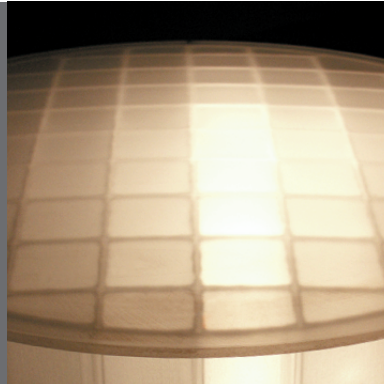


TSG

Titania Silicate Low Expansion Glass



CORNING



Advanced Optics
and Materials

TSG, Titania Silicate Low Expansion Glass is the newest member of Corning's titania silicate low expansion glass family. TSG has a similar composition to ULE[®] and is made using the same flame hydrolysis process. TSG has a relaxed Absolute CTE requirement for those applications that do not require a zero CTE material, however CTE variation remains controlled through process discipline.

Linear Coefficient of Thermal Expansion — CTE

The guaranteed maximum limits for absolute CTE are as follows:

TSG The mean CTE shall be 0 ± 100 ppb/^oC from 5^oC to 35^oC with a 95% confidence level.

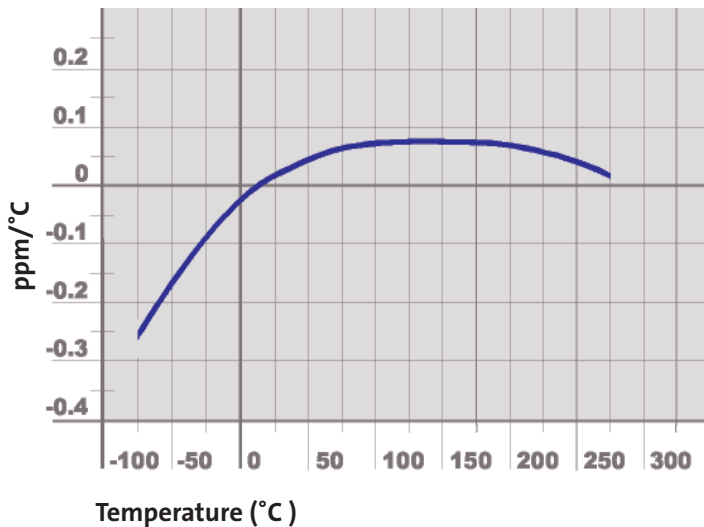
CTE Variation and Inclusion Quality Grades:

Inclusion Quality—The guaranteed maximum limits for seeds, bubbles and opaque inclusions are as follows:

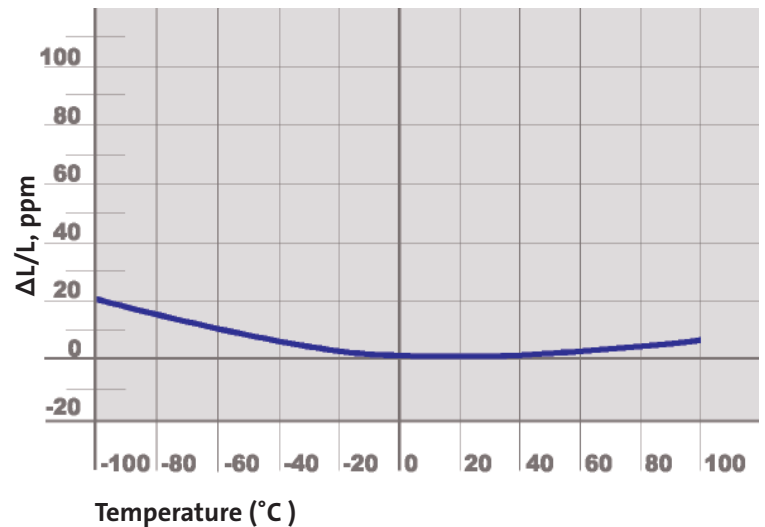
Quality Grade Selection Chart

Grade	Maximum CTE Variation (ppb/°C)		Optical Retardation	Inclusions		
	Radial Range	Axial Range	Birefringence (nm/cm)	Inclusion Quality	Diameter < 20"	Diameter 20" to 56"
Mirror Grade	30	20	35	Critical Zone: Inclusion Max Mean Diameter Inclusions per cubic inch Avg. no. of inclusions per cubic inch Non-Critical Zone: Inclusion Max Mean Diameter Inclusions per cubic inch Avg. no. of inclusions per cubic inch	0.040" 4 0.1	0.080" 6 0.2
Standard Grade	30	20	35	Inclusion Max Mean Diameter Inclusions per cubic inch Avg. no. of inclusions per cubic inch	0.100" N/S 0.2	0.250" N/S 0.6

Instantaneous CTE



Thermal expansion



Properties:

Unless otherwise stated, all values @ 25 °C

Thermal Properties:

Mean coefficient of thermal expansion 5–35 °C (∞)	$0 \pm 100 \times 10^{-9}/K$ [0 ± 100 ppb/°C]	Mean specific heat (C_p)	767 J/kg [0.183 cal/g]
Thermal conductivity (K)	1.31 w/(m • °C) [1.31 kcal/(m • hr • °C)]	Strain point	890 °C [1634 °F]
Thermal diffusivity (D)	0.0079 cm ² /s	Annealing point	1000 °C [1832 °F]
D.C. volume resistivity, 200 °C, 100Hz (R)	$10^{11.6}$ ohm • cm	Softening point (estimated)	1490 °C [2714 °F]
Mechanical Properties:			
Poisson's ratio (ν)	0.17	Specific stiffness (E/ρ)	3.12×10^6 m [1.23 x 10 ⁸ in.]
Ultimate tensile stress (MOR)	49.8 MPa [7220 psi]	Shear Modulus (G)	29.0 GPa [4.20 x 10 ⁶ psi]
Knoop Hardness, 200g load	460 kg/mm ²	Bulk Modulus (K)	34.1 GPa [4.95 x 10 ⁶ psi]
Density (ρ)	2.21 g/cm ³ [0.079 lbs./in ³]	Elastic Modulus(E)	67.6 GPa [9.80 x 10 ⁶ psi]

Chemical durability:

- Excellent resistance to weathering.
- Exhibits virtually no surface clouding or electrical surface leakage when subject to attack by water, sulfur dioxide, and atmospheric gases.
- High resistance to attack by nearly all chemical agents.

Solution @ 95°C	Test duration	Weight loss
5% HCl	24 hrs.	<0.01 mg/cm ²
5% NaOH	6 hrs.	0.9 mg/cm ²
.02N Na ₂ CO ₃	6 hrs.	0.02 mg/cm ²
5% H ₂ SO ₄	24 hrs.	<0.01 mg/cm ²
H ₂ O	24 hrs.	<0.01 mg/cm ²

- CTE verification is achieved through a non destructive ultrasonic method.
- Stability—Excellent long term dimensional stability at room temperature. No residual figure change when taking a blank from 350°C to water quench.
- Delayed elastic effect —There has been no measurable delayed elastic effect in TSG. This is an important consideration when large strain is present during fabrication or when environmental loading is present, such as during gravity release or dynamic control of active optics.
- No Measurable hysteresis results from thermal cycling regardless of the rate of temperature change.

Notes:

- Critical Zone — a quality layer typically extending to a depth of 0.200" below the surface specified by the customer for finishing.
- Non-Critical Zone — all glass outside the critical zone:
 - Inclusions with 0.005" or smaller mean diameter are disregarded.
 - Mirror and standard grades available in sizes up to 58" diameter or diagonal by 5" thick. Corning would be pleased to quote larger sizes to customer specs.
 - Tooling grade available. Please contact Corning for availability.

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*We are here to help you specify the best product for your application.
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