	1.50
n_C (656.3nm)	1.50	1.50
n_{785} (λ)	1.50	1.50
n_{1310} (λ)	1.49	1.49
n_{1550} (λ)	1.49	1.49

Dielectric Constant and tan δ

	T2X-1		T2X-7	
Frequency [MHz]	Dielectric constant [–]	tan δ [–]	Dielectric constant [–]	tan δ [–]
1	7.7	<0.03	6.7	0.01
2450	7.3	<0.03	6.6	0.01
6000	7.4	<0.03	6.5	0.01
10000	7.4	<0.03	6.5	0.01
28000	7.2	<0.03	6.4	0.02

Room temperature

Chemical Durability

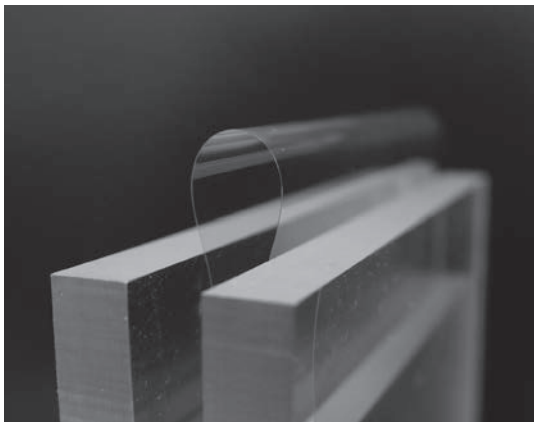
Reagent	Time	Temperature [°C]	Weight loss[mg/cm^2]	
			T2X-1	T2X-7
5wt% NaOH	6hrs.	80	0.6	1.5
10wt% HF	20min.	20	17	28
110BHF	20min.	20	0.9	0.8
5wt% HCl	24hrs.	80	0.1	20

Ultra-thin Glass for Chemical Strengthening

Ref. No. 2210-09E

Dinorex UTG™

Dinorex UTG™ is glass for chemical strengthening developed for use as cover glass for foldable displays. Dinorex UTG™ is formed by overflow technology cultivated in the manufacturing of thin glass for displays, and it has excellent bending properties due to its extremely smooth surface and uniform thickness. It contributes to the realization of highly reliable foldable displays.

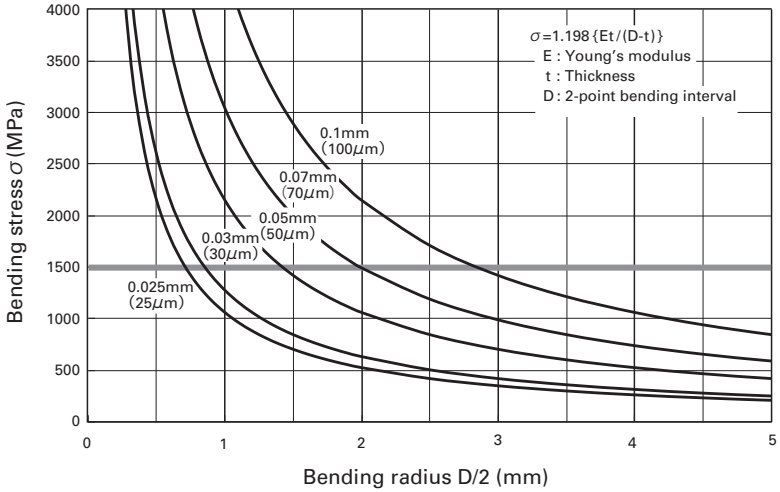


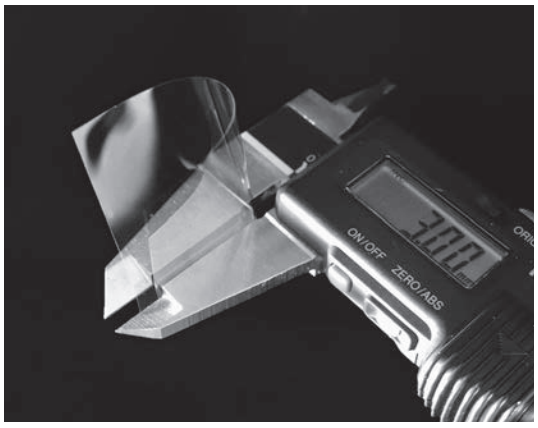
Features

- Superior smooth surface
- Uniformity of thickness distribution
- Excellent bending properties

Vast flexibility due to overflow forming and chemical strengthening

Stress generated by two-point bending





Can be bent to a diameter under 3mm (≦R1.5)

With the combination of a superior smooth surface and thickness distribution uniformity achieved through overflow forming, followed by chemical strengthening and a scratch elimination process, breaking stress of 1500MPa or more is realized, and enormous degrees of foldability are possible.

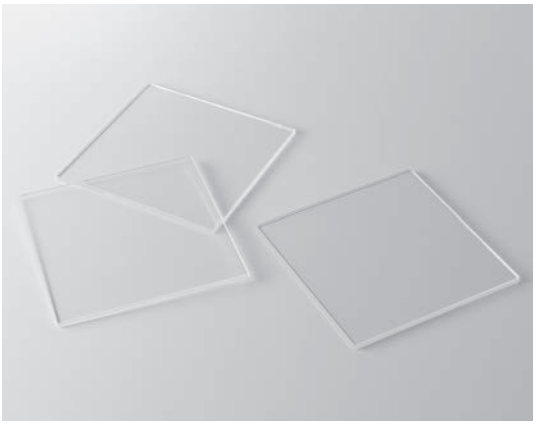
Specifications

- Thicknesses : 25, 30, 35, 50, 70, 100-250μm
- Shipping forms : Sheet forms

Images of Application Examples

Cerapure™

Cerapure™ is the world's first colorless and transparent glass-ceramic material with a zero thermal expansion coefficient. This epoch-making glass-ceramic material has the new value of being colorless and transparent, while maintaining the excellent properties of conventional zero-expansion glass-ceramics.



Features

● **Colorless and transparent**
Colorlessness and transparency enables white and other light-colored prints on the glass-ceramics to be more vivid, which was never possible before.

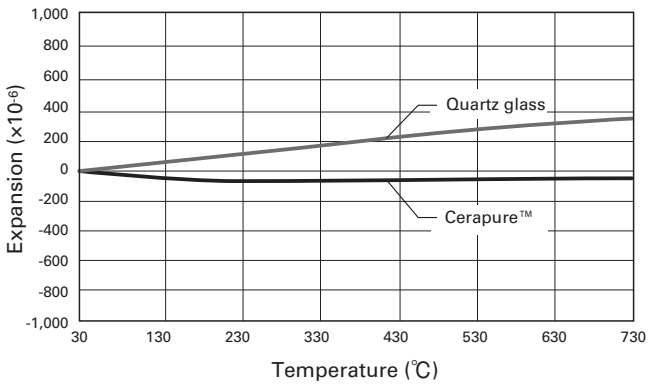
● **Zero thermal expansion coefficient**
Cerapure™ has excellent resistance to thermal shock. It does not crack if it is splashed with cold water immediately after being heated to 800°C.

● **Eco-friendly**
Cerapure™ is free of harmful substances, such as arsenic and antimony.

Properties

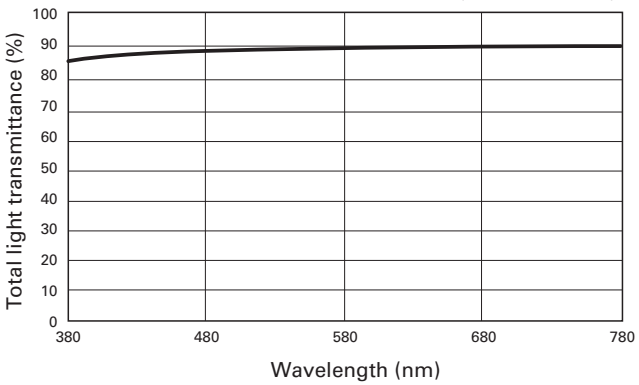
Properties/Glass Code			**Cerapure™**
Density		$\times 10^3$kg/m^3	2.51
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	−2
	30-750°C		−1
Refractive index (n_d)			1.53
Dielectric constant	1MHz, RT		7
tan δ	1MHz, RT		0.02

Thermal Expansion



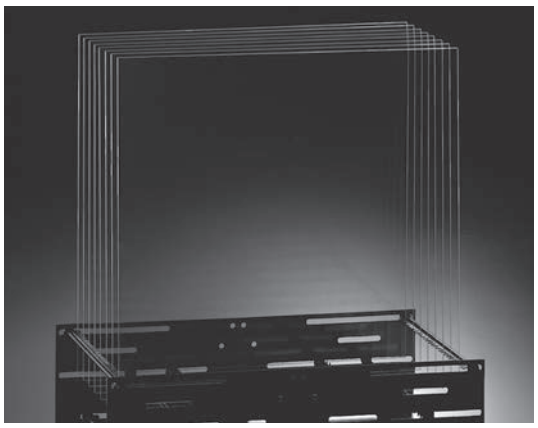
Transmittance

(Thinckness : 3mm)



Neoceram N-0 (for Electronic Products)

Neoceram N-0 is a transparent glass-ceramic with almost zero-expansion coefficient. The sheet glass N-0 is used for the color filter substrate and the micro lens array substrate of poly-silicon TFT liquid crystal displays.



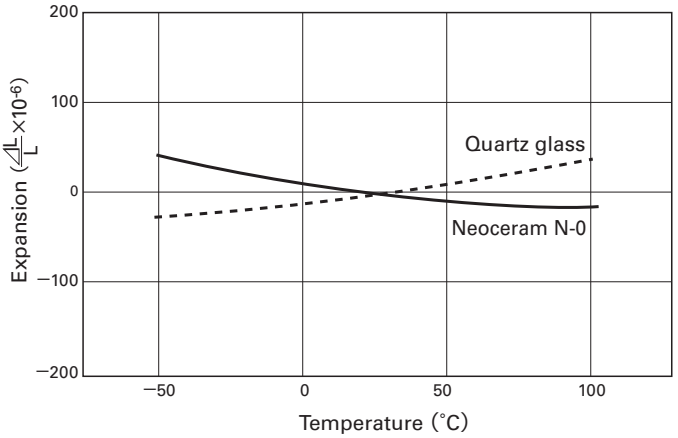
Features

- Good matching with fused quartz substrate in thermal expansion coefficient
- High visible light transmittance
- High thermal-shock resistance of △ T=800°C

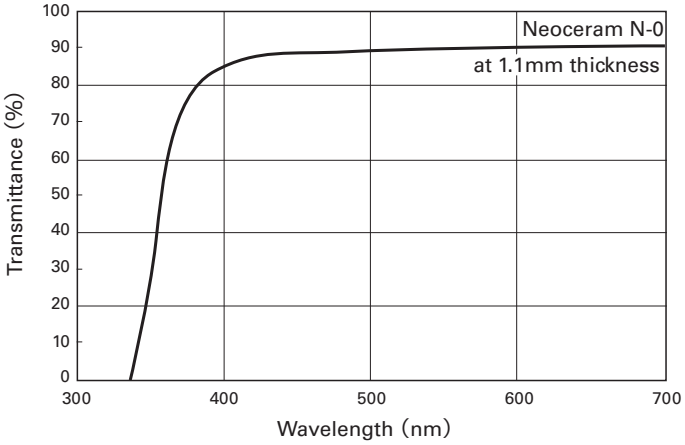
Properties

Properties/Glass Code			N-0
Coefficient of thermal expansion	30-380°C	$\times10^{-7}$/K	−7
	30-750°C	$\times10^{-7}$/K	−4
Heat resistant temperature (Short)		°C	800
Refractive index (n_d)			1.54
Density		$\times10^3$kg/m^3	2.5
Bending strength	JIS R1601	MPa	170
Vickers hardness	Hv (0.2)		700
Volume resistivity Log ρ	250°C	Ω·cm	7
	350°C	Ω·cm	5
Dielectric constant	1MHz, 25°C		8

Thermal Expansion



Transmittance



Dimensional Specifications (example)

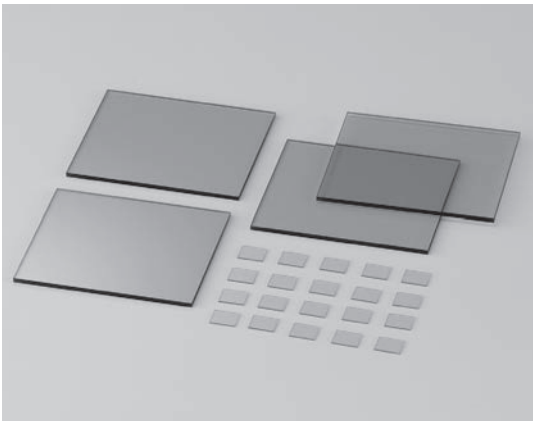
(mm)

Length	Width	Thickness
160 ± 0.4	170 ± 0.4	1.1 ± 0.05

Diameter	Thickness
ϕ 100- ϕ 170	0.5-1.5

IR Absorbing Filter

800EXL high-grade glass is processed with precision and can be used for high IR absorbing filters. These filters are used in lens-interchange-type cameras, video cameras, surveillance cameras, and smartphones.



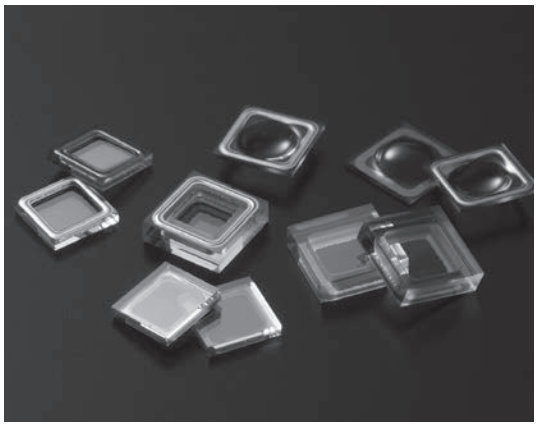
Features

- Excellent surface quality after weather-resistant test (85 ℃, RH 85%, 1,000 hrs.)
- High rate of cleanliness as an optical filter
- Thanks to integrated production from the coating design stage to shipping, only a short lead time is necessary.

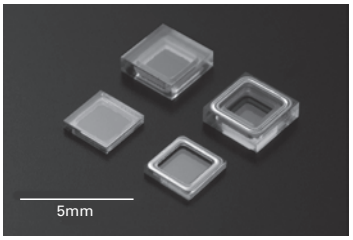
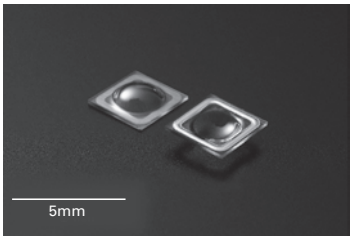
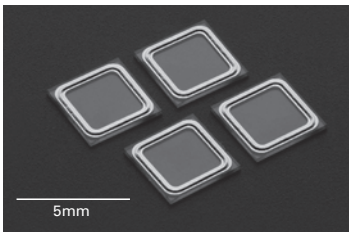
Lid with Sealing Material for UV-C LEDs

For UV-C LEDs used for sterilization and virus inactivation, we have developed two new cap lids with the world's highest* light extraction efficiency. Both of them use UV-C high-transmitting glass〈BU-41〉, which has a coefficient of thermal expansion close to that of aluminum nitride (AlN) and achieves highly reliable sealing.

* According to an internal investigation as of October 2021

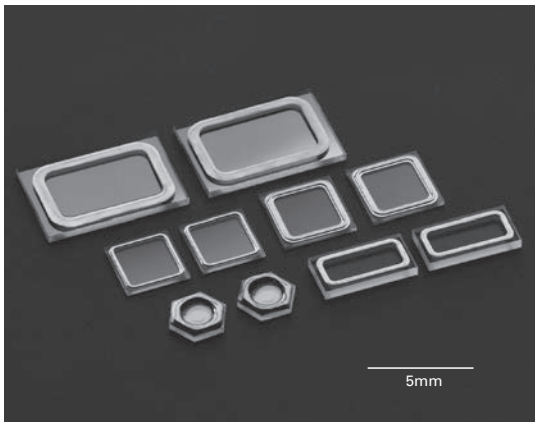


Product Lineup and Characteristics

Product	Square Lid	Domed Lid	Flat Lid
Photo			
Glass	UV-C high-transmitting glass〈BU-41〉		
UV-C AR coating	Double-sided	Under development	Double-sided
Type	High-power type	Light diffusion type	Thin type
Light extraction efficiency	96%	93%	90%
Light distribution angle	110°	120°	100°
Features	● World's highest light extraction efficiency ● Ideal for high-power UV-C LED ● Ideal for thinning the entire package	● Wider light distribution angle than square type ● World's highest light extraction efficiency of domed type ● Compatible with dome diameter of 2.4 to 60mm ● High productivity	● Plate shape suitable for AlN cavity ● Ideal for thinning the entire package
	● Prevention of damage after sealing with the base coating ● Any metal solder can be formed.		

Lid with Sealing Material for Optical Devices

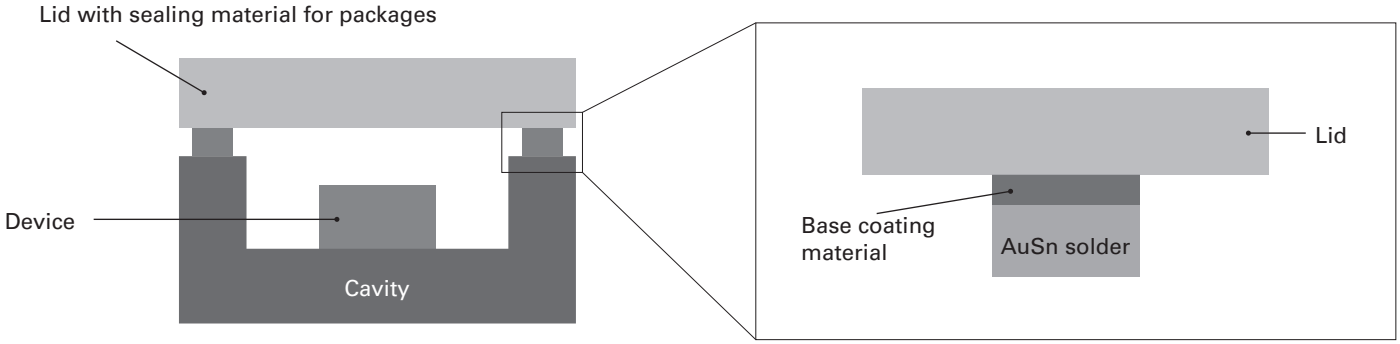
To realize a highly reliable LED, LD, and sensor package, we have developed a lid with a sealing material that reduces damage due to the difference in heat shrinkage after sealing cavities.



Features

- Achieves high yield by preventing breakage and leaks.
- Compatible with various metal solders, including gold tin solder.
- Compatible with lids such as glass, sapphire, and quartz.
- Compatible with prisms in addition to sheet lids.

Image of Application Example

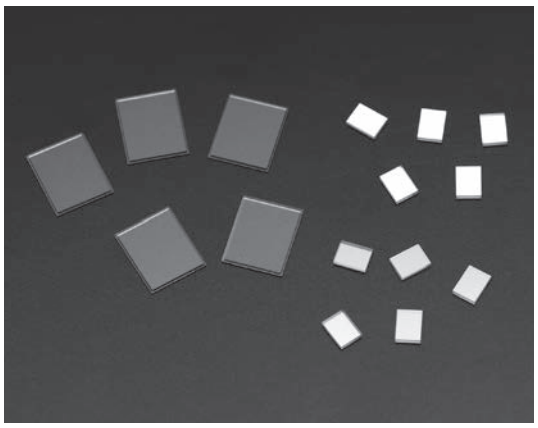


Applications

- UV-C LED
- Light sources for car headlights and projectors
- Light sources for 5G optical communication
- Light sources for laser processing machinery
- Space and aviation sensors

Band Pass Filter

This optical coated glass transmits or reflects light of any wavelength. It is mainly used as an IR cut filter on smartphones and within parts used as wavelength selective transmission filters of laser light sources and automotive LIDAR systems.

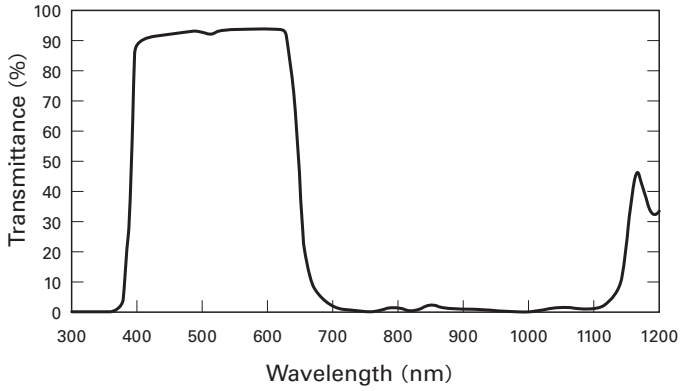


Features

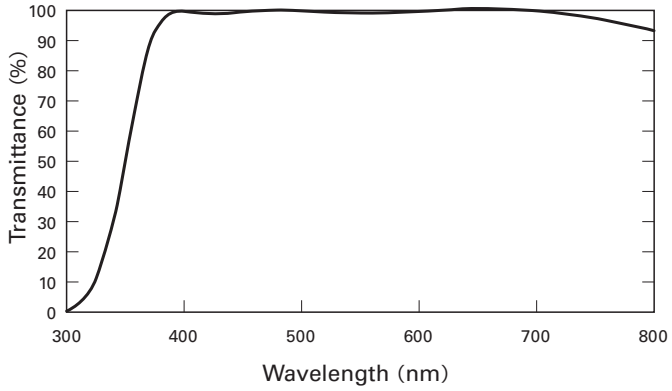
- Our unique coating technology ensures excellent appearance.
- Swift integrated production is possible from coating design to shipment, thanks to the use of our glass and coating equipment.
- Combination with different processing methods can meet diverse needs.
- Coating for our glass, BDA, BDA-E, and ABC-G is available.

Spectral Characteristics

Infrared Ray Cut Filter

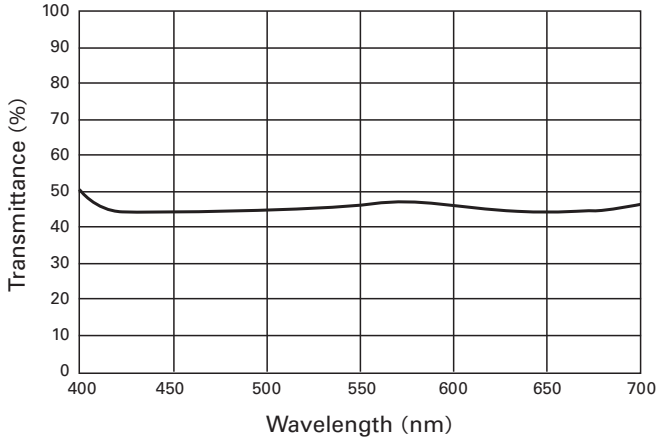


Double-sided Anti-reflection Coating

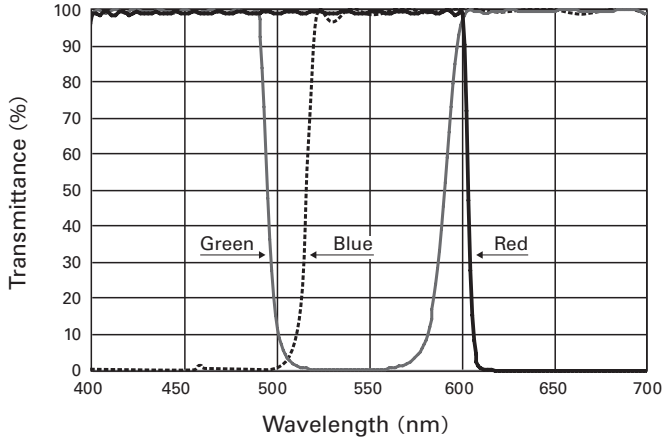


*Coatings can be designed as requested.
*Anti-reflection coatings can be applied on the reverse side.

Half Mirror



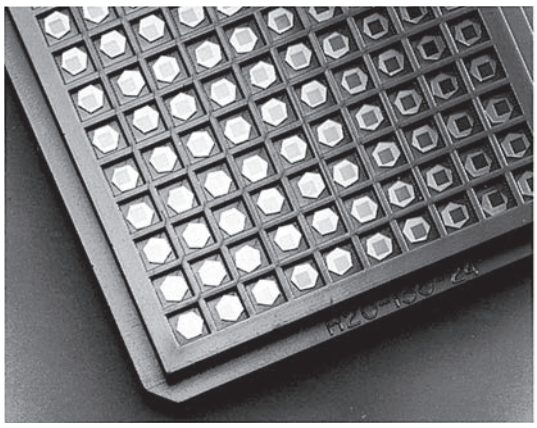
Wavelength Selective Transmission Filter



*Can accommodate various products with thin film coating.

Laser Diode Cover Glass

Laser diode cover glass is a high-quality glass (ABC-G) precisely finished into the shape of a hexagon. It is used for the windows of laser diodes (LDs) and also light emitting diodes (LEDs).



Features

- Cover glass for laser diodes and light emitting diodes is coated with specific AR coatings (type A: 405nm; type B: 650nm; type C: 780nm; type D: 1300nm; type E: 1550nm; type F: 650 and 780nm) to provide 99% min. transmission of the wavelength of emitted light.

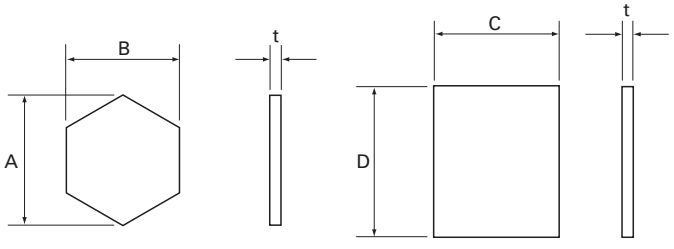
Properties

Properties/Item			ABC-G
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	38
Strain point		°C	650
Refractive index (n_d)			1.52
Density		$\times 10^3$kg/m^3	2.46

Dimensional (example)

(mm)

Length					Thickness	
A	B	C	D	Tolerance	t	Tolerance
2.5-10	$\frac{\sqrt{3}}{2}$A	2-10	2-10	± 0.05	0.25, 0.3	± 0.05



Type	Wavelength (nm)	Transmittance (%)
A	405	99min.
B	650	99min.
C	780	99min.
D	1300	99min.
E	1550	99min.
F	650	99min.
	780	99min.

AR coating with an application-specific wavelength is available upon request.

Part No.

Hexagon

$\frac{A}{2}$ — t(6) P-AR

- $\frac{A}{2}$: Side of hexagon
- t(6): Thickness
- (6): Shape
- P-AR: Specification of AR coating

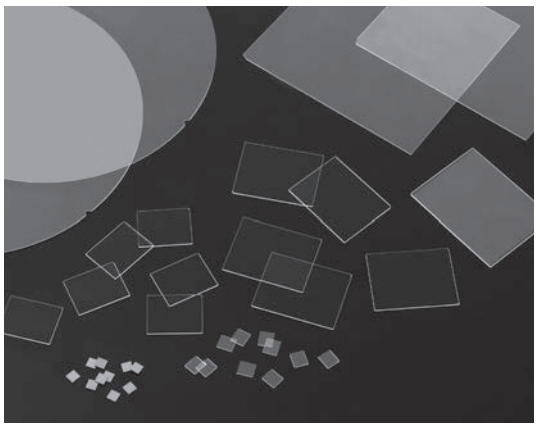
Rectangular

C × D × t P-AR

- C: Shorter side
- D: Longer side
- t: Thickness
- P-AR: Specification of AR coating

Flat Glass for Electronic Devices

We offer flat glass with various properties for electronic devices. You can choose the glass that is most suitable for the purpose of use.



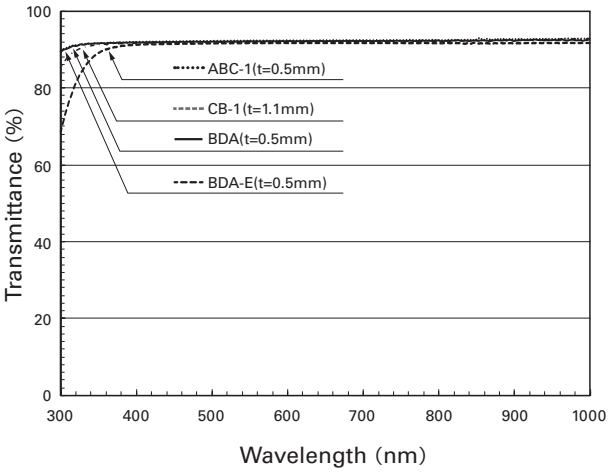
Features

1. High quality glass is manufactured using advanced technology.
   - •Technology for achieving very smooth glass surfaces
   - •Technology to achieve higher surface cleanliness
2. BDA-E with excellent chemical resistance can be used for a wide range of electronic devices.
3. CB-1 with a thickness of 1.1 mm can be used for a wide range of electronic devices.
4. ABC-1 is a low expansion alkali-free glass.
5. BDA is a glass exclusively developed not to influence the pixels of high-density image sensors.

Properties

Properties/Glass Code			BDA-E	CB-1	ABC-1	BDA
Coefficient of thermal expansion	30-380°C	$\times10^{-7}$/K	69	75	37	66
Strain point		°C	530	525	685	540
Annealing point		°C	570	560	745	575
Dielectric constant	1MHz, 25°C		6.8	6.9	5.6	6.5
tan δ	1MHz, 25°C	$\times10^{-4}$	100	100	10	100
Hydrolytic resistance	JIS R3502	R_2Omg	0.05	0.08	$<$0.01	0.07
Light transmittance	λ=500nm, t=0.5mm	%	92	92	92	92
Refractive index (n_d)			1.52	1.51	1.53	1.51
Density		$\times10^3$kg/m^3	2.46	2.47	2.52	2.44

Transmittance



Dimension example

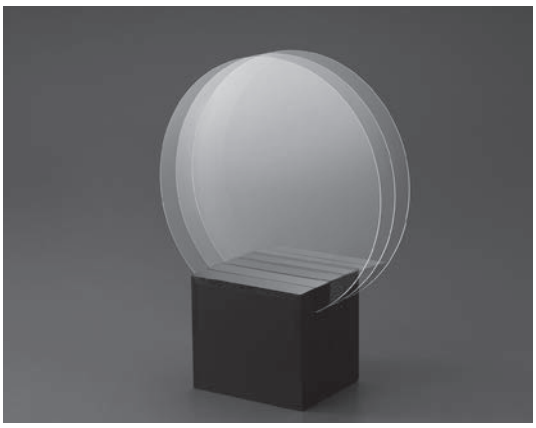
	Dimensions	Thickness	Tolerance of thickness
BDA-E	2×2mm-360×440mm	0.1-1.1mm	±0.01- ±0.1mm
CB-1		1.1mm	
ABC-1	Φ100-300mm	0.3-0.5mm	
BDA	2×2mm-50×50mm	0.3-0.7mm	

Various optical coatings can be designed as requested.

Glass Wafer for CSP

Alkali-free and polish-free glass wafer featuring low CTE* is used as cover glass for WLCSP (Wafer Level Chip Size Package) of CMOS image sensors.

*CTE: coefficient of thermal expansion



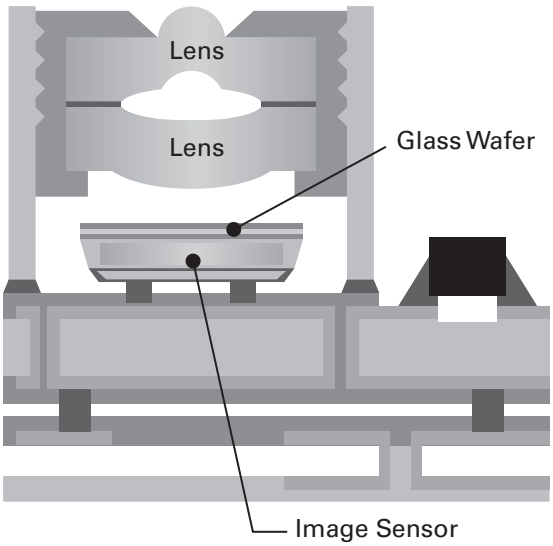
Features

- Alkali-free and polish-free
- As-free, Sb-free characteristics are eco-friendly.
- Excellent surface quality
- Available in various thin film coatings such as AR and metal.

Properties

Properties/Glass Code			**ABC-1**
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	37
Density		$\times 10^{3}$kg/m^{3}	2.52
Young's modulus		GPa	78
Poisson's ratio			0.2
Volume resistivity Log ρ	350℃	Ω·cm	13.0
Dielectric constant	1MHz, RT		5.6
tan δ	1MHz, RT		0.001
Refractive index(nd)	587.6nm	%	1.53
Light transmittance	λ=550nm	%	92

Configuration Image of Smartphone Camera



Low Temperature Sealing Glass 1

Low temperature sealing glass is a composite material made by blending matrix powder glass with a low softening temperature and specially synthesized ceramic filler powder. The sealing temperature and coefficient of thermal expansion (CTE) of sealing glass can be adjusted by changing the kind and blending ratio of the glass and filler.

LS-2010 is widely used for DIP and QFP made of alumina (CTE: approximately 70 × 10^{-7}/K).

LS-1401S's low sealing temperature of 380˚C makes it suitable for SMD packages for quartz oscillators.

LS-3051S is used for sealing low-expansion ceramics such as AIN (CTE: approximately 45 × 10^{-7}/K).

LS-1301 and BF-0901 are suitable for sealing silicon (CTE: approximately 35 × 10^{-7}/K).

Properties

Usage			Alumina		AIN, Mullite, Silicon		
Properties/Glass Code			**LS-1401S**	**LS-2010**	**LS-3051S**	**LS-1301**	**BF-0901**
Sealing temperature		˚C	380	435	430	450	560
Dielectric constant	1MHz, 25˚C		45.0	12.5	16	45.5	11.1
tan δ	1MHz, 25˚C	$\times10^{-4}$	38	34	41	60	19
Coefficient of thermal expansion	30-250˚C	$\times10^{-7}$/K	71*1	65	51	41	49*2
Transformation point		˚C	258	313	303	315	430
Softening point		˚C	355	400	390	390	528
Density		$\times10^{3}$kg/m^{3}	7.02	5.67	5.95	6.77	4.69
Volume resistivity Log ρ	150˚C	Ω·cm	6.2	12.4	12.7	12.0	13.3
Thermal conductivity		W/m·K	0.98	1.45	1.24	0.84	1.47
Specific heat		$\times10^{3}$J/kg·K	0.34	0.41	0.38	0.35	0.46
Acid durability	20% H_2SO_4, 70˚C, 1min	mg/cm^2	—	0.8	1.1	0.1	—
	10% H_2SO_4, 20˚C, 10min	mg/cm^2	—	0.5	0.9	0.1	—
	10% HCl, 20˚C, 10min	mg/cm^2	—	1.9	2.7	0.5	—
	10% HNO_3, 20˚C, 10min	mg/cm^2	—	120	120	123	—
Color			Black	Dark brown	Black	Black	Green
Glass type			$PbO·B_2O_3$(COM)*3				$Bi_2O_3·B_2O_3$ (COM)*3

*1 This figure was measured at 30 to 200˚C.
*2 This figure was measured at 30 to 300˚C.
*3 COM: Composite sealing glass
Please contact us about other types of Pb-free glass.

Application Examples

1. Printing and Drying (except LS-1401S)

The paste for printing is prepared by adding vehicle to the powder glass and mixing them well.

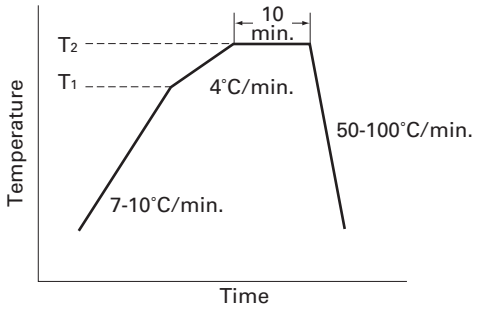
The vehicle is obtained by dissolving a low molecular weight acrylic resin in terpineol at a concentration of 5%. The paste obtained is printed on ceramic parts with an 80-100 mesh stainless screen. Printing and drying are repeated in order to increase the glass thickness of the film layer.

Drying is carried out at 120°C for 10-20 minutes.

2. Pre-firing

In order to eliminate the resin in the film layer pre-firing is done in an oxidizing atmosphere such as oxygen or air. Decomposition and firing of the resin takes place most actively at 320-380°C, so gradual heating is necessary in this temperature range.

Sintering of the powder glass is also carried out.



Glass Code	T_1 (°C)	T_2 (°C)
LS-1401S	250	350
LS-2010	320	390
LS-3051S	310	380
LS-1301	310	400
BF-0901	350	530

Fig. 1 Pre-firing profile

3. Lead-Frame Attaching

Lead-frame attaching is carried out in the air, and maintain the attaching temperature (T) for 5 to 7 minutes. When a heater block is used, the surface temperature of the block is kept higher than the attaching temperature by 30-50°C. Soak time is 1 to 2 minutes.

Glass Code	T (°C)
LS-2010	435
LS-3051S	430
LS-1301	450

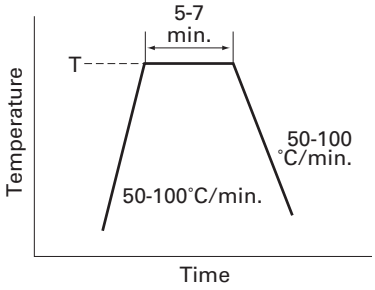


Fig. 2 L/A profile

4. Sealing

Sealing is carried out in either an air or a nitrogen atmosphere. Soak time is approximately 10 minutes and temperature is the same as lead-frame attaching temperature. Heating up rate is 50 to 100°C/min. and cool down rate is 20 to 40°C/min.

Low Temperature Sealing Glass 2

Low temperature sealing glass is a composite material made by blending matrix powder glass with a low softening temperature and specially synthesized ceramic filler powder. By changing the blending ratio and the kinds of glass and ceramics used, it is possible to change its sealing temperature and coefficient of thermal expansion.

- Composite sealing glass has a short sealing time and excellent ability to seal glass and metal.
- Devitrifiable glass can be re-fired without deformation.
- When a devitrifiable glass is heated, crystals form in the resulting melt, which then solidifies to produce a highly heat-resistant seal.

Properties

Properties/Glass Code			LS-3075	LS-3081	LS-0118	LS-0206	LS-7105	BF-0606
Sealing temperature		˚C	450	410	430	450	450	485
Coefficient of thermal expansion	30-250˚C	$\times10^{-7}$/K	36.5	74	72.5	72	85*1	73*1
Density		$\times10^{3}$kg/m^{3}	6.91	6.89	7.05	6.82	6.37	6.05
Transformation point		˚C	300	300	317	325	—	365
Deformation point		˚C	330	320	337	353	—	393
Softening point		˚C	—	365	390	410	400	450
Volume resistivity Log ρ	150˚C	Ω·cm	10.8	12.2	11.2	13.2	10.4	12.0
Color			Black	Black	Black	Black	Black	Green
Glass type			$PbO \cdot B_2O_3$ (COM)*2	$PbO \cdot B_2O_3$ (COM)*2			$PbO \cdot ZnO \cdot B_2O_3$ (DEV)*3	$Bi_2O_3 \cdot B_2O_3$ (COM)*2
Application			Alkali-free glass	Window glass, 50 Alloy, 426 Alloy				

* 1 This figure was measured at 30 to 300°C.
* 2 COM : Composite sealing glass
* 3 DEV : Devitrifiable sealing glass

Please contact us about other types of Pb-free glass.

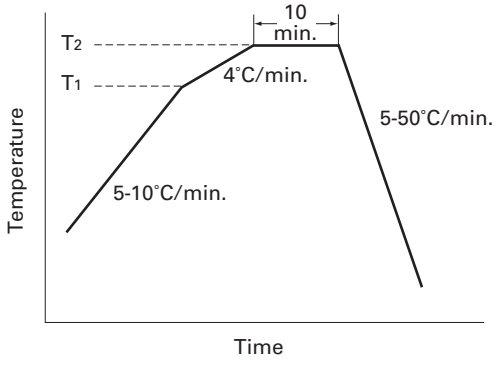
Application Examples

1. Printing and Drying

The paste for printing is prepared by adding a vehicle to the sealant and mixing them well. The vehicle is obtained by dissolving acrylic resin in terpineol at a concentration of 5%. The paste obtained is printed on the substrates with 80-100 mesh stainless screen. Drying is carried out at 120°C for 10-20 minutes.

2. Pre-firing

In order to eliminate the resin in the film layers, pre-firing is done in an oxidizing atmosphere such as oxygen or air. Decomposition and firing of resin take place most actively at 320-380°C, so gradual heating is necessary in this temperature range.

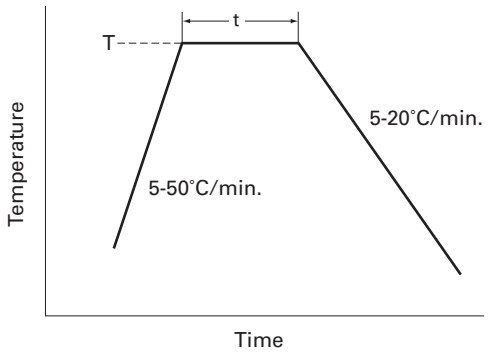


Glass Code	T_1 (°C)	T_2 (°C)
LS-3075	320	380
BF-0606	350	450
LS-3081	320	380
LS-0118	320	380
LS-0206	320	400
LS-7105	320	390

Fig. 1 Pre-firing profile

3. Sealing

Sealing is carried out in either an air or a nitrogen atmosphere.



Glass Code	T (°C)	t (min.)
LS-3075	450	10
BF-0606	485	10
LS-3081	410	10
LS-0118	430	10
LS-0206	450	15
LS-7105	450	20

Fig. 2 Sealing profile

Granulated Glass for Metal Packages

Granulated glass is used extensively for sealing stems and leads, and for part support in metal packages. Owing to their free flow characteristics, they have excellent workability in the tablet forming process.

Glass for matching seals is used with Kovar stems and leads, while those for compression seals are used with iron or stainless steel stems and leads of iron-nickel, iron-chrome alloys or Kovar.

Glass for part support is used for stand-off.

Properties

Usage			Seal							Part Support	
			Compression Seal			Matching Seal				Stand Off	
Glass Code			**ST-W/K**	**ST-4W/K**	**FN-13W/K**	**BH-W/K**	**BH-7W/K**	**BH-8W/K**	**BH-14W/K**	**ST-4F/K**	**BH-FW/K**
Particle size	D_{50}	μ m	135	130	110	135	135	135	135	120	125
	D_{99}	μ m	265	250	215	265	265	265	265	235	245
Firing temperature: T_1		˚C	650-660		680-690		700-710	670-680	730-750	650-660	750-800
Sealing temperature: T_2		˚C	960			980		930	980	960	1050
Coefficient of thermal expansion	30-380˚C	$\times 10^{-7}$/K	95	95	75.5	45.5	49.5	62.5	31.5	94	57
Density		$\times 10^3$kg/m^3	2.60	2.60	2.51	2.28	2.32	2.41	2.13	2.65	2.83
Transformation point		˚C	450	460	510	470	505	510	—	460	515
Deformation point		˚C	510	520	570	550	565	570	—	520	635
Strain point		˚C	420	427	480	435	472	475	—	—	—
Annealing point		˚C	460	472	517	480	513	520	—	—	—
Softening point		˚C	663	672	687	698	715	685	782	—	—
Working point		˚C	980	1030	990	1050	1130	990	1090	—	—
Dielectric constant	1MHz, 25˚C		6.4	6.5	6.3	5.0	5.5	5.8	4.0	6.7	6.4
tan δ	1MHz, 25˚C	$\times 10^{-4}$	22	21	32	30	39	37	3	24	31
Volume resistivity Log ρ	150˚C	Ω·cm	11.4	11.2	11.2	11.5	10.8	11.1	15.5	11.4	—
	250˚C	Ω·cm	8.8	8.7	8.7	8.8	8.2	8.5	12.3	8.8	—
	350˚C	Ω·cm	6.9	7.0	7.0	7.0	6.4	6.8	10.2	7.0	—
Young's modulus		GPa	68	68	—	57	57	—	—	—	—
Poisson's ratio			0.21	0.21	—	0.22	0.22	—	—	—	—
Glass type			$Na_2O \cdot BaO \cdot SiO_2$		$Na_2O \cdot Al_2O_3 \cdot B_2O_3 \cdot SiO_2$					$Na_2O \cdot BaO \cdot SiO_2$	$Na_2O \cdot Al_2O_3 \cdot B_2O_3 \cdot SiO_2$
Application			Fe,Fe-Ni,Fe-Cr,Fe-Ni-Cr		Fe Kovar	Kovar Mo				Fe	Kovar

ST-4F/K, BH-FW/K: Composite glass
Please contact us about color variations.

Application Examples

1. Pressing

The mold pressure of 8-10MPa is suitable for making preforms. The preforms manufactured under this condition have enough green strength for handling and the organic binder decomposes easily during the pre-firing process.

2. Pre-firing

Pre-firing is carried out in an oxidizing atmosphere such as oxygen or air. Pre-firing temperature should be applied to the temperature T_1 in the property table on the opposite page.

Decomposition and firing of the organic binder take place most actively at 150-530°C, so gradual heating is necessary in this temperature range.

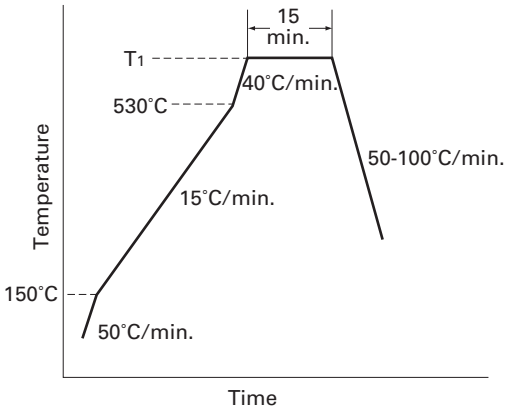


Fig. 1 Pre-firing profile

3. Sealing

Sealing is carried out in a nitrogen atmosphere. Sealing temperature should be applied to the temperature T_2 in the property table on the opposite page.

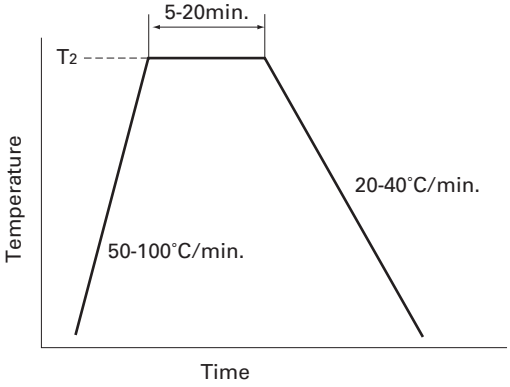


Fig. 2 Sealing profile

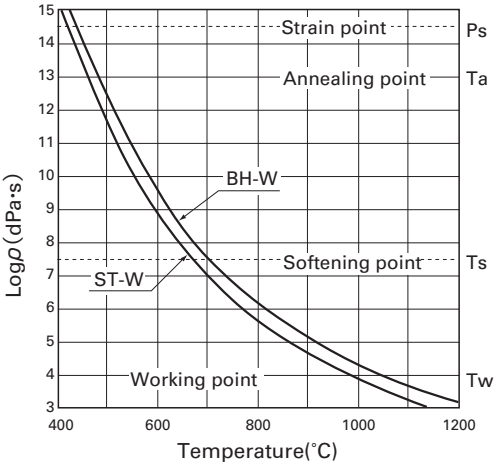


Fig. 3 Viscosity

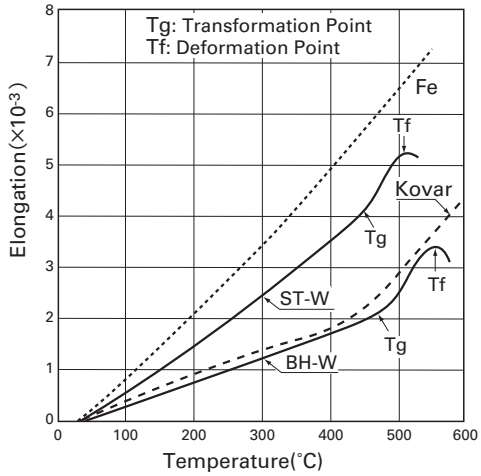


Fig. 4 Thermal expansion

Passivation Glass

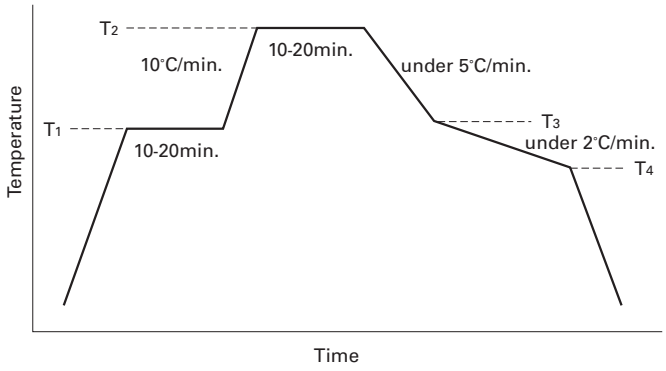
Zinc-borosilicate passivation glass is applicable for use in manufacturing highly reliable devices because no change occurs to surface charge density in BT treatment when applied with DC bias and heating.
Lead silicate glass and lead borosilicate passivation glass have excellent chemical durability and can be applied to transistors, thyristors, and diodes with nickel-plated electrodes.
Various particle sizes are available upon request.

Properties

Properties/Glass Code			GP-014	GP-031	GP-5210	GP-180	GP-190	GP-200
Grind type*1			350	350	350	S	S	S
Coefficient of thermal expansion	30-300°C	$\times10^{-7}$/K	43	36	33	44.5	43.5	44
Transformation point		°C	550	535	550	590	620	595
Softening point		°C	650	635	650	775	810	780
Density		$\times10^{3}$kg/m^{3}	3.78	3.93	3.84	3.87	3.81	3.78
Alkali content	Na_2O	ppm	≦20	≦20	≦20	≦30	≦30	≦30
	K_2O	ppm	≦10	≦10	≦10	≦10	≦10	≦10
	Li_2O	ppm	≦5	≦5	≦10	≦10	≦10	≦10
Application (Reverse breakdown voltage level)*2			Low	Low	High	Medium	High	Medium
Surface charge density: NFB*3		$\times10^{11}$/cm^{2}	0–+1	0–+1	+6–+7	+7–+8	+15–+16	+6–+7
Glass type			$ZnO{\cdot}B_2O_3{\cdot}SiO_2$	$ZnO{\cdot}B_2O_3{\cdot}SiO_2{\cdot}PbO$		$PbO{\cdot}SiO_2{\cdot}Al_2O_3$		

∗1 350: Dmax 44μm, D_{50} 16μm S: Dmax 44μm, D_{50} 7.5μm
∗2 Selection guide depending on your device level.
∗3 Silicon side

Firing Profile



Glass Code	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)
GP-014	590	680-690	590	540
GP-031	570	700-720	570	520
GP-5210	590	720-730	590	540
GP-180	650	800-820	630	580
GP-190	670	860-870	650	600
GP-200	650	810-820	630	580
GP-230	670	855-865	650	600
GP-605	660	850-860	630	580
GP-620	670	850-860	650	600
GP-350	520	710-720	520	450
GP-370	570	750-760	570	450
GP-380	600	770-780	560	510
GP-390	600	770-780	570	520

*You may not be able to obtain sufficient firing, crystallizing status, and electrical characteristics, in case your firing profile is not within our recommendation.

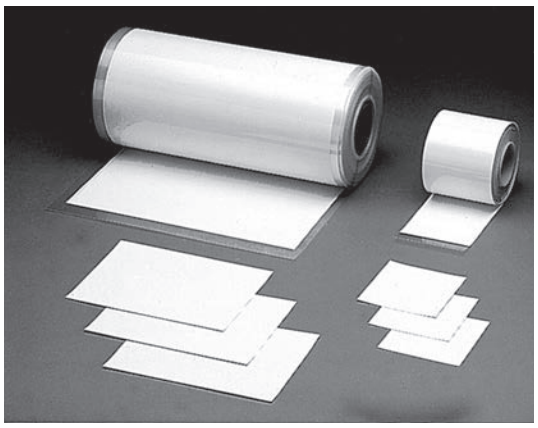
GP-230	**GP-605**	**GP-620**	**GP-350**	**GP-370**	**GP-380**	**GP-390**
S	S	S	S	S	S	S
41.5	44	43	46.5	42.0	44.5	43
610	590	620	470	475	535	540
830	790	810	645	680	740	740
3.58	3.84	3.76	3.53	3.32	3.61	3.54
≦30	≦30	≦30	≦30	≦30	≦30	≦30
≦10	≦10	≦10	≦30	≦10	≦10	≦10
≦10	≦10	≦10	≦10	≦10	≦10	≦10
Medium	High	High	Low	Medium	Medium	High
+7–+8	+11–+12	+14–+15	+2–+3	+5–+6	+6–+7	+14–+15
			$PbO{\cdot}B_2O_3{\cdot}SiO_2{\cdot}Al_2O_3$			

Composite Powder for Low Temperature Cofired Ceramics

Composite powder for low temperature cofired ceramics is a composite material that is made by uniformly blending glass and ceramic fillers. Firing can be conducted at a low temperature in the range of 870-900°C, which allows the use of highly conductive elements such as gold and silver paste to create a screen print circuit pattern with high electric properties.

- MLS-25M is a vitreous material with a low CTE* and a low dielectric constant.
- MLS-25E is a vitreous material with a very low dielectric constant.
- MLS-41 is a devitrifiable material with a high dielectric constant.
- MLS-1000 is a devitrifiable material with high heat resistance and mechanical strength (contains lead).
- MLS-26 is a devitrifiable material with high mechanical strength.
- MLS-63 is a devitrifiable material with high mechanical strength and low tan δ .

*CTE : coefficient of thermal expansion



Green sheets

Properties

Properties/Glass Code			MLS-25M	MLS-25E	MLS-41	MLS-1000	MLS-26	MLS-63
Bending strength		MPa	157	125	250	274	320	400
Dielectric constant	1MHz, 25°C		4.9	3.9	17.0	7.8	7.1	8.0
	15GHz, 25°C		4.8	3.9	19.0	7.6	6.7	7.9
tan δ	1MHz, 25°C	$\times10^{-4}$	25	5	20	16	4	5
	15GHz, 25°C	$\times10^{-4}$	47	21	50	47	58	11
Coefficient of thermal expansion	30-380°C	$\times10^{-7}$/K	42	60	84	59.5	58	87
Density*		$\times10^{3}$kg/m^{3}	2.52	2.29	4.36	3.39	3.02	3.52
Transformation point		°C	500	500	700	565	625	725
Volume resistivity Log ρ	150°C	Ω·cm	13.5	>14	—	>14	12	>14
Thermal conductivity		W/m·K	1.9	1.7	3.1	3.1	3.9	4.1
Particle size	D_{50}	μm	3.3	3.5	1.1	1.8	2.6	1.6
	D_{max}	μm	20	20	10	15	15	10
Glass type			$Al_2O_3 \cdot B_2O_3 \cdot SiO_2$		$Nd_2O_3 \cdot TiO_2 \cdot SiO_2$	$PbO \cdot Al_2O_3 \cdot SiO_2$	$SiO_2 \cdot CaO \cdot Al_2O_3$	

*Powder theoretical density

Application Examples

Method

1. Casting and Printing

Glass-ceramic powder, binder resin, solvent, and plasticizer are thoroughly mixed and cast into a 50-300 μm thick green sheet using the doctor blade method. Individual sheets are cut into appropriate sizes from the green sheet and punched with via holes and then screen-printed with a circuit pattern.

2. Lamination

Green sheets are laminated at 50-100°C and under 10-35 MPa pressure.

3. Firing

Firing is carried out in the air.

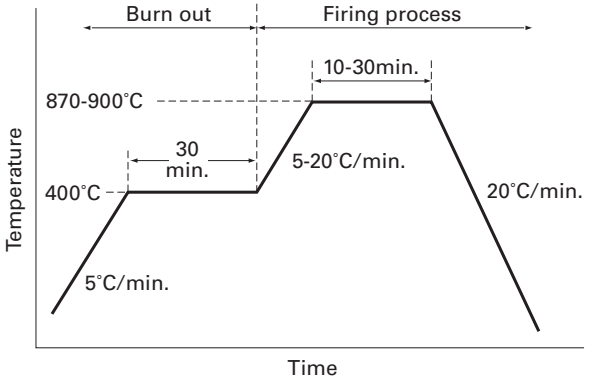
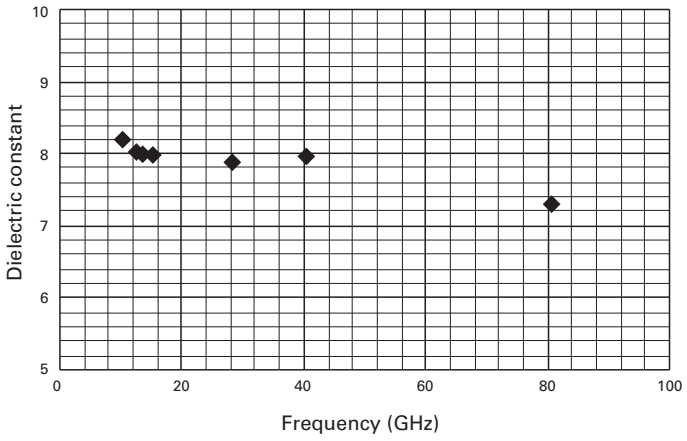


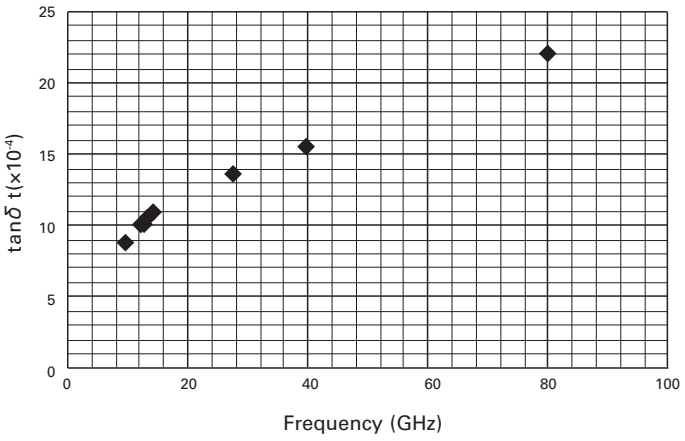
Fig. 1 Firing profile

High Frequency Dielectric Properties of MLS-63

Dielectric constant



tan δ



Powder Glass for Coating, Binding, and Sealing

Powder glass is used to coat a wide variety of substrates and elements. Please make your selection using the coefficient of thermal expansion and softening point as a guide. Powder glass is also used as a binder for thick film paste, conductive paste of solar cells, and ceramic chip devices.
Please make your selection using glass type and softening point as a guide.

Properties

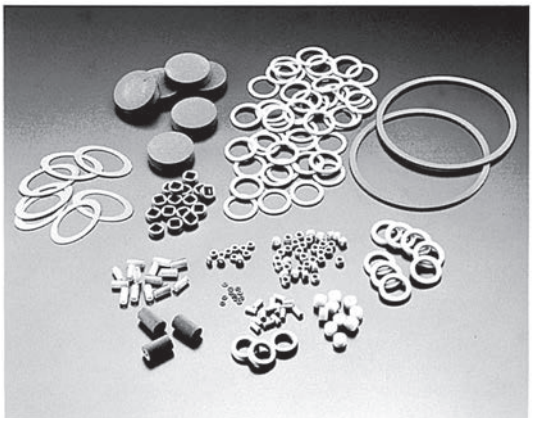
Properties/Glass Code			GA-1	GA-4	GA-8	GA-9	GA-12	GA-13	GA-21	GA-34*	GA-44	GA-47
Coefficient of thermal expansion		× 10^{-7}/K	60	63	81	90	73	66	83	45	117	37
Density		× 10^{3}kg/m^{3}	4.03	2.70	5.38	5.77	2.95	3.04	5.74	3.93	3.02	2.36
Transformation point		˚C	445	475	400	360	460	660	375	535	630	645
Deformation point		˚C	505	545	430	385	505	715	402	560	—	715
Softening point		˚C	595	625	490	430	560	850	450	635	—	—
Dielectric constant	1MHz,25˚C		8.8	6.2	11.7	14.7	6.7	7.2	—	—	8.5	5.2
tan δ	1MHz,25˚C	× 10^{-4}	12	20	26	17	17	15	—	—	40	8
Volume resistivity Log ρ	250˚C	Ω·cm	13.1	10.8	12.2	11.3	10.4	14.1	—	—	—	—
	350˚C	Ω·cm	11.0	8.0	9.5	—	8.3	12.0	—	—	—	—
Main composition (Glass type)			$PbO·B_2O_3·SiO_2$	$Na_2O·B_2O_3·SiO_2$	$PbO·B_2O_3·SiO_2$	$PbO·B_2O_3·SiO_2$	$Na_2O·ZnO·B_2O_3$	$CaO·BaO·SiO_2$	$PbO·B_2O_3·SiO_2$	$PbO·ZnO·B_2O_3·SiO_2$ (devitrifiable)	$MgO·B_2O_3·SiO_2$ (devitrifiable)	$Al_2O_3·B_2O_3·SiO_2$
Color			White,Black	White	White	White	White	White	White	Pale Purple	White	White

Properties/Glass Code			GA-50	GA-55	GA-59	GA-60	LS-0500	BG-0600	BG-0700	BG-0800	BG-0900	BG-1300
Coefficient of thermal expansion		× 10^{-7}/K	24	87	38	96	83	109	112	98	96	70
Density		× 10^{3}kg/m^{3}	2.15	4.54	3.80	2.88	3.06	6.96	7.29	5.76	6.74	5.23
Transformation point		˚C	495	700	550	640	495	365	350	435	390	497
Deformation point		˚C	600	730	—	—	535	395	385	475	420	546
Softening point		˚C	825	—	645	—	585	430	410	510	460	615
Dielectric constant	1MHz,25˚C		4.1	26.0	—	7.2	7.6	23.6	25.8	16.2	22.4	13.4
tan δ	1MHz,25˚C	× 10^{-4}	20	25	—	35	138	19	27	29	17	17
Volume resistivity Log ρ	250˚C	Ω·cm	12.4	—	—	—	9.2	9.3	8.7	10.9	9.7	11.5
	350˚C	Ω·cm	—	—	—	—	7.4	7.4	6.8	8.8	7.9	9.4
Main composition (Glass type)			$B_2O_3·SiO_2$	$Nd_2O_3·TiO_2·SiO_2$	$ZnO·B_2O_3·SiO_2$ (devitrifiable)	$MgO·B_2O_3·SiO_2$ (devitrifiable)	$Na_2O·B_2O_3·SiO_2$	$Bi_2O_3·B_2O_3$	$Bi_2O_3·B_2O_3$	$Bi_2O_3·B_2O_3$	$Bi_2O_3·B_2O_3$	$Bi_2O_3·SiO_2$
Color			White	Pale Green	Pale Purple	White	White	Green	Green	White	Green	Light Brown

＊ We recommend GA-59 as a Pb-free alternative for GA-34 (low expansion type glass).
Please contact us about other types of Pb-free glass.

Tablet

Tablets are preformed and made of sintered powder glass.



Features

- A broad lineup of products offering glass matching virtually every application.
- Comes in sintered form that is easy to handle and eliminates the need for paste preparation and other preprocessing.
- Can be applied to fine holes and deep grooves that are difficult to fill in with paste.

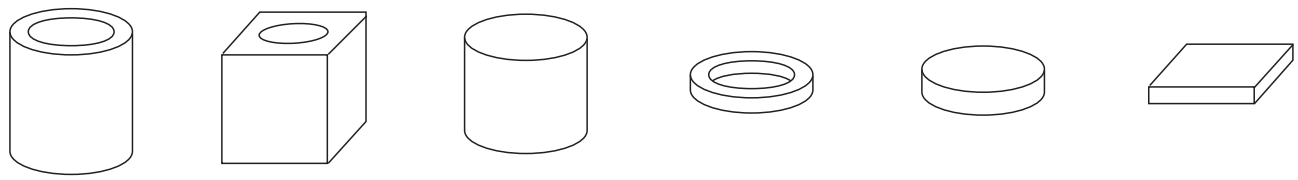
Please contact us about optimal glass selection, forms and sizes. The table below shows examples of glass selections available.

Selection of Sealing Glass (example)

Application	Working point (°C)		
	Less than 500	500-600	700-1000
Kovar, AlN	LS-1301	BF-0901	BH-7
Alumina	LS-2010	BF-0606	GA-1
Window glass	LS-0118	GA-8	—
Forsterite	—	GA-9	GA-11
Fe, Fe-Ni	BG-0600	BG-0800	ST-4

For further information on properties, see p.24-27 regarding glass which has sealing temperature less than 500°C and see p.28 or 34 for others.

Forms (example)



Example of Dimensions

(Unit : mm)

Form	Outer diameter	Inner diameter	Height
Ring	15.5	13.5	1.0
	0.6	0.2	0.2
Cylinder	4.0	2.0	5.0
Disc	3.0	—	0.8

Please contact us about other forms and dimensions.

Glass Paste

Glass pastes are made by homogeneously dispersing powder glass upon the vehicle.

- A broad lineup of products offering glass paste for virtually every application
- Can be applied directly to paste application process.
- PLS-3123 and PLS-3124 form excellent moisture-protective and laser-trimmable overglaze. These overcoat pastes are ideal for network resistors.
- PLS-3150B1 has excellent acid durability that prevents discoloration after the electrode plating.

Please contact us about optimal glass selection, viscosity, and other information. The table below shows only few examples of glass selections available.

Properties

Application		Thick Film Hybrid IC Substrates for Ag/Pd, Ag/Pt Circuit		Chip Resistors	Chip Resistors	Various Ceramics
		Overglaze		Secondary Coating	Overglaze	Overglaze, Sealing, Bonding
Glass Code		**PLS-3123**	**PLS-3124**	**PLS-3150B1**	**PLS-3900**	**PLS-3143**
Temperature Firing conditions Soak time at peak		510°C Fireable in air 10 minutes		580-620°C Fireable in air 10 minutes	600°C Fireable in air 10 minutes	850°C or more Fireable in air 10 minutes
Screen		165-325mesh				
Film thickness after firing	μm	10-50				
Color		Green		Black	Light brown (White and semi-translucent after firing)	White (Semi-translucent after firing)
Viscosity	Pa·s	90	180	230	120	150
Coefficient of thermal expansion	$\times 10^{-7}$/K	67		70	52	66
Softening point	°C	530		585	597	840
Thinner				Terpineol		
Feature		Forms moisture protective and highly hermetic glass film. Used widely for hybrid ICs in automobile	High viscosity type of PLS-3123	Excellent acid durability		
Type		Pb			Pb-free	

Please contact us about other types of Pb-free glass.

Application Examples

1. Printing
The paste is printed on a substrate by the screen printing method. Adjustment of printing conditions is suggested, referring to the following table based on the purpose.

2. Leveling
In order to achieve a smooth surface, the prints are leveled at room temperature for 5 to 10 minutes.

3. Drying
The prints are dried at a temperature of 100 to 150°C for 10 to 15 minutes.

4. Firing
The prints are fired using a belt furnace or a batch furnace. A heating rate of 20 to 50°C/min. is recommended for burning out the organic materials in the paste. A suitable cooling rate is 20 to 50°C/min. to prevent the substrate and the glassy film from thermal cracking.

● **Reference: Factors which affect print quality**

	Improving print resolution	Increasing film thickness	Decreasing film thickness
Squeegee hardness	hard	soft	hard
Squeegee angles	increase	reduce	increase
Squeegee speed	slow	fast	slow
Squeegee pressure	low	low	high
Screen mesh	fine	wide	fine
Screen emulsion	thin	thick	thin
Screen gap	small	large	small
Paste viscosity	high	high	low

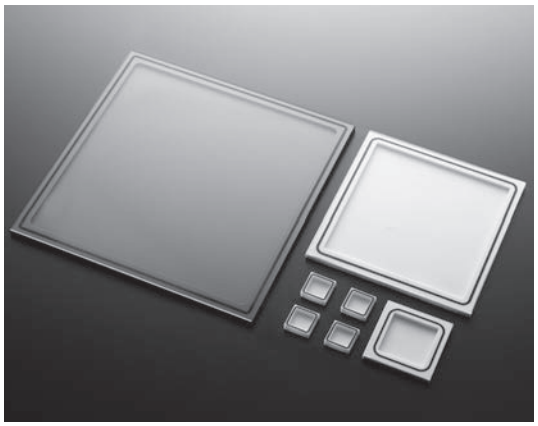
Caution

- It is necessary to store the paste in a cool, dark place to prevent deterioration.
- The paste, stored for a long time, needs to be stirred well with a stainless-steel spatula before use.
- Adjust viscosity as necessary.
- Vapor from the paste is hazardous to the health. Be sure printing worksite is adequately ventilated.
- When the skin is stained with paste, it must be cleaned at once.

Glass Frit for Laser-sealing of Ceramic Packages

**Glass frit for laser-sealing can create hermetic seals between glass lids and ceramic packages.
This glass frit has a lower CTE* than conventional products and excellent wettability with ceramics.
Therefore, this glass frit is suitable for hermetic sealing applications requiring high reliability.**

*CTE: coefficient of thermal expansion

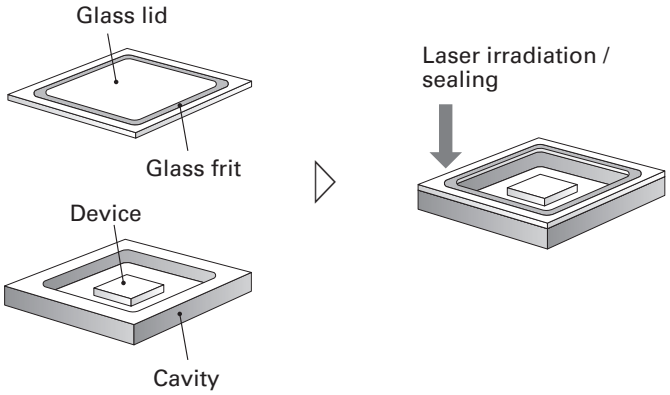


Application examples

Features

- Similar CTE to ceramic material CTE: 6.5 to 7.2ppm/°C
- Excellent wettability with ceramics
- Prevents thermal damage to internal devices
- High reliability of hermetic sealing
- Glass lids with glass frit are available.

Laser-sealing Process



Available Materials and Sizes

Cavity Material	Package/Substrate Size	Glass Lid thickness
LTCC	up to 60mm	up to 1mm
Alumina	up to 60mm	up to 0.5mm
Glass	up to 200mm	up to 1mm
Silicon	up to 10mm	up to 0.2mm

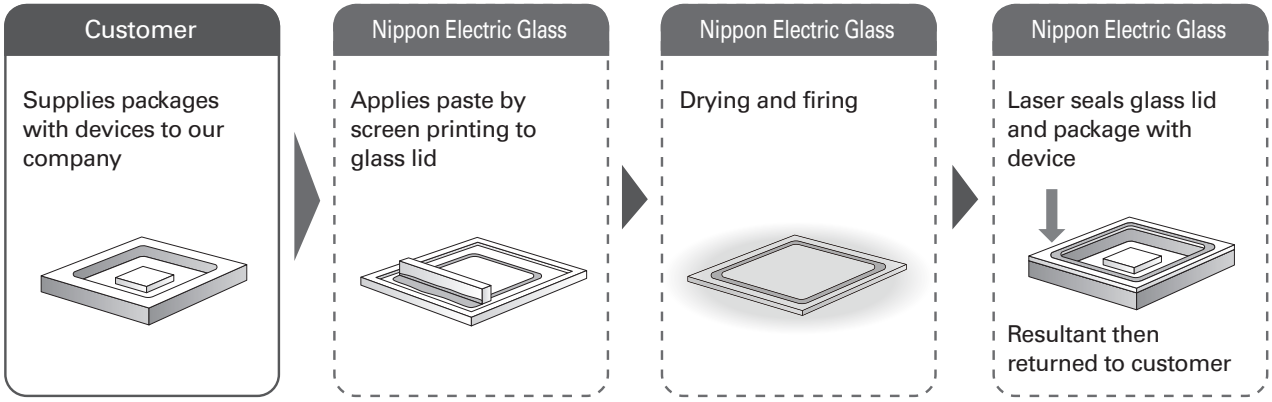
Applications

- Micro Electro Mechanical Systems (MEMS) packages
- Deep UV LED packages
- Hermetic sealing for packages
- OLED devices

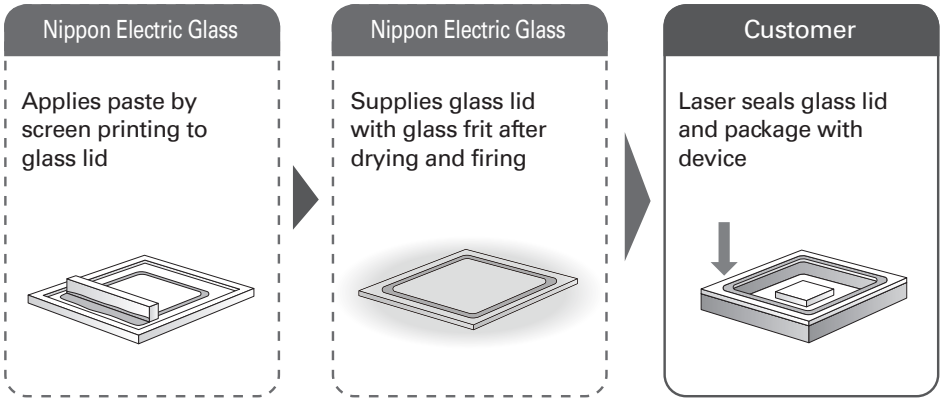
Supply Forms and Processes

- Our general supply methods are given below.
- Customers can simplify the process.

1. We (Nippon Electric Glass) supply laser-sealed packages to customers.



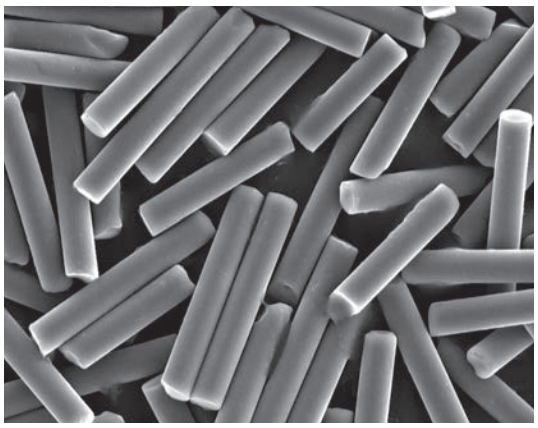
2. We supply glass lids with glass frit printed and fired. Customers conduct laser sealing on their own.



- In addition, a combination of a glass lid with glass frit and LTCC cavity made by our company that is suitable for laser-sealing can be supplied. In such case, we can also supply the same in the form of a package after sealing by our company.
- Customers can select the optimal glass lid with fired glass frit from our various glass lids with a wide CTE range.

Micro Rods

**Micro Rods are manufactured by cutting glass fiber and used mainly as gap spacers in LCDs.
Owing to their high dimensional precision, they can be used as gap spacers not only in LCDs but also in a diversity of other sub-micron-grade applications.**



Features

- Very precise diameter distribution attributable to manufacturing method
- High adhesive strength with coupling agents and sealants

Part No.

Product Code — Diameter Code — Length Type

- Product Code: PF
- Diameter Code: Rod Diameter Center (μm)×10
- Length Type: No Code: Normal Length Type; S: Short Type

Example: PF-60S
- 60: 6.0μm
- S: Short Type

Specifications (example)

Rod Diameter Center	Part No.	Rod Diameter (μm) Mean	Standard Deviation	Maximum
6.0μm	**PF-60**	6.00±0.01	0.07 max.	6.20
	PF-60S			

Product Lineup

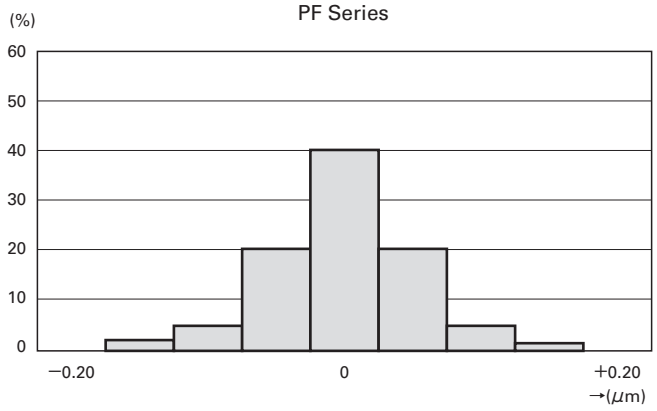
	PF Series	
Rod Length	Normal Length Type	Short Type
Rod Diameter	5.0-30.0μm	3.0-15.0μm

Please contact us for details.

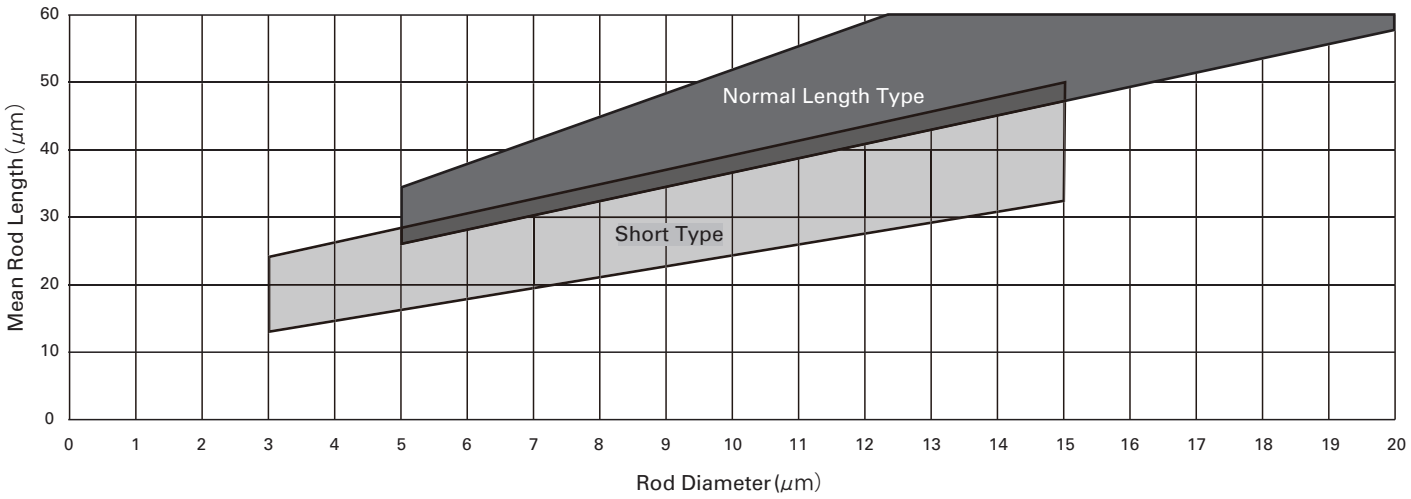
Properties

Properties/Glass Code			PF
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	56
Strain point		°C	635
Annealing point		°C	680
Softening point		°C	850
Dielectric constant	1MHz, 25°C		6.7
tan δ	1MHz, 25°C	$\times 10^{-4}$	15
Volume resistivity Log ρ	150°C	Ω·cm	17
	200°C	Ω·cm	13.6
Thermal conductivity	0°C	W/m·K	1.04
Vickers hardness	Hv (0.2)		640
Moh's hardness			6.5
Density		$\times 10^3$kg/m^3	2.6
Refractive index (n_d)			1.56

Distribution of Rod Diameter (example)

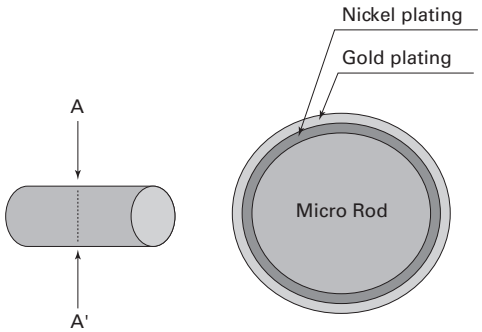


Correlation between Rod Diameter and Rod Length by Type



Conductive Type (option)

Conductive Micro Rods with nickel/gold double-layer plating are available.



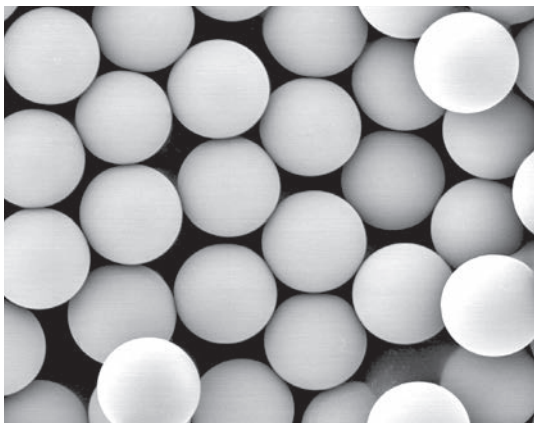
Cross section (A-A')

Plating Specifications

Material	Base: Ni	Surface layer: Au
Plating Thickness (μm)	0.10	0.05
Specific Volume Resistance (Ω·cm)	0.1 max.	

Fine Sphere

Fine Spheres can be used as gap spacers in LCDs.



Features

- Very precise diameter distribution
- Chemical and thermal stability and very few impurities
- Provides stable gaps with high hardness and very small deformation under compression load.

Part No.

Product Code — Diameter Code

- Product Code: SK
- Diameter Code: Center Diameter (μm) × 10

Example : SK-42 (42 → 4.2μm)

Diameter Range

2.0-8.0μm

＊Please contact us for details.

Standard Deviation (example)

Part No.		SK-42
Center Diameter	μm	4.2
Standard Deviation	μm	0.07

Properties

SiO_2		99.9% min
Density	$\times 10^3 kg/m^3$	2.2
Material Structure		Amorphous

LWIR Transmitting Glass Lens

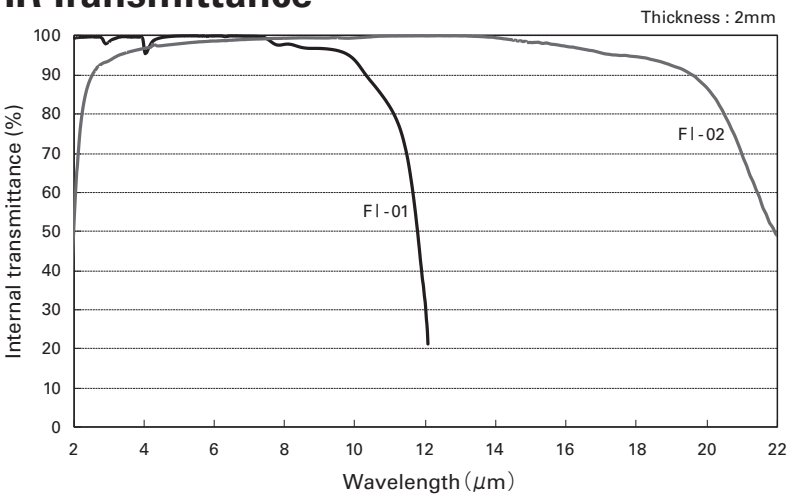
Our glass has excellent IR transmitting properties.
It results in bright and clear infrared images.

Features

- **FI-01**
  - Good athermal efficiency
  - IR transmittance in LWIR
    (Wavelengths up to 12μm can be transmitted.)
- **FI-02**
  - The world's highest* IR transmittance in LWIR
    (Wavelengths up to 20μm can be transmitted.)
  - High refractive index (3.4 at wavelength 10μm)
- **FI-01 & FI-02**
  - Available for mold press
  - Environmentally friendly; no hazardous substances included.

*According to an internal investigation as of October 2022

IR Transmittance

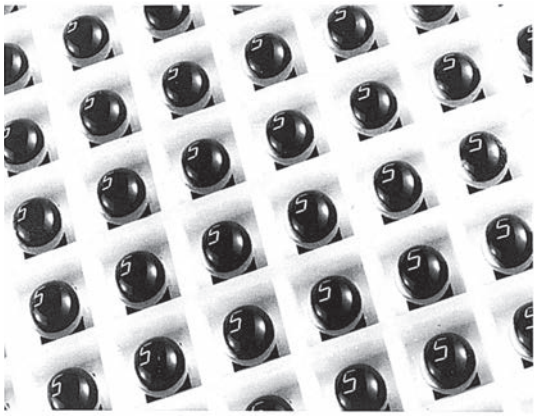


Applications

- Security cameras
- Thermography
- Night vision cameras (for automobiles)
- Gas sensors

Micro Ball

Micro Ball is precisely manufactured from optical glass. It is used as a high precision ball lens in optical communication systems and as a lens for specialty optical equipment such as endoscopes.



Properties

Glass code	Refractive index (n_d)	Abbe number (νd)	Density ($\times 10^3 kg/m^3$)	Thermal expansion coeff. 100-300°C ($\times 10^{-7}/K$)
BK-7	1.517	64	2.51	86
LaSF015	1.804	47	4.67	74

Other types of optical glass are available upon request.

Half Ball Lens

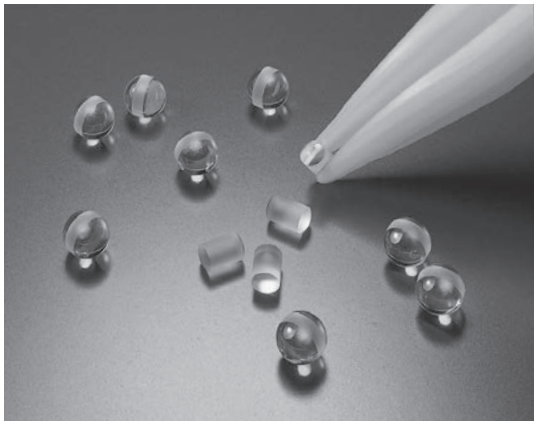
Half Ball Lens is a hemispherical lens that has been precisely manufactured from a Micro Ball. It is possible to adjust the thickness of the hemisphere as well as the flat area of the Half Ball Lens.

Dimensions

Surface roughness (Rmax)	Å	≦100
Nominal diameter	mm	1.0-7.0

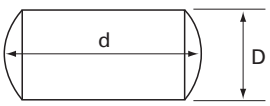
Micro Drum

Micro Drum is a lens manufactured from a Micro Ball by cylindrically grinding. The Micro Drum can be coated on both sides with application-specific wavelength AR coatings.



Standard Dimensions

- Lens diameter (d): 1.0mm –
  Tolerance: ± 5μm
- Drum diameter range (D): 0.8mm –
  Tolerance: ± 5μm



Other dimensions are available upon request.

Ball Lens with AR Coating

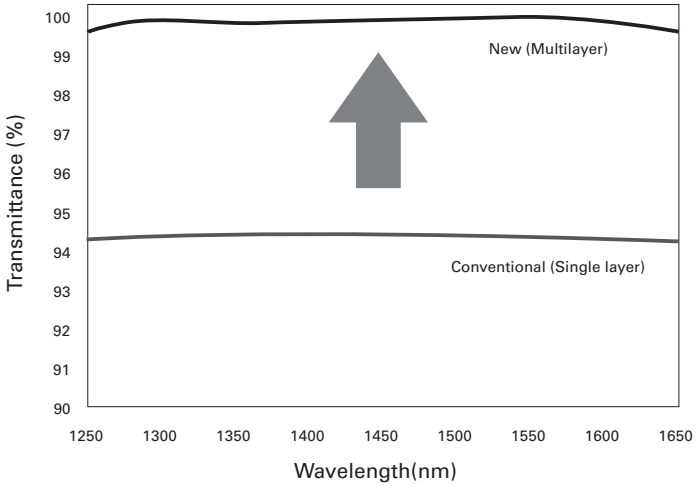
The Ball Lens with AR Coating is precisely processed from optical glass. It realizes the simplification of alignment for the entire AR coating.

Left : ϕ0.50mm Right : ϕ0.75mm

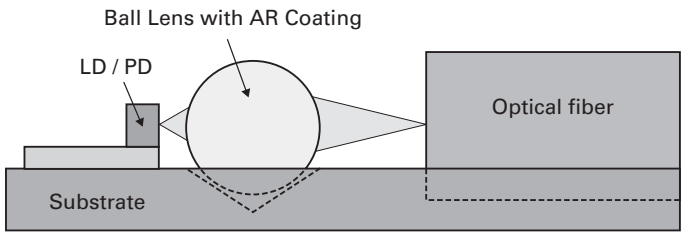
Features

- Minimization ϕ0.75mm → ϕ0.30mm
- High transmission (more than 99.5% λ = 1250-1650nm)
- Various glass materials are available.
- No orientation issue, easy alignment

Transmittance (Conventional: Single layer; New: Multilayer)



Example of Application



Application Image

Ball Lens Cap

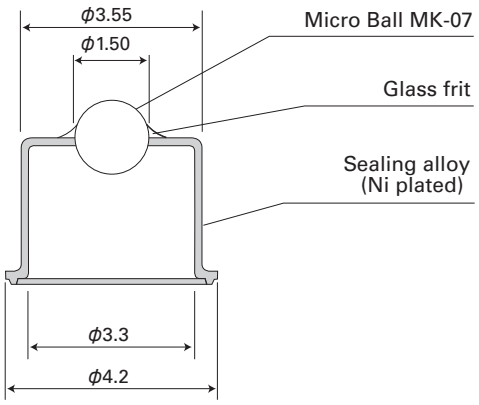
Ball Lens Cap consists of a high-precision Micro Ball sealed in a can cap made of sealing alloy with glass frit. You can choose the standard type for TO-56 and TO-46, depending on the desired application.

Properties

Glass Code	Refractive Index	
	1310nm	1550nm
BK-7	1.504	1.500
LaSF015	1.780	1.775

〈MK-CAP〉
MK-CAP provides high productivity and competitiveness with the use of our original glass manufactured consistently from glass melting, and it is the best solution for FTTH applications.
In addition, the newly developed RH-21 has an extremely high refractive index and significantly improves coupling efficiency, which contributes to miniaturization of modules.

Example (mm)



Properties

Glass Code	Refractive Index	
	1310nm	1550nm
MK-07	1.496	1.493
MK-18	1.775	1.771
RH-21	1.968	1.962

Ball Lens Unit

Ball Lens Unit includes high-precision Micro Ball or Micro Drum directly sealed into a modular package or receptacle with glass frit. Easy to use highly reliable, Ball Lens Unit can simplify the assembly of complex optical system.

Features

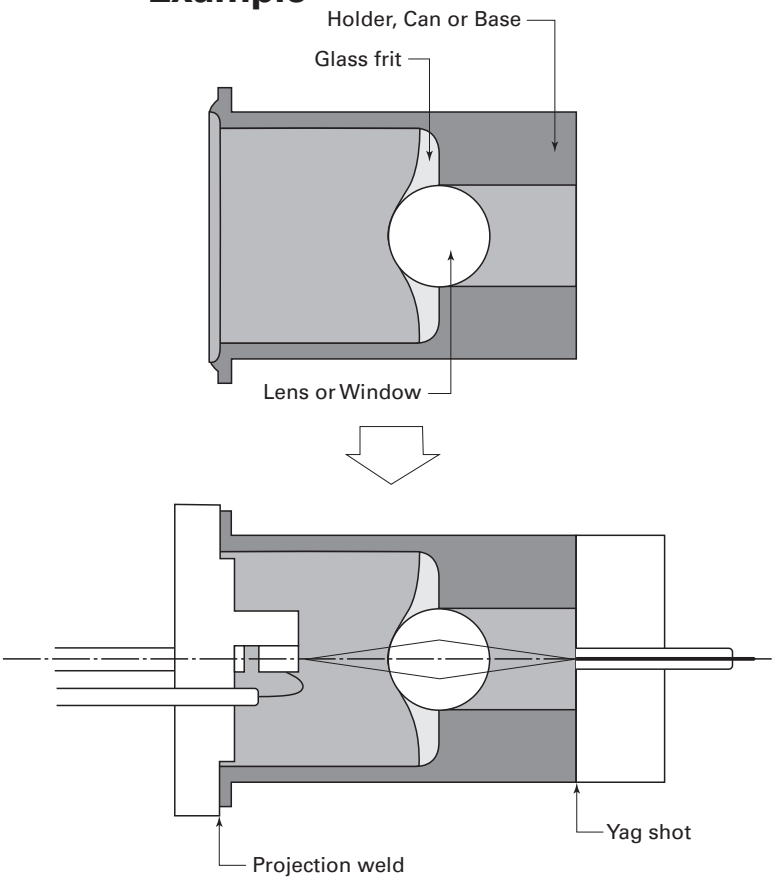
- Alignment allowance is excellent.
- No strain and excellent hermeticity
- Improves the production efficiency of mass-produced optical devices.
- Can be welded to metal stem as is.
- Can be welded to optical fiber unit as is.
- Can be soldered to optoelectronics package.

Properties

Glass Code	Refractive Index	
	1310nm	1550nm
BK-7	1.504	1.500
LaSF015	1.780	1.775
RH-21	1.968	1.962

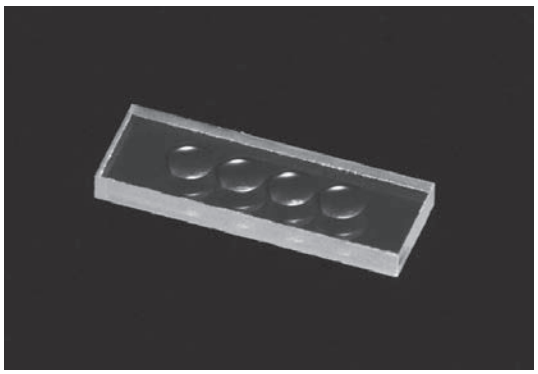
Other types of optical glass are available upon request.

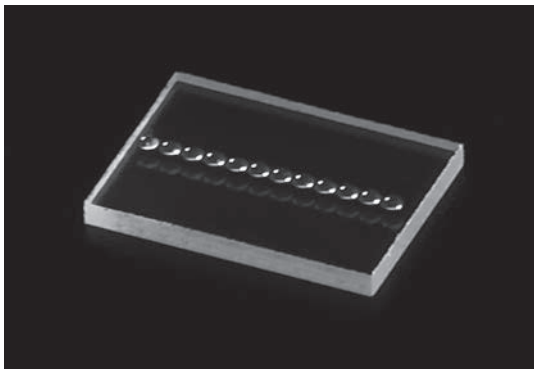
Example



Micro Lens Array

Micro Lens Array is made of original high refractive index optical glass using a precision molding process.
Micro Lens Array can be used with optical interconnection, a 40G/100G parallel optical module, and the like.





Features

- High accuracy through high precision molding process
- High coupling power achieved by high refractive index glass material and aspherical lens design
- High heat resistance, and corresponds to the reflow process
- Various coatings, such as AR coating and ND coating, are available

Glass Material

Glass code	**XC-1**
Refractive index (n_d)	1.81

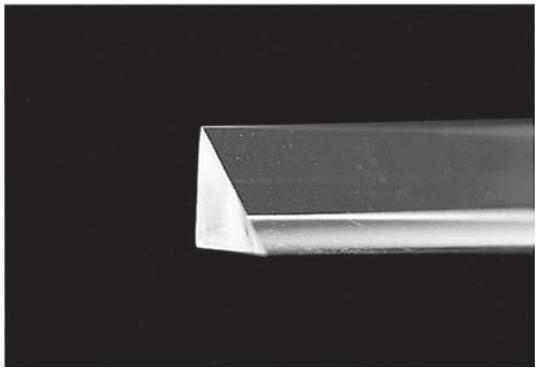
Dimensions (example)

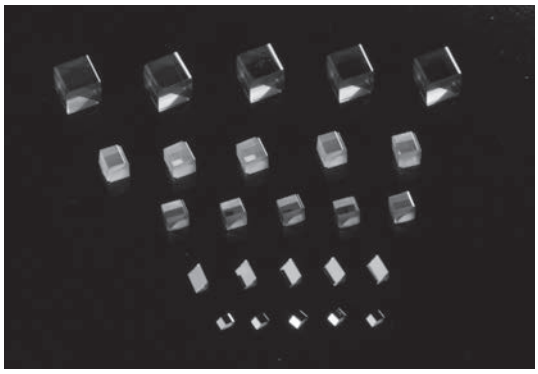
Standard shape	Plano-Convex
Curvature radius	R0.165mm –
Thickness of substrate	about 0.450mm
Lens height (SAG)	about 0.040mm
Pitch	0.25mm, 0.50mm, and others

Consult us regarding other specifications.

Micro Prism

Micro Prism is a precise small prism made of optical glass. It can be used as a prism for optical communication and optical equipment. Surface coatings, such as AR coating and BPF, are available.
A beam splitter with prisms glued together is also available.





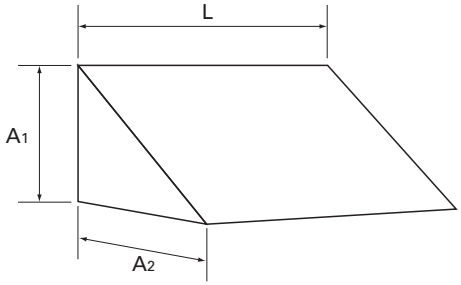
Features

- Excellent dimensional accuracy
- Excellent light transmittance
- Low cost
- Contributes to size reduction of modules

Dimensions (example)

(mm)

Isosceles side length (A)	0.3-2.0
Tolerance	≦ ± 0.03
Length (L)	1.0-70.0
Tolerance	≦ ± 0.05
Tolerance of angle	≦ 0.3°

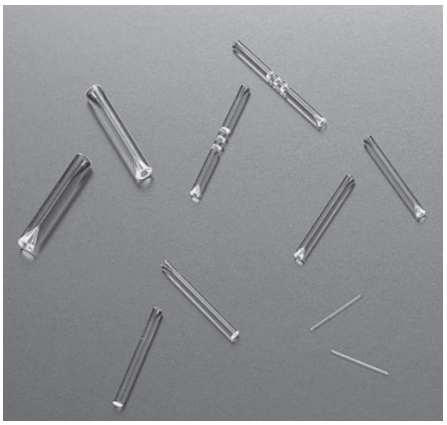


Glass Material

Glass code	**MK-07 (equivalent to BK-7)**
Refractive index (n_d)	1.51
Density ($\times 10^3 kg/m^3$)	2.44

Other dimensions are available upon request.

Micro Capillary



Micro Capillaries are borosilicate glass capillaries with an inner diameter accuracy of ± 0.5 microns. They are used for optical connectors, optical fiber splices and fiber supports in optical devices. Because Micro Capillaries have a polishing characteristic similar to silica optical glass fibers, the excellent polished face required for optical PC (physical contact) connection can be easily obtained by polishing.
As a result, Micro Capillaries are suited for high-speed analog devices including CATV systems which require high return-loss properties.
Micro Capillaries exhibit good elasticity that enhances the PC connection properties of the optical fiber. In addition, their high UV transmitting characteristic makes it possible to adhere capillaries and fibers, lenses or holders with UV-curable adhesive in a short time.
Nozzle End type which allows firm insertion of the whole optical fibers with jackets and Precision glass tube type which can be used as outer tube are also available.

Features

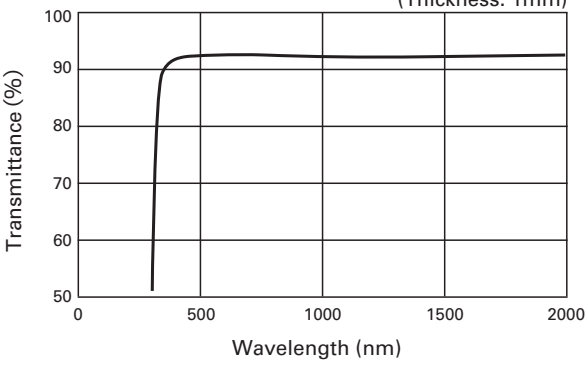
- Excellent polishing characteristics
- Smooth cone end
- High UV transmittance
- High chemical durability

Properties

Properties/Glass			Borosilicate glass
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	51
Density		$\times 10^{3}$kg/m^{3}	2.36
Refractive index (n_d)			1.49
Vickers hardness	Hv		680
Hydrolytic resistance	JIS R3502	R_2Omg	0.05
Dielectric constant	1MHz, 25°C		5.6
tan δ	1MHz, 25°C	$\times 10^{-4}$	85

Transmittance

(Thickness: 1mm)



Dimensional Specifications

(mm)

Nominal Dimensions (O.D.×I.D.×L)	Capillary Form	Outer Diameter		Inner Diameter		Concentricity	Length Tolerance
		Tolerance	Out of Roundness	Tolerance	Out of Roundness		
0.99 × 0.127 × 7.0	Single-cone end	± 0.005	0.001	$^{+0.001}_{-0}$	0.001	ϕ 0.001	± 0.2
1.80 × 0.126 × 15.0	Dual-cone ends	± 0.005	0.001	$^{+0.001}_{-0}$	0.001	ϕ 0.003	± 0.2
1.80 × 1.010 × 8.0	Precision glass tube	± 0.010	0.001	±0.005	0.001	ϕ 0.005	± 0.2
2.78 × 1.805 × 8.0	Precision glass tube	± 0.030	0.002	$^{+0.010}_{-0}$	0.002	ϕ 0.005	± 0.2

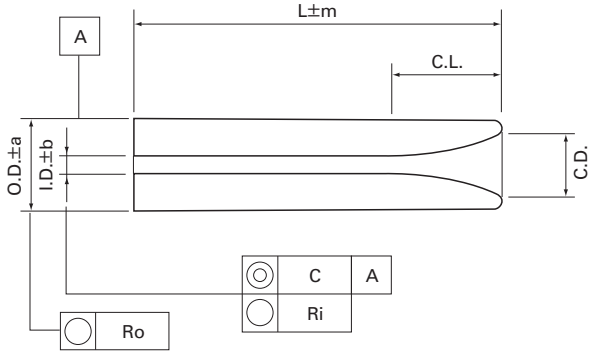
Part No.

1.8 — **0.127** — **10.5** — **SC** — **HC-Type** (**W = 0.2**)

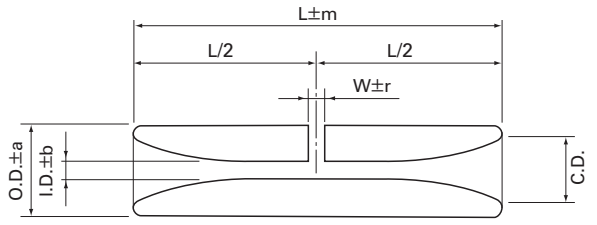
- 1.8: Outer Dia.
- 0.127: Inner Dia.
- 10.5: Length
- SC: End form
- HC-Type: Grade
- W = 0.2: Slit width

Dimensions

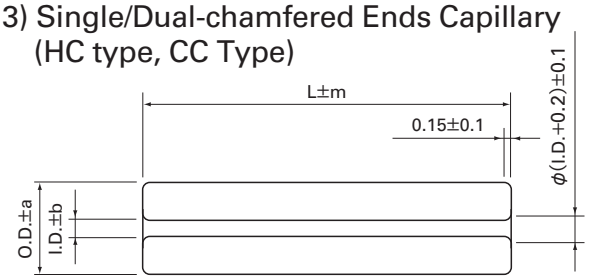
1) Single-cone End Capillary (HC Type, CC Type)



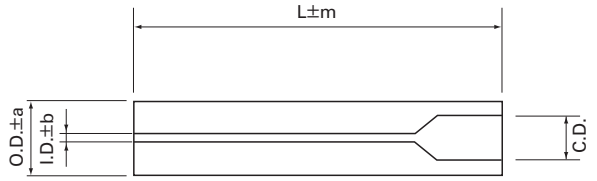
2) Dual-cone Ends Capillary (HC Type, CC Type)



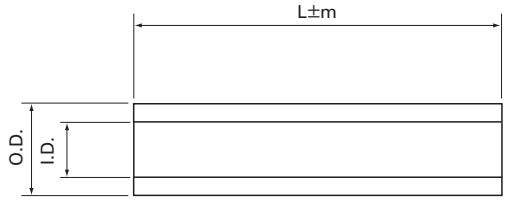
3) Single/Dual-chamfered Ends Capillary (HC type, CC Type)



4) Nozzle End Capillary



5) Precision Glass Tube



*Please refer to the dimensional specifications on the left side page regarding sizes.

Dimensional Specifications

(mm)

Subjects	Dimensions	Tolerance	HC Type	CC Type
Outer Diameter (O.D.)	0.99 2.00 1.25 2.50 1.80	a	± 0.005	± 0.01
O.D. roundness (Ro)	O.D. ≦ 2.5	—	0.001	0.002
Inner Diameter(I.D.)	0.086 0.128 0.126 0.130 0.127	b	+0.001 − 0	+0.003 − 0
I.D. roundness(Ri)	I.D. ≦ 0.2	—	0.001	0.003
Concentricity(C)	O.D. ≦1.0	—	φ 0.001	φ 0.003
	1.0≦O.D.≦2.5	—	φ 0.003	
Length (L)	50max.	m	± 0.2	
Slit width (W)	0.2	r	± 0.05	

Cone Dimensions — example

(mm)

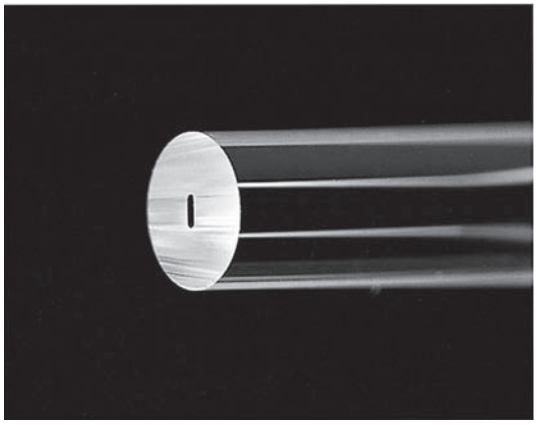
Form	Inner Diameter (I.D.)	Cone Diameter (C.D.)	Cone Length (C.L.)
Single-cone End	≦ 0.130	0.75 ± 0.2	1.5 ± 1.0
		1.1 ± 0.2	2.5 ± 1.0
	> 0.130	0.75 ± 0.2	3.0 ± 1.5
Dual-cone Ends	≦ 0.130	0.75 ± 0.2	1.5 ± 1.0
	> 0.130		3.0 ± 1.5
Nozzle End	—	1.0 ± 0.1	—

Other combinations of dimensions are available upon request.

Variously Shaped Micro Capillaries

Rectangular-hole Micro Capillary

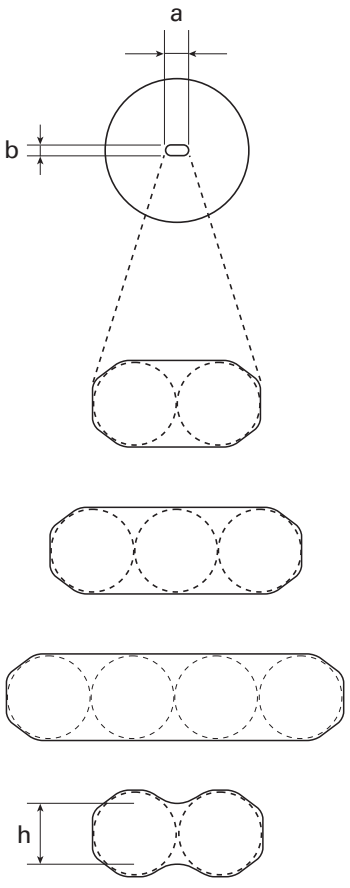
Using one Rectangular-hole Micro Capillary, several fibers can be aligned. Peanuts-style Dual-fiber Micro Capillary is suitable to align two PM-fibers beside each other.

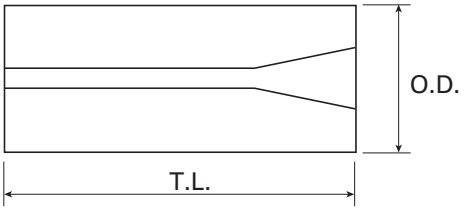


Features

- High chemical durability
- High environmental durability
- Excellent polishing characteristics
- High UV transmittance ⟶ It is possible to use UV curable adhesive.

Dimensions





example (mm)

Rectangular-hole for 2 fibers

a=0.253+/−0.003 b=0.128+/−0.003
O.D.=1.800+/−0.010, T.L.=7.0+/−0.2
C.D.=1.0+/−0.3, C.L.=3.0+/−1.0

Rectangular-hole for 3 fibers

a=0.378+/−0.003 b=0.128+/−0.003
O.D.=1.800+/−0.010, T.L.=7.0+/−0.2
C.D.=1.0+/−0.3, C.L.=3.0+/−1.0

Rectangular-hole for 4 fibers

a=0.504+/−0.004 b=0.128+0.005/−0.003
O.D.=1.800+/−0.02 T.L.=7.0+/−0.2
C.D.=1.25+/−0.2 C.L.=4.0+/−1.5

Peanuts-style-hole for 2 fibers

a=0.252+0.004/−0 h=0.105+/−0.01
O.D.=1.800+/−0.010, T.L.=7.0+/−0.2
C.D.=1.0+/−0.3, C.L.=3.0+/−1.0

Other combinations of dimensions are available upon request.

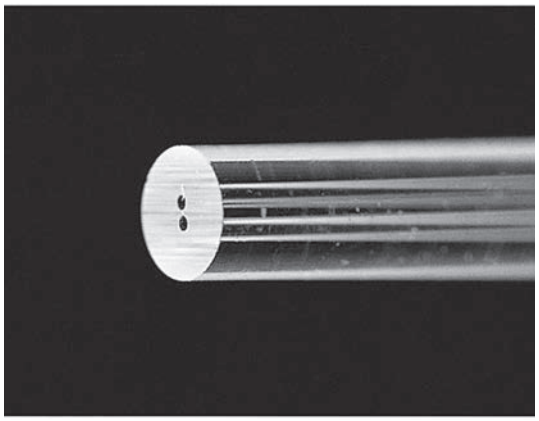
Part No.

1.800 − **0.252** * **0.127** − **7.0**

1.800: Outer Dia. 0.252: Longer Side 0.127: Shorter Side 7.0: Length

Dual-hole Micro Capillary

Dual-hole Micro Capillary can align two fibers very precisely. It is possible to establish the distance between two fibers flexibly. Dual-hole Micro Capillary offers a simple solution for the alignment of two fibers.

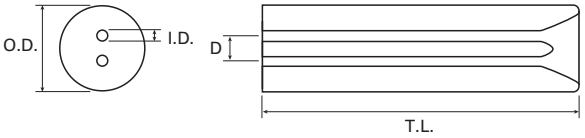


Dimensions (example)

(mm)

Subjects	Dimensions	Tolerance
Outer Diameter (O.D.)	1.800	± 0.005
Inner Diameter (I.D.)	0.127	+0.002/−0.001
Distance (D)	0.132-0.250	± 0.002
Total Length (T.L.)	7.0	± 0.2

Other combinations of dimensions are available upon request.



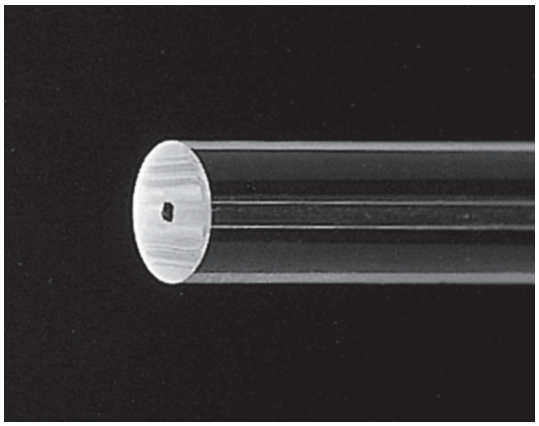
Part No.

1.800 — 0.127 — D0.147 — 7.0 — HC Type

Outer Dia. · Inner Dia. · Distance · Length · Grade

Square-hole Micro Capillary

Square-hole Micro Capillary features square holes that can be used to align four or more fibers precisely, making it possible to achieve low cost high-density optical devices.

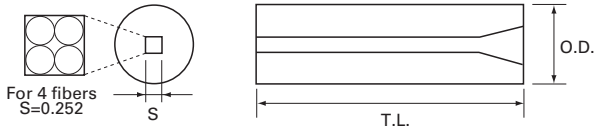


Dimensions

(mm)

Subjects	Dimensions	Tolerance
Outer Diameter (O.D.)	1.800	± 0.005
A side of inner square-hole (S)	0.252 for 4 fibers	+0.004/−0
Total Length (T.L.)	7.0	± 0.2

Other combinations of dimensions are available upon request.



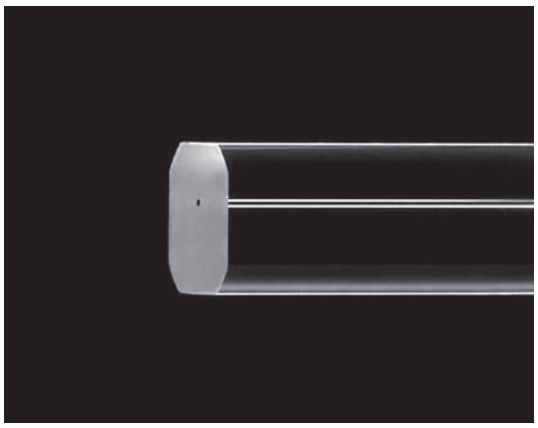
Part No.

1.800 — S0.252 — 10.5 — HC Type

Outer Dia. · A side of the inner square-hole · Length · Grade

Polygonal Capillary

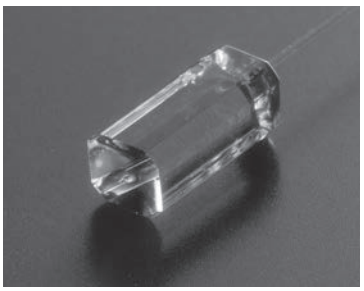
Polygonal Capillary enables reduction of single fiber assembly costs while maintaining high reliability. Conventional assembly requires the use of two parts (a V-groove substrate and a lid), but with the Polygonal Capillary, no further components are necessary.



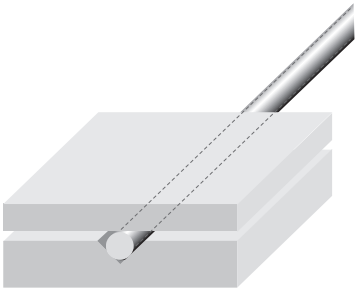
Features

- Low cost
- Easy assembly
- High reliability

Assembly (example)



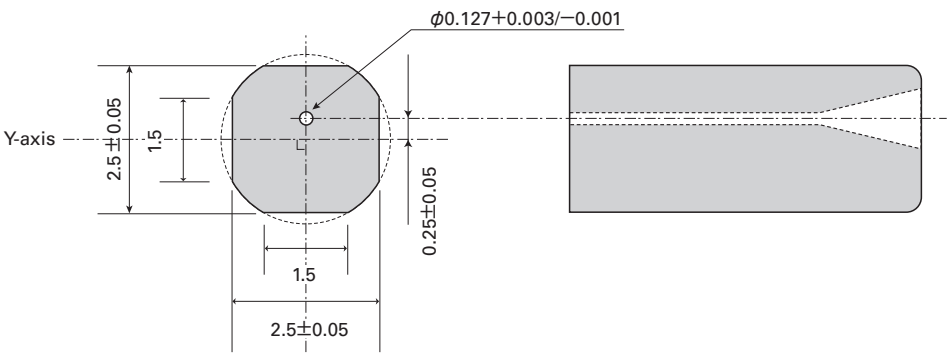
Polygonal Capillary



Conventional structure

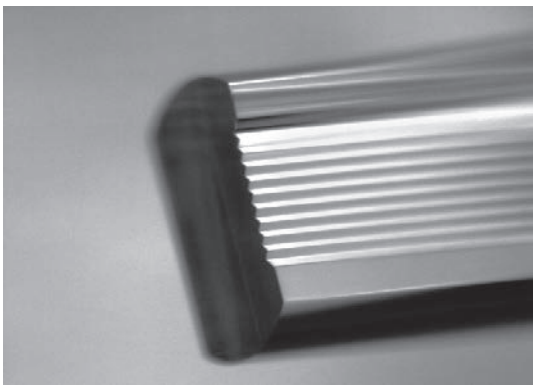
Dimensions

(mm)



V-Groove Substrate

With the high demand for broadband and high speeds in optical fiber networks, optical devices of the optical fiber array type are in the spotlight.
The V-groove substrate is used for arranging and aligning multiple optical fibers.
We provide a highly-precise glass V-groove substrate at a low price with the drawing process.

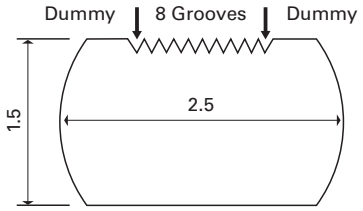


Features

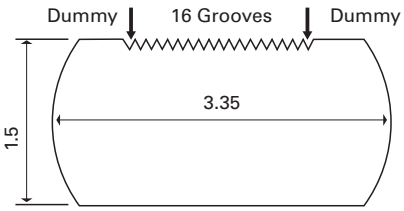
- Low price due to drawing process
- Sub-micron precision
- Smooth groove surface due to heating process

Cross section of V-groove Substrate

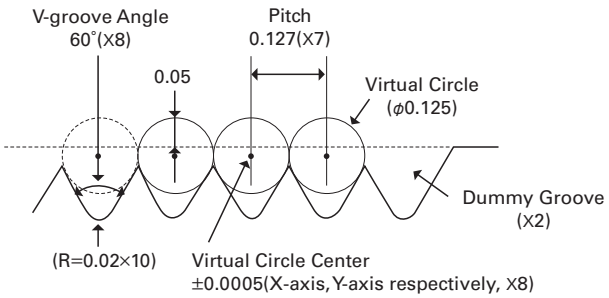
[**8 Grooves**]



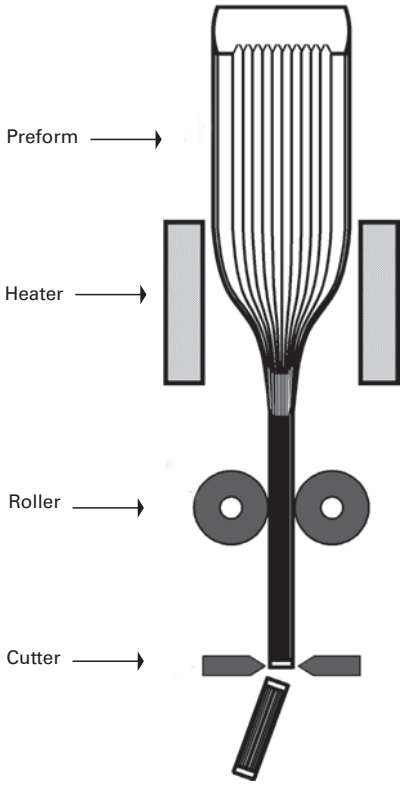
[**16 Grooves**] (mm)



V-groove Details



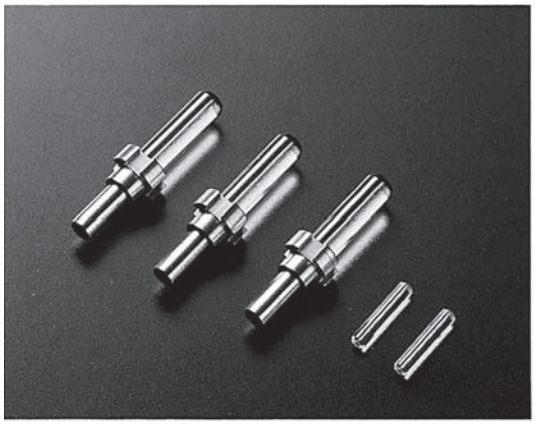
Drawing Method



Each fiber (virtual circle) center is positioned with ± 0.5μm (X-axis, Y-axis, respectively) absolute error.

Glass Ferrule BTF

**Glass Ferrule is made of borosilicate glass.
It has a high dimensional precision and is suitable for single-mode fibers.
Glass Ferrule needs less polishing than ceramics. It also has polishing properties similar to silica optical fiber, making it highly suitable for PC and AdPC configurations.
Its high UV transmittance characteristics facilitate quick fiber fixation using UV-curable adhesive.**

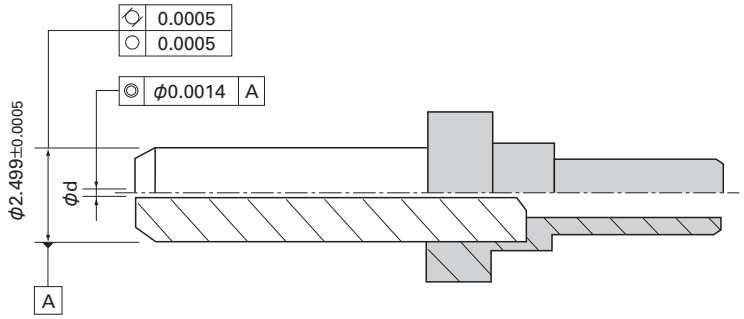


Features

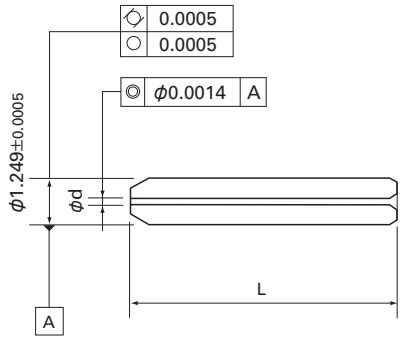
- High dimensional precision (as Zirconia ferrule)
- Excellent polishing properties
- High UV-light transmittance
- Smooth cone end
- High chemical durability
- Low cost

Dimensions

〈ϕ2.5BTF〉



〈ϕ1.25BTF〉



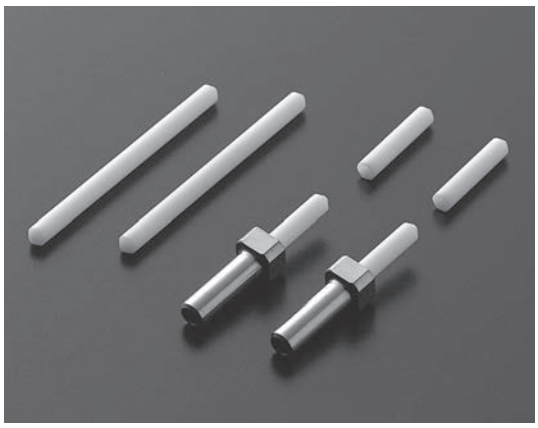
Outer/Inner Diameter

(mm)

Item	Outer dia.	Code	Inner Dia. ϕd	Tolerance of I.D.
Glass Ferrule **BTF**	ϕ2.499	BW1250S1E4S	0.125	+0.001/-0
		BW1255S1E4S	0.1255	
		BW1260S1E4S	0.126	
		BW1270S1E4S	0.127	
	ϕ1.249	BV1250SBC00	0.125	+0.001/-0
		BV1255SBC00	0.1255	
		BV1260SBC00	0.126	
		BV1270SBC00	0.127	

Glass-Ceramic Ferrule GCF/GCF-200S

Glass-Ceramic Ferrule GCF is suitable for single-mode optical connectors.
Durability matches or exceeds that of ceramic ferrules especially under high-temperature and high-humidity conditions.
GCF can be polished quickly without using diamond polishing film. The cost saving is substantial.
Glass-Ceramic Ferrule GCF-200S features an enhanced eccentricity of 0.2μm. This enables improved connection performance without the sacrifice of the excellent polishing properties and environmental durability of the GCF.

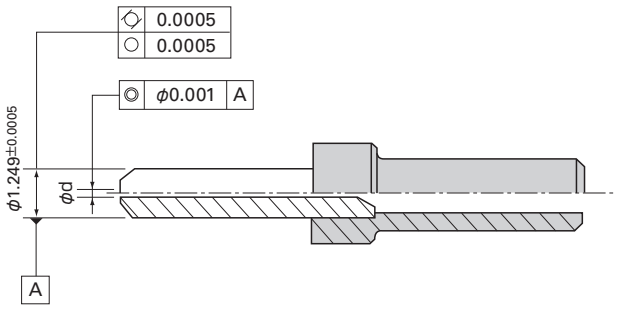


Features

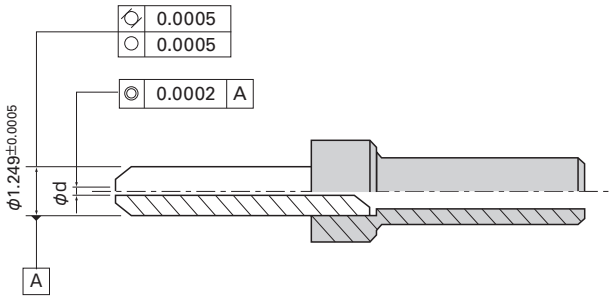
- Excellent environmental durability
- Excellent polishing properties

Dimensions

〈GCF〉 **[NTT Standard]**



〈GCF-200S〉

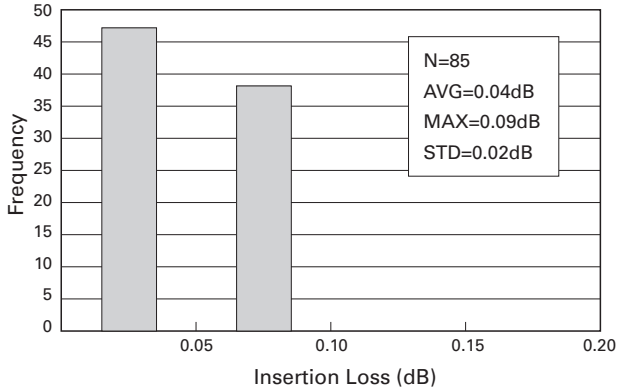


Outer/Inner Diameter

(mm)

Item	Outer dia.	Code	Inner dia. φ d	Tolerance of I.D.
Glass-Ceramic Ferrule **GCF**	φ 2.499	GW1250S194S	0.125	+0.001/−0
		GW1255S194S	0.1255	
		GW1260S194S	0.126	
		GW1270S194S	0.127	
	φ 1.249	GV1250SB9MS	0.125	
		GV1255SB9MS	0.1255	
		GV1260SB9MS	0.126	
Glass-Ceramic Ferrule **GCF-200S**	φ 1.249	GV1250HB9MS	0.125	
		GV1255HB9MS	0.1255	
		GV1260HB9MS	0.126	
		GV1270HB9MS	0.127	

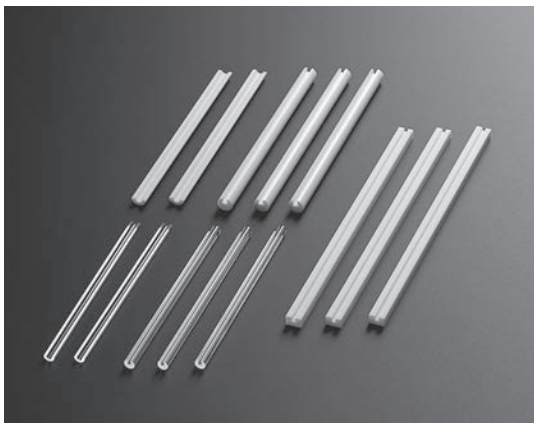
The connection properties of GCF-200S in random connections



*These figures show that GCF-200S is applicable to a general market requirement of less than 0.3dB even though it is no-tuning.

Neoceram N-0 and N-11

Neoceram is a glass-ceramic with almost zero thermal expansion. There are two types of Neoceram: transparent N-0 and opaque N-11. High-precision Neoceram products are used for optical fiber coupler housings and cover glass.



Features

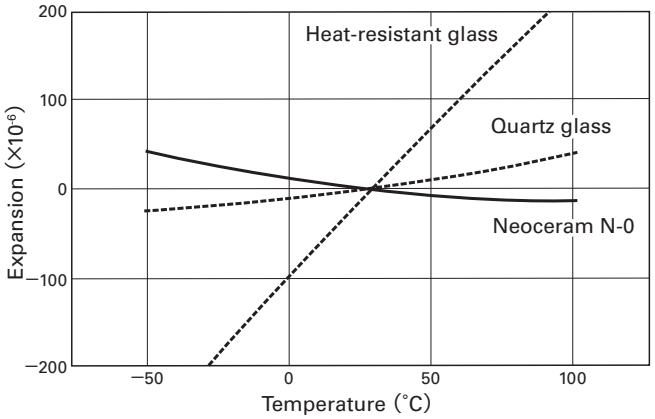
- Good α matching with quartz-type fiber
- High dimensional precision
- High hardness and durability
  (Resistance to water, weather and vibration)
- Available in both transparent N-0 and opaque N-11

Properties

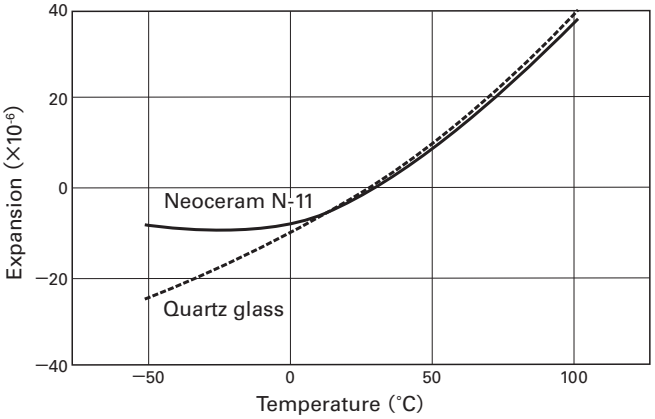
Properties/Glass Code			N-0	N-11
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	− 1	10
	30-750°C	$\times 10^{-7}$/K	1	13
Heat resistant temperature* (Short term)		°C	800	900
Refractive index (n_d)			1.54	−
Density		$\times 10^3$kg/m^3	2.5	2.5
Bending strength	JIS R1601	MPa	170	220
Vickers hardness	Hv (0.2)		700	800
Young's modulus		GPa	94	86
Acid resistance	5% HCl, 90%, 24hrs	mg/cm^2	0.05	0.1
Alkali resistance	5% Na_2CO_3, 90°C, 24hrs	mg/cm^2	0.3	0.8

*Heat resistant temperature is based on mechanical deformation. Specifically, it is the temperature at which a 100×300×3.8mm plate specimen (supported to form a 280mm span) deforms by 1mm after 24-hour heating.

Thermal Expansion



Thermal Expansion



Dimensions (examples)

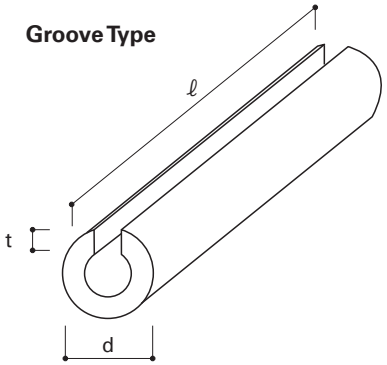
Tube

Groove Type, Half-tube Type (mm)

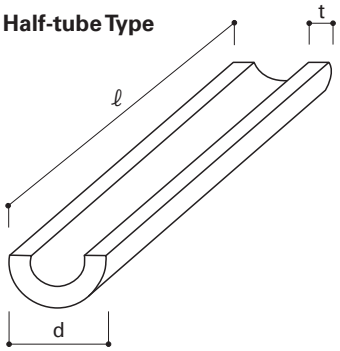
Outer Diameter (d)	Wall thickness (t)	Length (ℓ)
2.00±0.15	0.50±0.10	10 to 70
3.00±0.15	0.75±0.10	10 to 70
3.00±0.15	1.00±0.10	10 to 70
3.50±0.15	1.00±0.15	10 to 70
4.00±0.15	1.00±0.15	10 to 70

Other groove dimensions are available upon request.
Minimum groove width: 0.20±0.10mm.

Groove Type



Half-tube Type



Rod

Groove Type (mm)

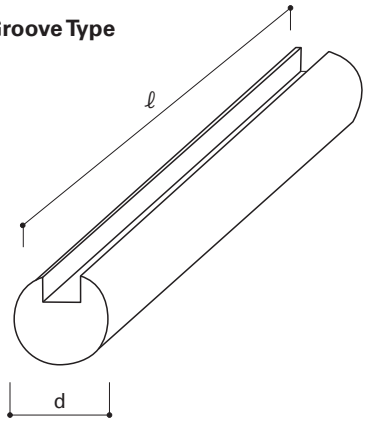
Diameter (d)	Length (ℓ)
2.00±0.15	10 to 70
3.00±0.20	10 to 70
3.50±0.30	10 to 70
4.00±0.30	10 to 70

Half-rod Type

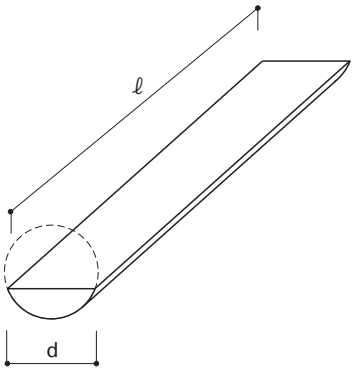
Diameter (d)	Length (ℓ)
2.00±0.15	40
3.50±0.30	40
4.00±0.30	40

Other groove dimensions are available upon request.
Minimum groove width: 0.20±0.10mm.

Groove Type



Half-rod Type



Plate

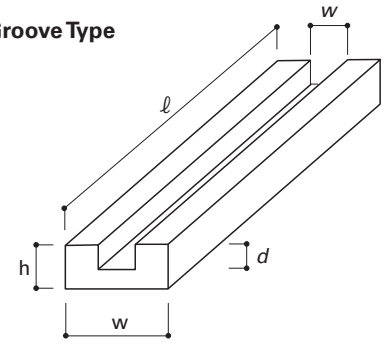
Groove Type (mm)

Width (w)	Height (h)	Length (ℓ)
3.00±0.10	2.00±0.10	60.00±0.50

Groove Dimensions	
(*w*)	(*d*)
0.80±0.10	0.80±0.10

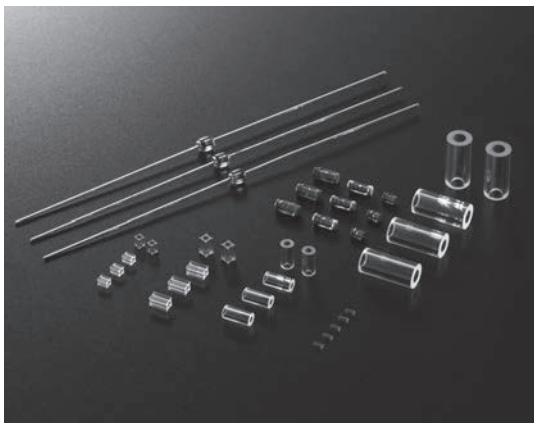
Other groove dimensions and the number of grooves are available upon request.
Minimum groove width: 0.20±0.10mm

Groove Type



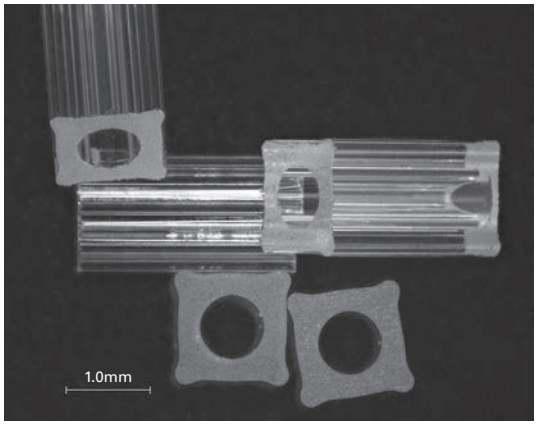
Glass Sleeves for Low Temperature Sealing

LG-16 has long been used in encapsulation of thermistors. NLT-600 is Pb-free glass and environment friendly. The acid resistance level of NLT-600 is equivalent to that of Pb glass and LG-16. We can supply not only round type glass tubes but also square type glass tubes. Square glass tubes can be mounted securely without shifting or falling.



Features

- Low sealing temperatures
- Good acid resistance in plating process
- Excellent electrical characteristics

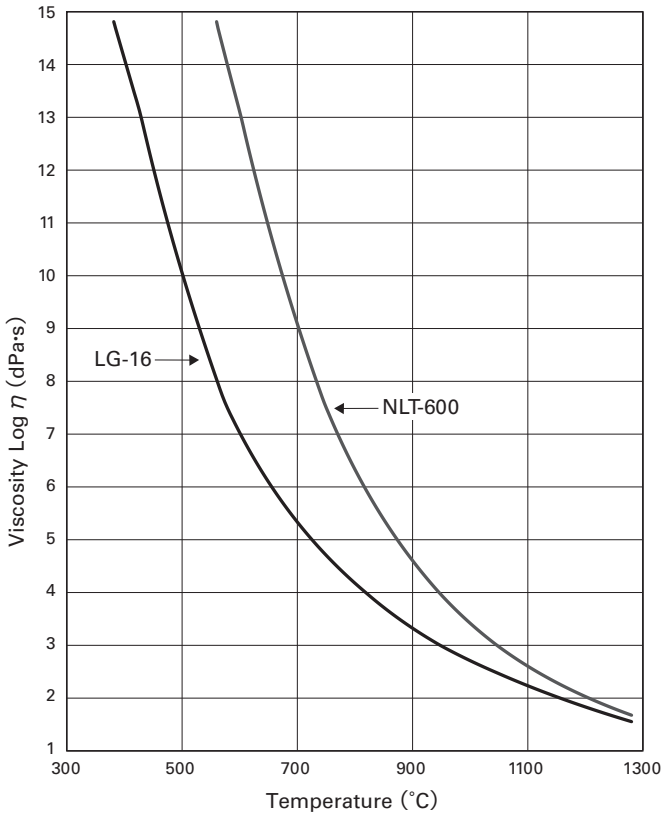


Square glass tube

Properties

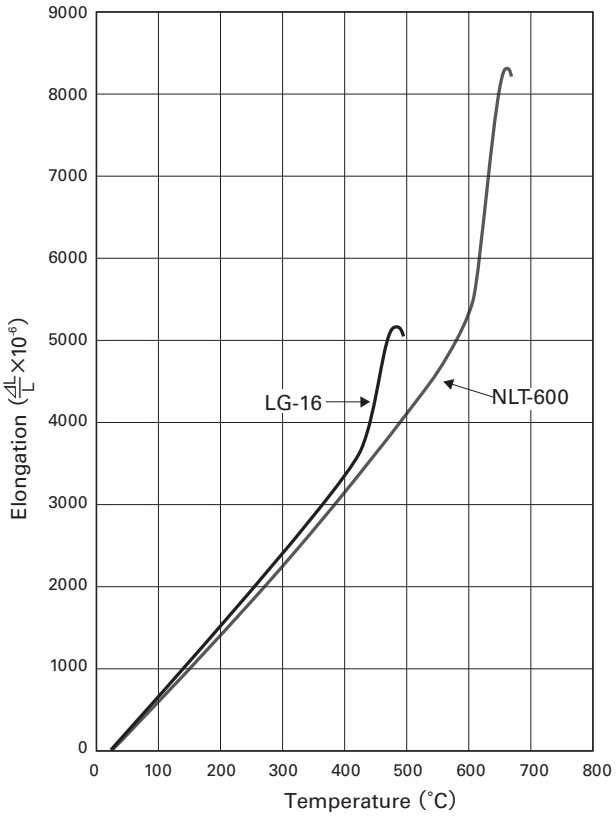
Properties/Glass Code			LG-16	NLT-600 (Pb-free)
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	91	85
Density		$\times 10^{3}$kg/m^{3}	4.31	3.09
Strain point		°C	390	567
Annealing point		°C	430	603
Softening point		°C	575	747
Sealing temperature		°C	655	817
Working point		°C	820	947
Volume resistivity Log ρ	150°C	Ω·cm	14.8	18.0
	250°C	Ω·cm	11.7	14.0
Dielectric constant	1MHz, 25°C		9.5	7.5
tan δ	1MHz, 25°C	$\times 10^{-4}$	8	7
Refractive index (n_d)			1.69	1.57
Color			Clear	Clear
Glass type			$PbO \cdot K_2O \cdot SiO_2$	$BaO \cdot K_2O \cdot B_2O_3 \cdot SiO_2$

Viscosity



The figures on the chart are standard values, therefore the properties are not guaranteed.

Thermal Expansion



The figures on the chart are standard values, therefore the properties are not guaranteed.

Standard Dimensions

(mm)

Glass Code	Outer Diameter	Inner Diameter	Length
LG-16	0.55±0.05	0.45±0.05	1.50±0.05
	0.85±0.05	0.70±0.05	1.50±0.05
	1.35±0.05	1.05±0.05	3.00±0.05
	1.78±0.05	0.86±0.05	3.81±0.05
	2.10±0.05	1.30±0.05	5.00±0.05
NLT-600	1.35±0.05	1.05±0.05	3.00±0.05
	2.15±0.05	1.35±0.05	4.00±0.05

High Infrared-Absorbing Glass Tubes (for Reed Switches)

We supply high infrared-absorbing glass tubes for use of reed switches.

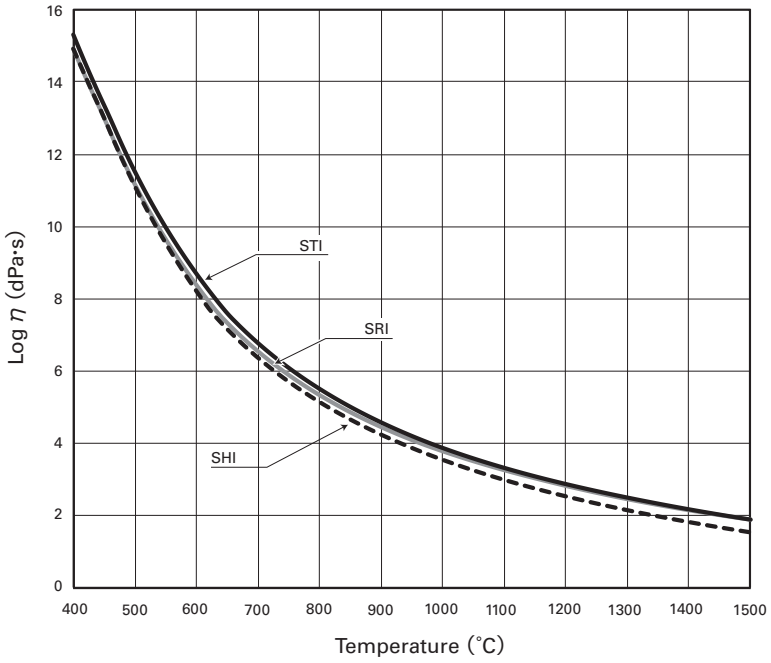
Features

- High rate of infrared absorbance
  (It is possible to heat local areas for sealing by halogen lamp or laser-irradiation.)
- STI and SRI have excellent sealing characteristics with 52 Ni-Fe alloy, and SHI is excellent with Co-Fe alloy.
- We can supply "ultra-short glass tubes" as short as 3.0mm in length.
- We can supply "one-side sealed glass," which can be adjusted to fulfill the required need for airtightness.
- Pb-free

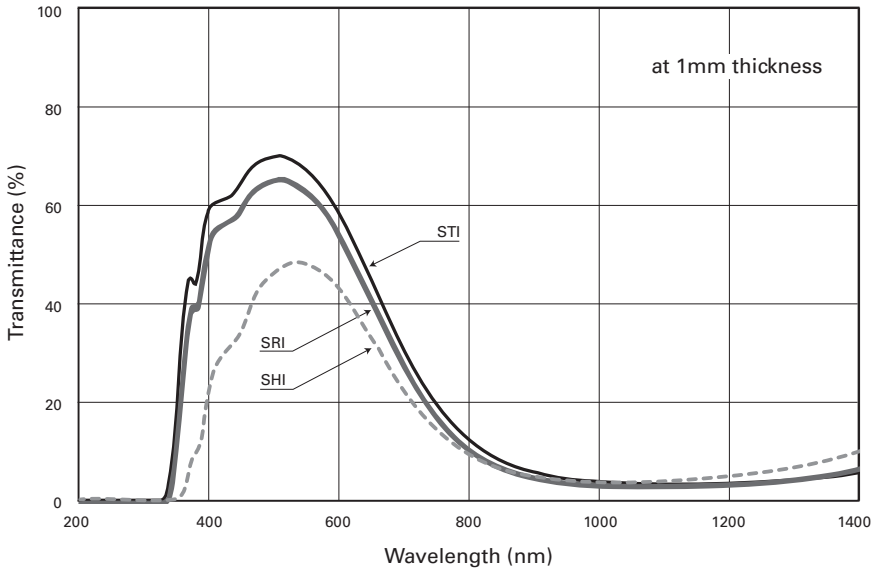
Properties

Properties/Glass Code			STI	SRI	SHI
Coefficient of thermal expansion	30-380°C	$\times 10^{-7}$/K	94	92.5	119.5
Density		$\times 10^{3}$kg/m^{3}	2.53	2.53	2.67
Strain point		°C	420	410	410
Annealing point		°C	460	450	450
Softening point		°C	650	635	625
Working point		°C	980	965	930
Hydrolytic resistance	JIS R3502	R_2O mg	0.6	0.4	0.5
Volume resistivity Log ρ	150°C	Ω·cm	12.2	10.3	10.6
	250°C	Ω·cm	9.3	7.8	8.0
Color			Green	Green	Green
Transmittance	λ =1050nm, t=1mm	%	≦5	≦5	≦5
Glass type			$K_2O \cdot BaO \cdot SiO_2$	$Na_2O \cdot BaO \cdot SiO_2$	$Na_2O \cdot K_2O \cdot ZnO \cdot SiO_2$
Sealing metal			52 Ni-Fe Alloy		CO-Fe Alloy

Viscosity



Transmittance



Standard Dimensions

(mm)

Glass Code	Outer Diameter	Wall Thickness	Length
STI	1.70 ± 0.05	0.25 ± 0.05	3.0-50.0
	2.05 ± 0.05	0.23 ± 0.05	
	2.50 ± 0.05	0.40 ± 0.05	10.0-50.0
	4.95 ± 0.10	0.64 ± 0.10	
	6.00 ± 0.20	0.60 ± 0.10	
SRI	2.40 ± 0.05	0.32 ± 0.05	
	3.07 ± 0.05	0.47 ± 0.05	
SHI	2.50 ± 0.05	0.35 ± 0.05	17.0-22.0

Other dimensions are available upon request.

UV-C High-transmitting Glass Tube〈BU-41〉

UV-C high-transmitting borosilicate glass tubes are used for UV lamps and UV sensors.

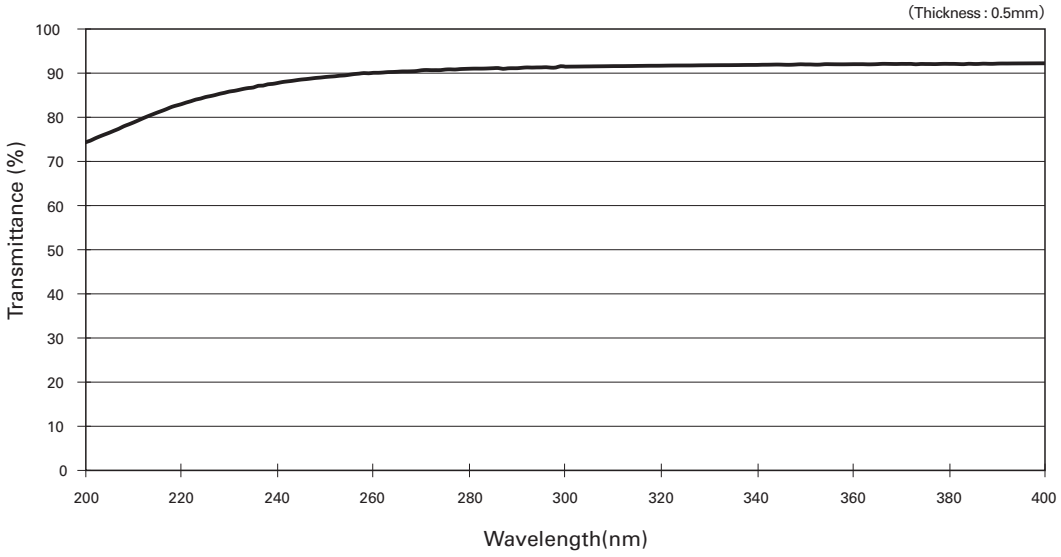
Features

- UV-C high-transmittance
- Excellent sealing characteristics with Kovar metal.
- Various shapes such as sheets and prisms as well as tubes are available.

Properties

Properties/Glass Code		**BU-41**
Coefficient of thermal expansion	$\times 10^{-7}$/K	42
Density	$\times 10^{3}$kg/m^{3}	2.22
Strain point	˚C	425
Softening point	˚C	697
Working point	˚C	1076

Transmittance



Antibacterial Glass Powder

ZF-0 and DL-7900 are new types of antibacterial glass powders that are mainly composed of zinc. Compared to conventional antibacterial glass, which is mainly composed of silver, DL-7900 is especially advantageous in providing anti-bacterial performance, and the compounded quantity in resin can be reduced without compromising performance.

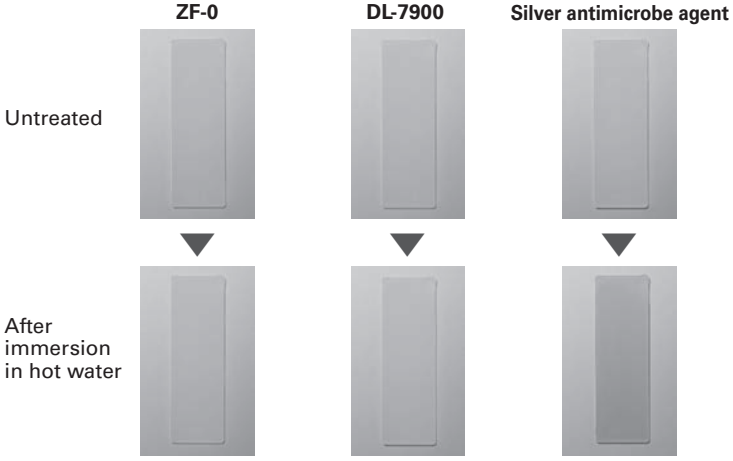
Properties

Properties/Glass Code	ZF-0	DL-7900
Glass type	$ZnO\text{-}B_2O_3$	$ZnO\text{-}B_2O_3\text{-}Ag_2O$
Resin discoloration resistance	◎	◎
Durability of antibacterial property	◎	◎
Initial antibacterial property	△	◎

◎ : Excellent, ○ : Strong, △ : Good

Color change test with warm water immersion (60°C-48h)

The material was added to PP resin (0.5%).

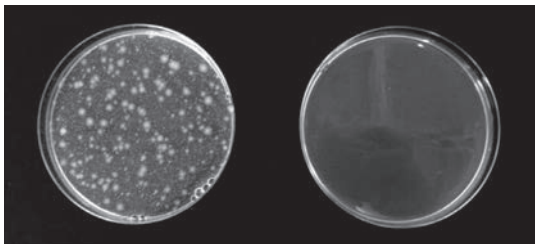


Antibacterial Activity Values

(JIS Z 2801: 2010)

Glass Code	ZF-0	DL-7900
Adding ratio into PP resin (wt%)	0.5	0.3
E. coli	3.4	4.2
S. aureus	4.1	2.9

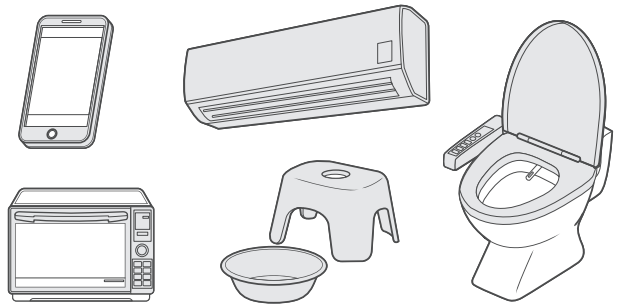
*The above data was derived from a measuring example.



PP (No Additives)　　PP (Containing ZF-0)

Applications

- Consumer electronics (refrigerators, air conditioners, vacuum cleaners, and other items)
- Daily use items (kitchenware, bathroom goods, and other items)



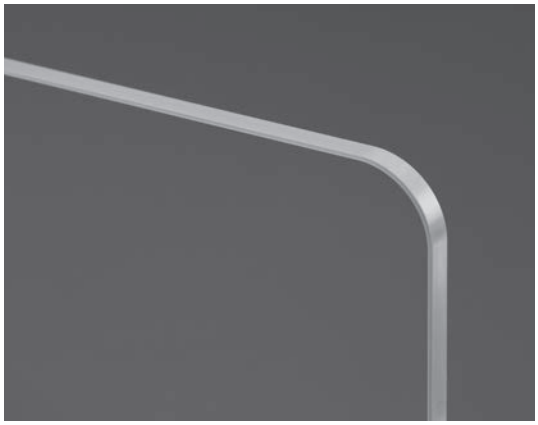
Ultra-thin Glass Laminated on Resin

Ref. No. 2210-48E

Lamion™

Lamion™ is a composite material of resin with ultra-thin glass G-Leaf™* or thin glass laminated on both or only one side with adhesive layer. Lamion™ has features specific to glass such as abrasion resistance and gas barrier properties. It is an effective material for making devices more lightweight.

*G-Leaf™ is our ultra-thin glass with a thickness of 0.2mm (200μm) or less. See p. 4 and 5.



Features

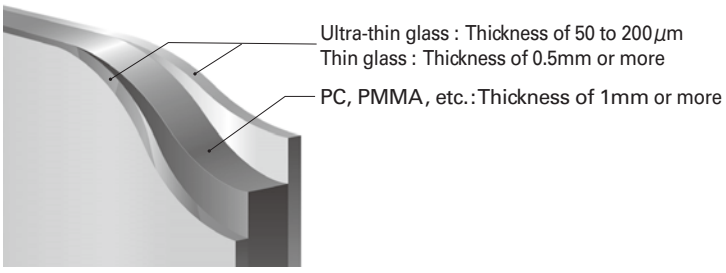
- Lightweight
- Shock resistance and shatter resistance
- Abrasion resistance (pencil hardness: harder than 9H)
- High gas barrier properties (water vapor permeation rate: below the lower measurable limit (1×10^{-6}g/(m^2・day))

Combination Examples

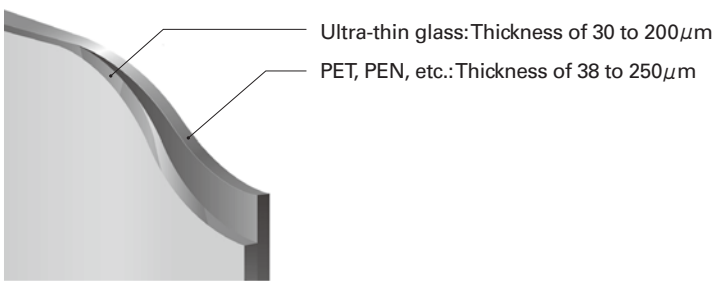
Various types of resin, including polycarbonate (PC), acrylic (PMMA), PET, and PEN, can be adopted. The thickness of the glass and the resin and lamination structure can be changed to impart necessary features.
It is also possible to add various properties (such as heat shielding) and decoration effects (such as wood patterns and Japanese paper), by laminating functional film between the resin and glass.

Lamion™ with various function coatings such as ITO, anti-reflection, anti-glare, and anti-fingerprint are also available.

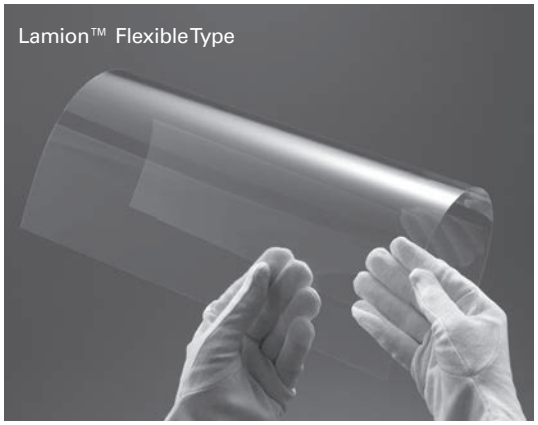
Lamion™ (G-Leaf™ or thin glass laminated on both sides)
Transparent laminate that is both lightweight and shock resistant



Lamion™ Flexible Type (G-Leaf™ laminated on one side)
Flexible transparent laminate with high dimensional stability



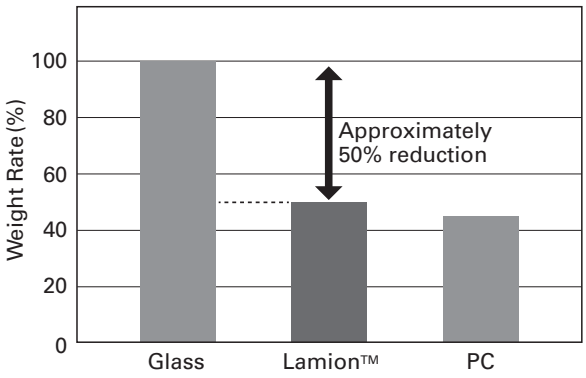
Laminated on both sides (example)
(glass 0.5mm + Polycarbonate 4mm + glass 0.5mm)



Laminated on one side (example)
(PET38μm + glass50μm)

Lightweight

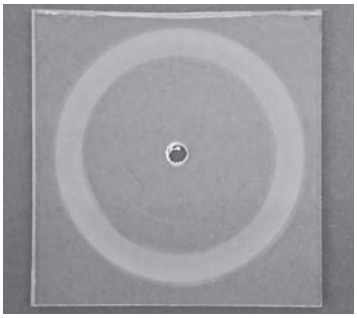
Comparison of materials by weight
(total thickness: 5mm)



Abrasion Resistance

Results of wear and abrasion resistance test
using the Taber Abraser

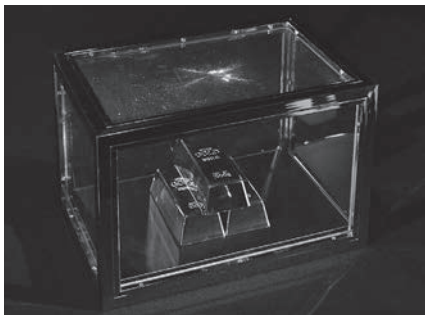
Lamion™ (1,000 cycles)
Haze: 2.5%



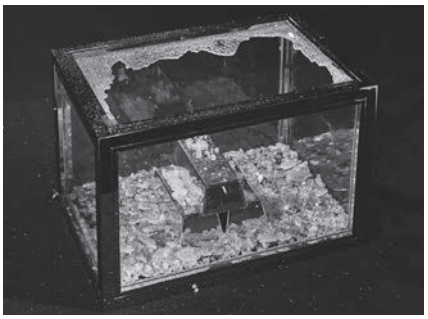
Polycarbonate (500 cycles)
Haze: 48%

Shock Resistance

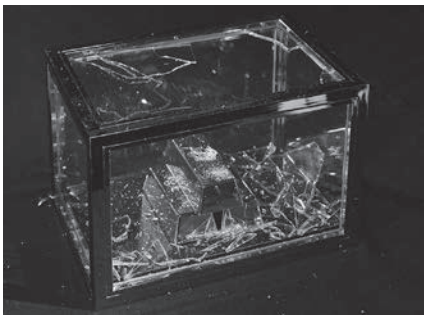
Lamion™ is highly resistant to shock and will not shatter like tempered glass even when smashed with a hammer.
Lamion™ has passed rank E of the flying object impact test stipulated in JIS R 3109 and 1.2m height in the shot bag impact test stipulated in JIS R 3205.



Lamion™



Tempered glass



Common glass (Soda-lime glass)

Comparison of Properties

	Lightweight	Bending rigidity	Abrasion resistance	Shock resistance, anti-penetrability	Shatter resistance	Incombusti-bility	Weather resistance	Sound insulating	Electrostatic properties	Gas barrier properties	Dimensional stability	Texture
Lamion™	○	○	◎	◎	◎	○	◎	◎	○	◎	○	◎
Polycarbonate	○	×	×	◎	◎	×	×	○	×	×	×	×
Soda-lime glass	×	○	○	×	×	◎	○	×	○	◎	◎	◎

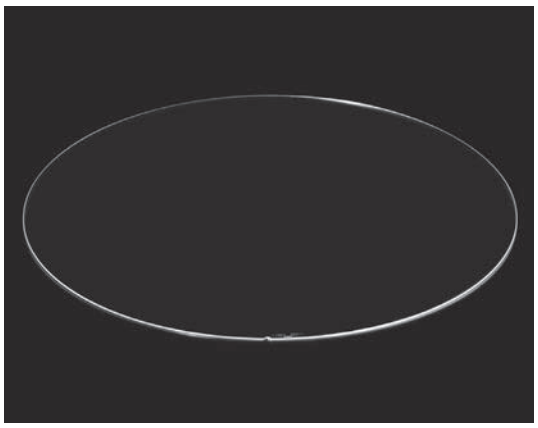
◎: Excellent, ○: Good, × : Not good

Applications

- Display cover for digital signage
- Platform screen doors
- Showcase for crime prevention
- Disaster prevention window
- Window for automobiles and railways
- Flexible mold for nanoimprint lithography
- Transparent antenna

Glass Wafer for Supporting Semiconductors

Various CTE*1 glass wafers are available as substrates for supporting semiconductors.



Features

- Various CTE glass are available.
- TTV*2 < 1μm (φ12 inches)
- T7 code is available

*1 Coefficient of thermal expansion
*2 Total thickness variation

Properties

Properties / Glass Code			ABC-G	A58	A66S	A69	A75	A91S
CTE	20-220°C	ppm/°C	3.6	5.6	6.3	6.6	7.2	8.7
	20-260°C	ppm/°C	3.7	5.7	6.4	6.7	7.3	8.8
Young's modulus		GPa	73	70	77	74	75	70
Dielectric constant	1MHz, 25°C		5.3	6.2	6.5	6.8	6.9	7.7
tan δ	1MHz, 25°C		0.001	0.02	0.01	0.01	0.01	<0.03
Volume resistivity Log ρ	150°C	Ω・cm	–	8.1	8.1	8.3	8	7.1
	250°C	Ω・cm	–	–	6.8	–	6.2	–

Other CTE glass are available upon request.

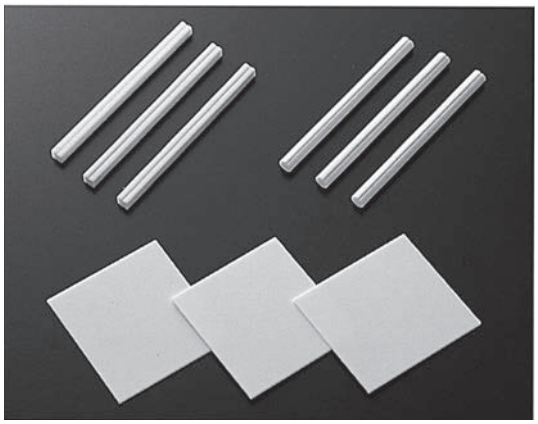
Applications

- Substrates for supporting Fan-Out packages
- Substrates for supporting compound semiconductors
- Substrates for supporting for grinding process

Negative Thermal Expansion Ceramic Substrate Ref. No. 2210-50E

CERSAT

CERSAT is ceramic substrate material that has a negative thermal expansion coefficient.
It can be used as packaging material for parts that require temperature compensation.



Properties

Properties/Glass Code		N-80	N-70
Coefficient of thermal expansion	$\times 10^{-7}$/K	−82	−70
Young's Modulus	GPa	19.5	17.0
Color		White	White

The figures of the properties are standard values and are not guaranteed.

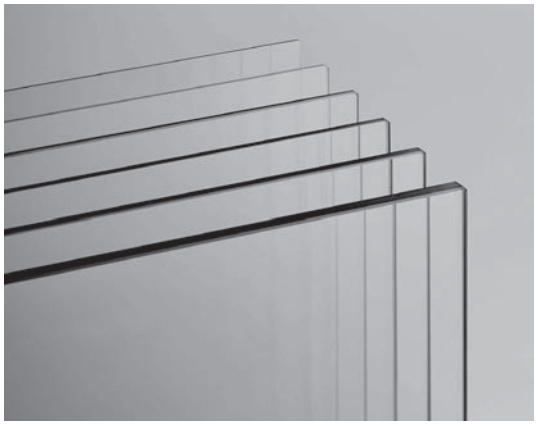
Shape

- CERSAT can be supplied in the shape of rods or plates. Please feel free to consult with us.

Neoceram N-0 and N-11

Neoceram N-0 is a transparent glass-ceramic material with a CTE* of virtually zero, and it has excellent thermal shock resistance at temperatures below 750°C. Neoceram N-11 is a white opaque glass-ceramic material with a low CTE of 12×10^{-7}/°C, and it can be used in continuous thermal cycles at temperatures below 850°C. Both of these materials are thin, lightweight, and have low thermal capacity. They are used as carriers and/or muffle plates for thermal treatment processes for LTPS, OLED, photovoltaic cells, and the like, as well as heated beds/tables for 3D printers.

*CTE: coefficient of thermal expansion



Neoceram N-0

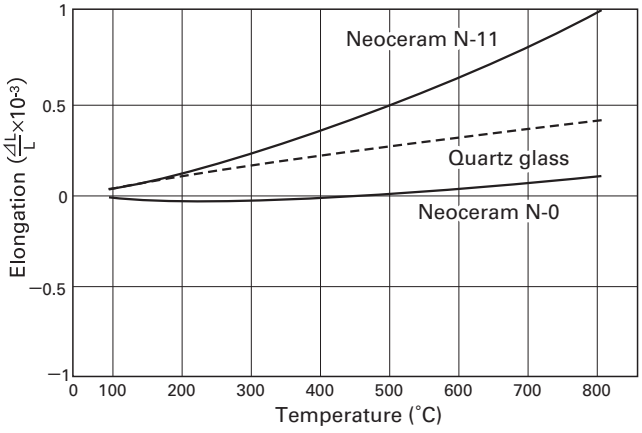
Features

- Excellent thermal shock resistance
- Zero water absorption rate
- Surface can be finished to a high level of precision.
- Wide range of sizes and thicknesses
  (Thickness: 0.7 to 8mm. Please contact us about the size.)

Properties

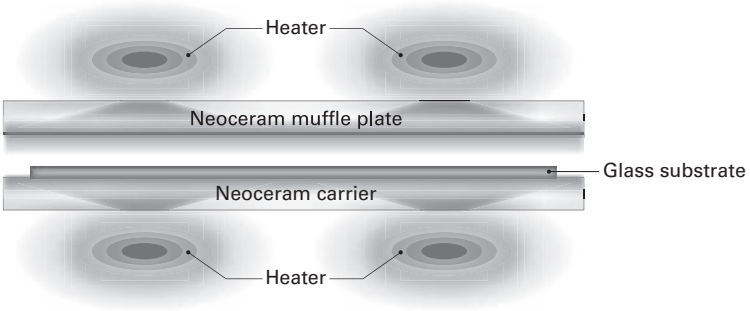
Properties/Glass Code			N-0	N-11
Appearance			Transparent	White
Coefficient of thermal expansion	30-750°C	×10^{-7}/K	1	12
Specific heat		J/kg·K	800	800
Thermal conductivity		W/m·K	1.6	1.6
Heat resistance		°C	750	850
Bending strength	JIS R1601	MPa	170	220
Vickers hardness	Hv (0.2)		700	800
Density		×10^{3}kg/m^{3}	2.5	2.5

Thermal Expansion



Others

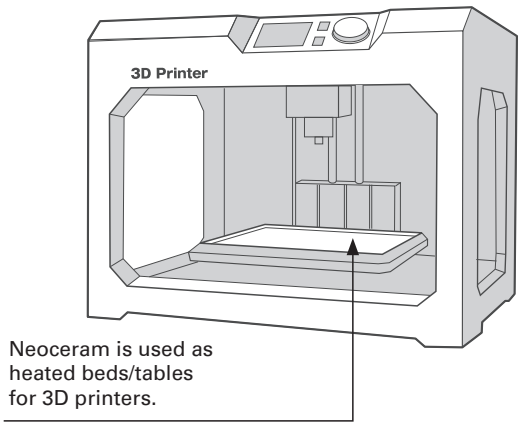
Uniform Heating by Radiant Heat



Neoceram can assume many different shapes and can be used in applications involving work at high temperatures. Because of their low water absorption rate, it is also possible to use Neoceram in places requiring high degrees of cleanliness.

Applications

- Neoceram is widely used in the thermal process of the below products.
  - Low temperature poly-silicon
  - OLED
  - Solar cell
  - High heat-resistant flexible polyimide substrate
- Heated beds/tables for 3D printers



Zero CTE Glass

Ref. No. 2210-52E

ZERØ™

ZERØ™ has zero CTE. It is suitable as a material for temperature compensation.
ZERØ™ is used as a material for various parts that require high levels of thermal dimensional stability.

Properties

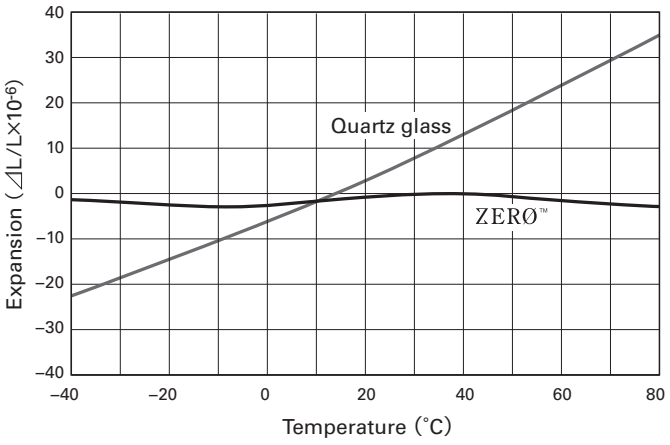
Coefficient of thermal expansion	−40-80°C	$\times 10^{-7}$/K	0
Young's modulus		GPa	95
Vickers hardness	Hv		680
Density		$\times 10^3$kg/m^3	2.55
Refractive index	n_d		1.54
	1550nm		1.53

Reference Data

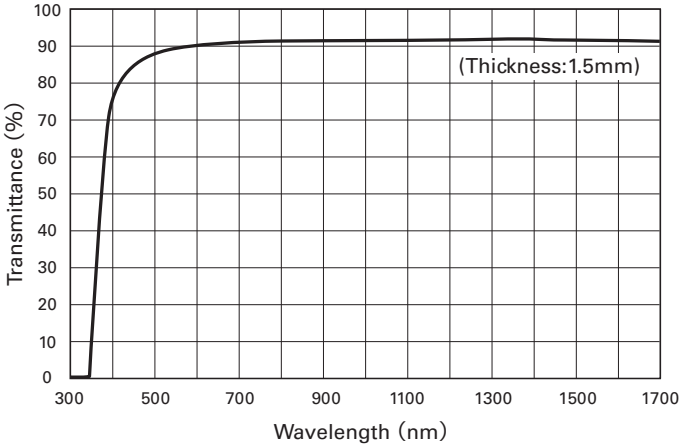
Thermal conductivity	W/m·K	25° C	1.6
		100° C	1.7
Thermal diffusivity index	$\times 10^{-6}$m^2/s	25° C	0.80
		100° C	0.75
Specific heat	kJ/(kg·K)	25° C	0.80
		100° C	0.90
Shear modulus	GPa		39
Poisson's ratio			0.2
Knoop hardness Hk			590
Abrasion Aa		JOGIS	50
Bending strength	MPa	3 point bending	180
Abbe number ν_d			57
Photo-elastic constant		$\times 10^{-6}$/MPa	3
Internal transmittance (10mmt)	%	580nm	88
		1550nm	93
Water resistance		JOGIS RW	Class1
Acid resistance		ISO 8424	Class1
Alkali resistance		ISO 10629	Class1
Volume resistivity (Log ρ)	Ω·cm	350° C	5.4
Dielectric constant		1MHz, 25° C	7.4
		2.45GHz, 25° C	6.5
Dielectric loss tan δ	$\times 10^{-3}$	1MHz, 25° C	17
		2.45GHz, 25° C	43

The figures of the properties are measured values, but they are not guaranteed.

Thermal Expansion



Transmittance

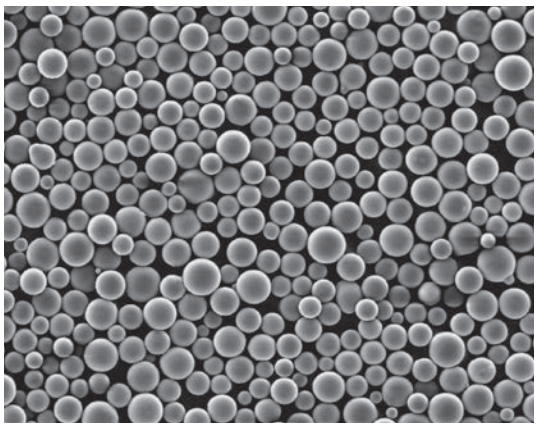


Others

Negative CTE Filler

The volume of the Negative CTE* Filler becomes smaller as temperatures rise. This makes it effective for reduction of the thermal expansion of the resin composite. Its spherical shape contributes to its excellent resin filling status.

*CTE: coefficient of thermal expansion



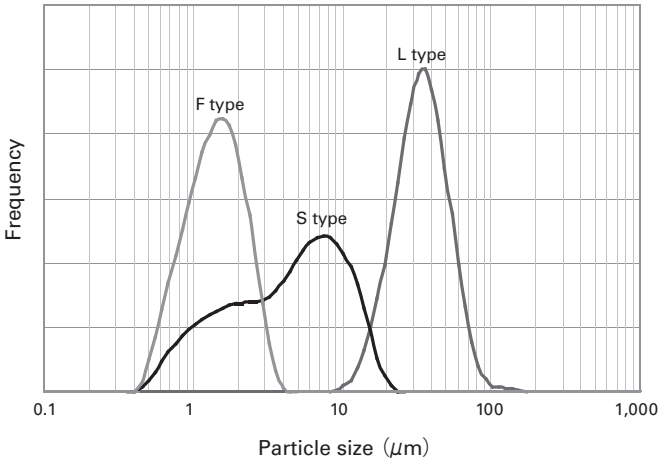
Features

- Negative CTE
- Water resistance
- Small particle size
- Electric insulation

Properties

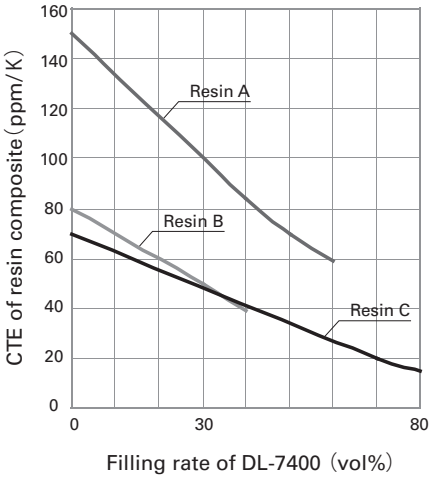
Glass Code			DL-7400
Coefficient of thermal expansion	25-150°C	ppm/K	-1.1
	150-240°C		-0.9
Density		$\times 10^3$kg/m^3	2.5

Particle Distribution



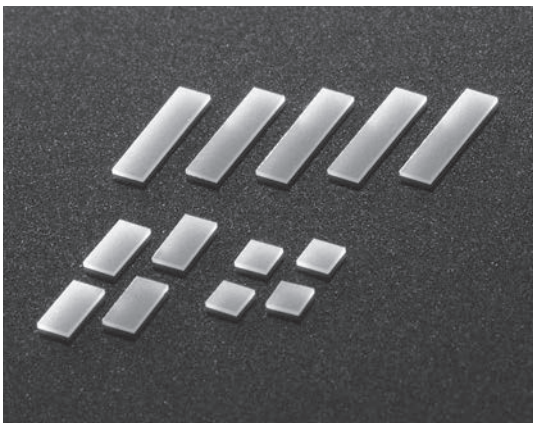
※Other sizes are also available.

CTE of Resin Composite



Lumiphous™

Lumiphous™ was developed for wavelength conversion glass for LED or LD. It has features such as low color deviation and a high latitude of colors. It also has excellent heat, water, and light resistance, and it allows high power light emission.
In addition, we customize various wavelength conversions according to the wavelength of the light source, such as visualizing the ultraviolet rays emitted from UV lamps and UV-LEDs.



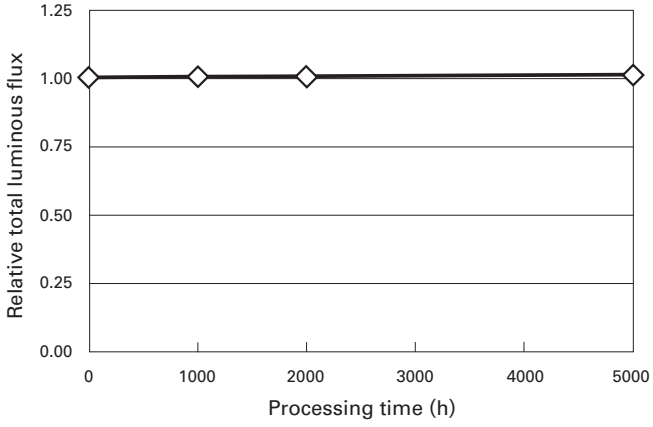
Features

- High accuracy color control
- Various chromaticities are available.
- Various shapes and sizes are available.
- Good light emission continues after weathering test. (85°C/85%RH×5000h)
- Mirror-finishing in sheet shape by precision polishing is possible.
- UV light shielding or transmission is adjustable.

Applications

- Automotive lighting
- Medical lighting
- Industrial lighting
- UV detection
- UV excitation light source

Weathering Test (85°C/85%RH ×5000h)



*Applied same light and same power for 5000 hours

Properties

		Glass A	Glass B
Coefficient of thermal expansion*	$\times 10^{-7}$/K	68	42
Heat resistance temperature	˚C	＞500	
Refractive index(n_d)(Glass matrix)		1.6	1.5

*Depending on the amount and type of phosphor.

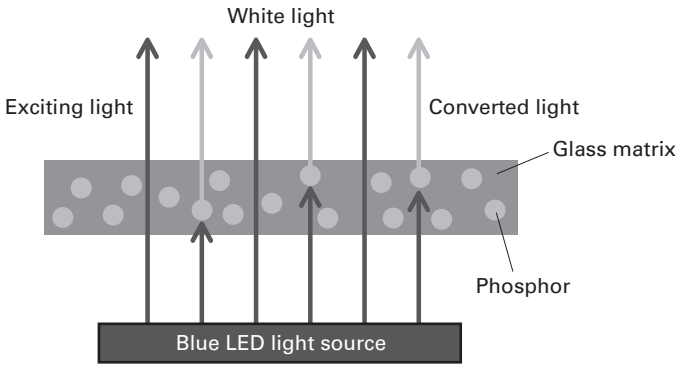
Size Examples

(mm)

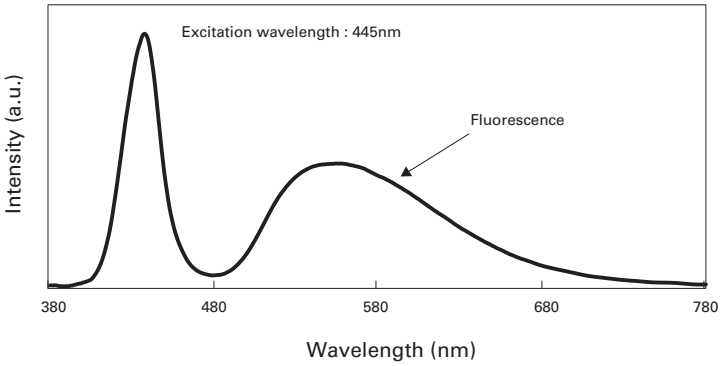
	Length	Width	Thickness
I	1.0	1.0	0.1
II	1.0	4.0	0.2
III	10.0	10.0	0.3

We are able to accommodate individual requests.

Example of Wavelength Conversion (Visible light conversion)

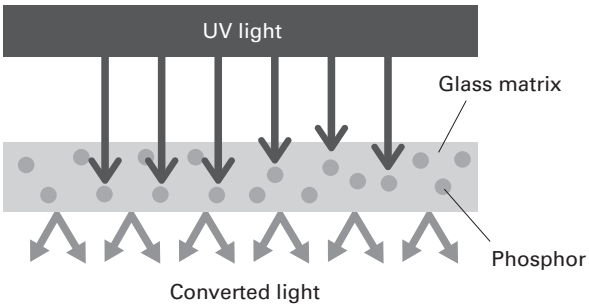


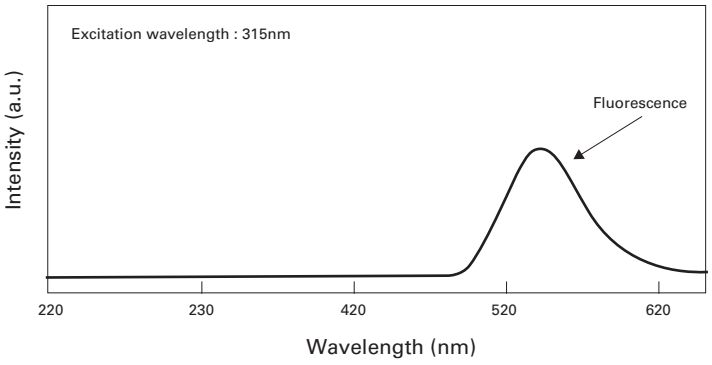
Spectral Examples (YAG)



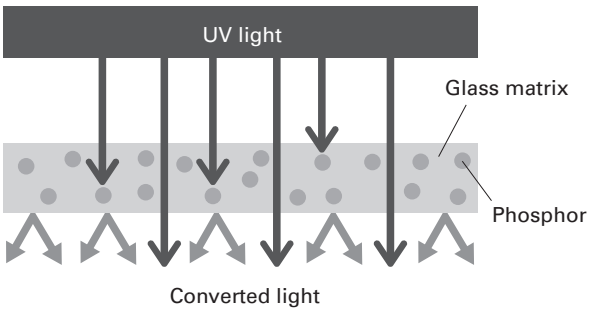
Example of Wavelength Conversion (UV light conversion)

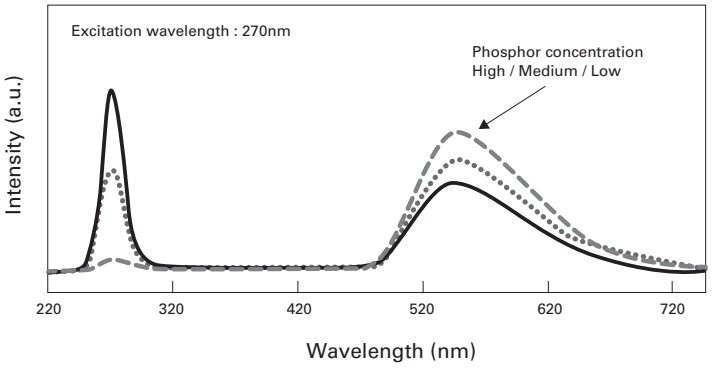
■ In case of UV shielding



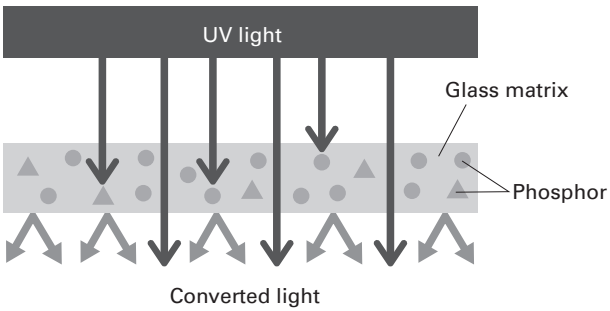


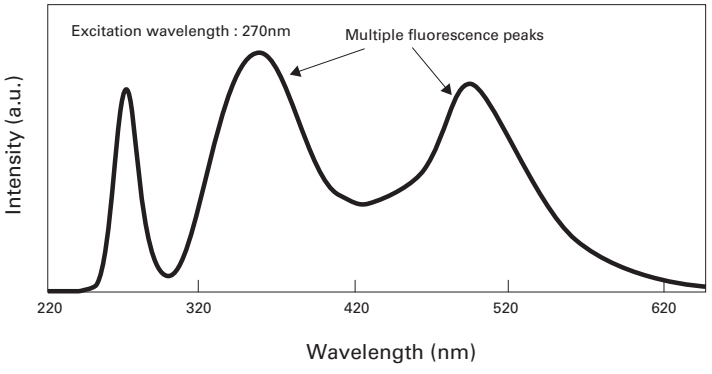
■ In case of UV transmitting





■ In case of containing multiple phosphors

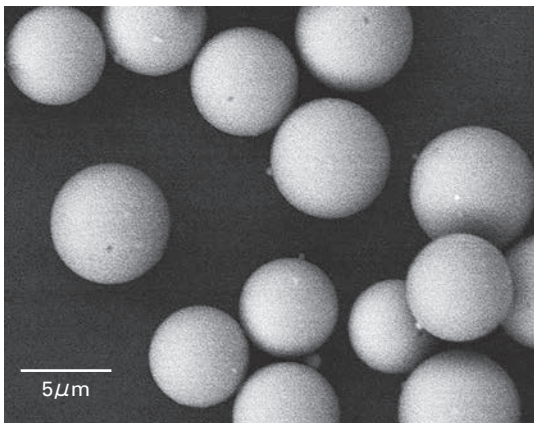




Glass Beads for 3D Printer

**We developed minute glass beads with a refractive index that can be matched with a resin for 3D printing.
In addition to their heat resistance and strength, these beads allowed a translucent 3D model to be realized for the first time in the world.***

*According to an internal investigation as of February 2020



SEM image

Features

● **Translucency**
Translucent printed models are obtained with the use of refractive-index-matched glass beads.
The degree of translucency can also be adjusted by changing the proportion of this product with other additives.

● **Heat resistance and strength**
The heat resistance and strength of printed models increase with the use of this product.

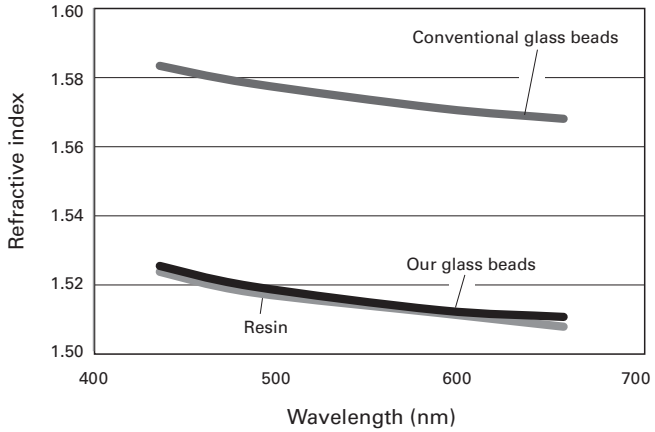
● **Uniform dispersion**
Uniform dispersion in resins is achieved by optimizing the particle size of beads.

Applications

- Temporary teeth
- Connectors
- Jewelry
- Simulation models for automobiles and aircraft, etc.

Comparison with Conventional Products

Appearance of 0.5mm-thick resin plates containing 30vol% glass beads

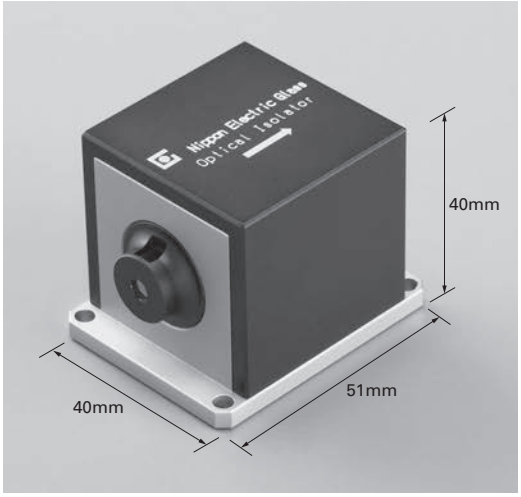


Refractive indices of materials used for resin plates shown on the left

Others

Optical Isolator for High Power Lasers

This optical isolator for high power lasers uses glass that has the highest magneto-optical performance in the industry.
Its high Verdet constant allows for a great reduction in size.



Outer size of prototype

Features

1. Downsizing
The installation area is reduced to 1/2 or less compared with conventional products.
This increases the flexibility in the laser device design.

2. High performance
The incident light loss is 0.1dB or less and the isolation is 38dB or higher (reference values).

3. Support for higher power
A high laser damage threshold can be achieved through the use of high-performance glass parts and materials developed in-house.

4. Wide-range wavelength coverage
High transmittance from ultraviolet rays to near infrared rays (NIR)
Better magneto-optical properties than those of TGG's (TGG: $Tb_3Ga_5O_{12}$)

Properties of Prototype

(for reference only; not guaranteed)

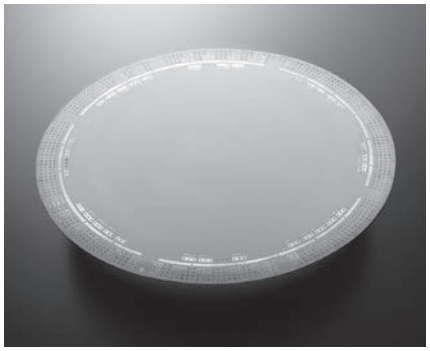
Wavelength		nm	1,064
Isolation		dB	38
Incident light loss		dB	0.1
Pulsed damage threshold	10ns pulse	J/cm^2	>10
Aperture		mm	Φ 2

∗ Both free-space type and in-line type units are available.
∗ Wavelengths other than 1,064nm are available.
∗ Chassis design can be changed upon request.

LTCC Substrate

LTCC* substrates possess excellent electrical characteristics. In addition, they enable multi-layering, dense-mounting and lower profile of electronic devices. Thus, they are used for communication module substrates, probe card substrates used in semiconductor inspection and high thermal conductivity LED packages, etc. Application of LTCC is spreading to the fields of communication devices, semiconductor processes, automobile devices, and beyond.

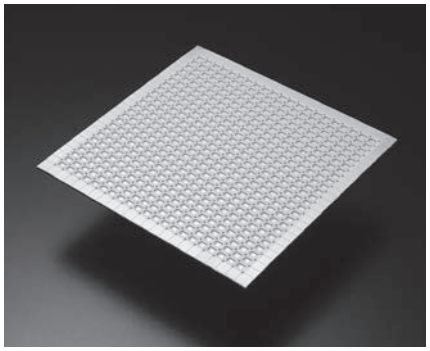
*LTCC : low temperature cofired ceramics



Probe card board

Features

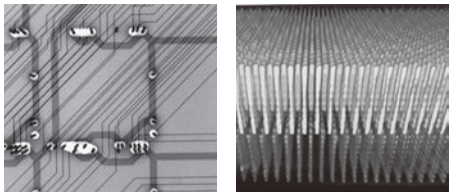
- Excellent RF characteristics (Low dielectric loss material, low resistance conductor)
- Multi-layer / high-density / low-profile
- High affinity with semiconductor (silicon) thermal expansion



LED package array

Applications

- Communication module
- Probe card board
- Electronic device package



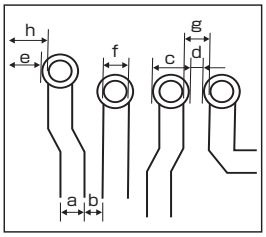
Internal wiring / through conductive path

Design Guide

1. Features of Material

Item	Material	Dielectric constant	tanδ	Color	Poisson's ratio	Density [kg/m^3]
YDM71	Glass Ceramic (Pb free)	7.3 @8GHz	0.005 @8GHz	White*1	0.24	2810
YDM74		7.4 @8GHz			—	2950
YDM79		7.9 @1MHz	0.003 @1MHz		0.26	3100

Item	Coefficient of thermal expansion [ppm/°C]	Thermal conductivity [W/(m·K)]	Specific heat [J/kg·K]	Young's modulus [GPa]	Flexural strength [MPa]
YDM71	5.5	2.2	690	114	250
YDM74	5.8	2.8	710	133	350
YDM79	4.9	1.7	600	102	200



*1: Light shield dark brown and black are available.
These data are typical values, but they are not guaranteed.

2. Circuit Board Specifications

Item		Unit	Specification
Maximum dimension		mm	150×150×5.5
Layer thickness		μm	70 min.
Tolerances (with machining)	X,Y plane	μm	100 min.
	Thickness	μm	50 min.
	Warp	μm	100 min.
Conductor	Thickness	μm	5-20(depends on line width)
	Resistivity	Ω·cm	Line : 2.5×10^{-6}, Via : 3.0×10^{-6}
	Outer/Inner	—	Ag/Ag (Ag/Pd, Ag/Pt are available)
	Adhesion strength	kg/mm^2	cofire: 0.5, post fire: 0.2
Plating			Ni/Au, Ni/Pd/Au, etc.

3. Design Rules

(Tolerance of line width, space or via-hole dia. is ±10%)

Item		Symbol	Rules Max.	Rules Min.	Unit
Wiring	Line/Space	a/b	—	60/80	μm
	Land/Space	c/d	—	80/70	μm
	Distance from edge	e	—	300	μm
Via-Hole	Via-hole diameter*2	f	ϕ300	ϕ70	μm
	Via/Via space	g	—	80	μm
	Distance from edge	h	—	300	μm

*2: Max./min. via-hole diameter will be constrained by the layer thickness (thickness of the used sheet.)

This product is a product of LTCC Materials Co., Ltd., our group company.

Contact : LTCC Materials Co., Ltd.
Tel. +81-274-89-1666 https://www.ltccm.co.jp/en/

■ Corporate Profile

Company Name	Nippon Electric Glass Co., Ltd.
Head Office	7-1, Seiran 2-chome, Otsu, Shiga, Japan
Founded	December 1, 1949
Plants	Otsu, Shiga-Takatsuki, Notogawa, and Precision Glass Center
Sales Headquarters	Osaka and Tokyo
Capital	32,155 million yen (as of June 30, 2022)
Employees (consolidated)	6,335 (as of June 30, 2022)
Primary Business	Production and sales of specialty glass products; manufacture and sales of glassmaking machinery

■ Main Products

〈Electronic and Information Technology〉

Glass for Flat Panel Displays (FPD)
- Glass for Liquid Crystal Displays (LCD)
- Glass for Organic Light Emitting Diodes (OLED)

Cover Glass
- "Dinorex™"Glass for Chemical Strengthening
- "Dinorex UTG™"Ultra-thin Glass for Chemical Strengthening

Glass for Optical Devices
- Capillary and Ferrule for Optical Communication Devices
- Lens for Optical Communication Devices

Glass for Electronic Devices
- Functional Powdered Glass
- Flat Glass for Electronic Devices
- Glass Tube for Small Electronic Products
- "Lumiphous™" Phosphor-Glass Composite

〈Performance Materials and Others〉

Glass Fiber
- Chopped Strands for Function Plastic Reinforcement
- Wet Chopped Strands for Building Materials
- Roving for Plastic Reinforcement
- Chopped-Strand Mats for Automobiles
- Alkali-Resistant Glass Fiber for Cement Reinforcement

Glass for Building Materials
- Glass Blocks
- "Neopariés™" Glass-Ceramic Building Materials
- "FireLite™" Fire Rated Glass
- "Lamion™"Ultra-thin Glass Laminated on Resin
- "Invisible Glass™"Ultra-Low Reflection Glass

Heat-Resistant Glass
- "Neoceram" Super Heat-Resistant Glass-Ceramics
- "StellaShine™" Super Heat-Resistant Glass-Ceramics for Cooking Appliances

Glass for Pharmaceutical and Medical Applications
- Glass Tubing for Pharmaceutical and Medical Use
- "LX Premium" Radiation-Shielding Glass

Others
- Glass for Lighting Use
- Glassmaking Machinery

Nippon Electric Glass Co., Ltd.

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Phone: +1-630-285-8500
Fax: +1-630-285-8510

The Otsu, Shiga-Takatsuki, and Notogawa Plants, and the Precision Glass Center of Nippon Electric Glass Co., Ltd. are all certified to comply with the requirements of ISO 14001 of Environmental Management System.
Certificate No. JQA-EM0506

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VEGETABLE OIL INK

- Specifications are subject to change without notice.
- The figures of the properties in this guide are standard values, not guaranteed.

E002ELA 9B OCT '22