

The SD-2 glass substrate by HOYA is designed to match the thermal expansion curve of Si single crystals as accurately as possible.

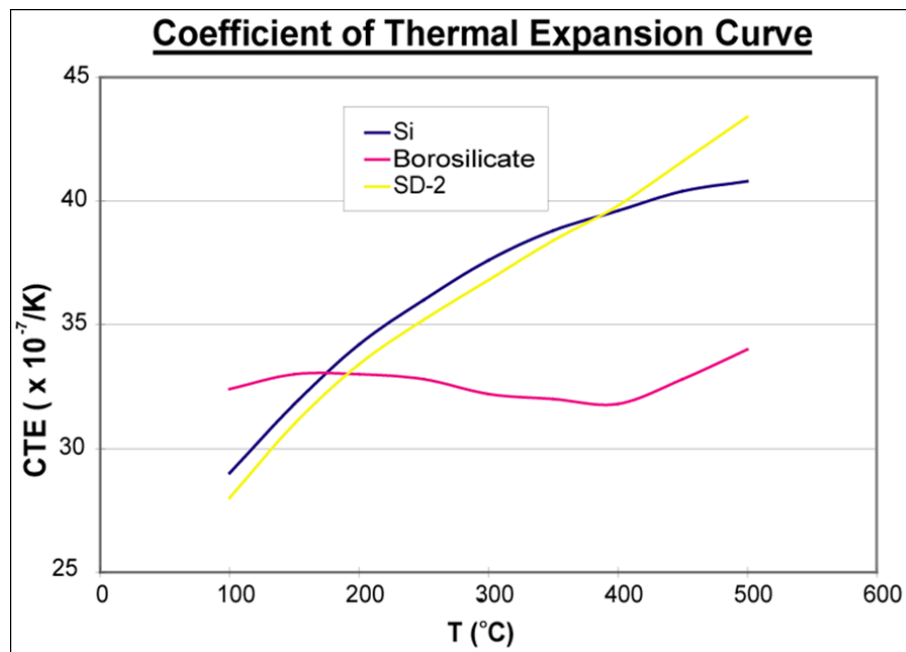
THERMAL EXPANSION PROPERTIES

Borosilicate glass has been widely used as a bonding material to Silicon Wafers. The CTE curves of Borosilicate glass and Silicon Single Crystal Wafers cross at about 240°C. When anodic bonding is performed at 400°C, the different expansions at high temperatures create residual stress in the Si chip especially while cooling to room temperature. As precision LSI circuit patterns use spaces of less than 0.25 microns, distortion between the silicon and glass wafers becomes a critical issue.

HOYA's SD-2 substrate is engineered to minimize the distortion or bowing effect caused by the thermal miss-match between the two wafers.

ANODIC BONDING

Silicon and glass wafers are generally fused together by way of Anodic Bonding. This bond is formed by pressing and heating the wafers while positive (+) DC voltage is applied to the Si wafer and negative (-) voltage is applied to the glass wafer. During the bonding process, a small amount of Na⁺ ions, engineered into the SD-2, move as electro conductive carriers to facilitate a very short bonding time.



Thermal Properties	SD-2	Borosilicate
Coefficient of Thermal Expansion	$32.0 \times 10^{-7} / ^\circ\text{C}$	$32.5 \times 10^{-7} / ^\circ\text{C}$
Transformation Point (T_g)	721°C	552°C
Sag Point (T_s)	787°C	
Strain Point	669°C	510°C
Annealing Point	720°C	560°C
Thermal Conductivity	0.0026 Cal/sec·cm·°C	0.0027 Cal/sec·cm·°C
Specific Heat	0.176 Cal/g·°C	0.180 Cal/g·°C
Mechanical Properties		
Specific Gravity	2.6	2.23
Young's Modulus	8860 kgf/mm ²	6400 kgf/mm ²
Modulus of Rigidity	3560 kgf/mm ²	
Poisson's Ratio	0.244	0.2
Knoop Hardness	638 kgf/mm ²	418 kgf/mm ²
Electrical Properties		
Volume Resistivity (DC500V) 20°C	$4.1 \times 10^{14} \Omega \cdot \text{cm}$	$1.4 \times 10^{16} \Omega \cdot \text{cm}$
Volume Resistivity (DC500V) 100°C	$4.2 \times 10^{11} \Omega \cdot \text{cm}$	$4.6 \times 10^{11} \Omega \cdot \text{cm}$
Volume Resistivity (DC500V) 200°C	$3.8 \times 10^9 \Omega \cdot \text{cm}$	$0.9 \times 10^9 \Omega \cdot \text{cm}$
Dielectric Coefficient (1MHz) 20°C	6	4.8
Dielectric Coefficient (1MHz) 100°C	7	4.9
Dielectric Coefficient (1MHz) 200°C	7	5.1
Dielectric Loss (1MHz) 20°C	1.0×10^{-2}	5.5×10^{-3}
Dielectric Loss (1MHz) 100°C	1.9×10^{-2}	1.0×10^{-2}
Dielectric Loss (1MHz) 200°C	4.9×10^{-2}	2.9×10^{-2}
Chemical Properties		
Acid Durability (30% HNO ₃ 80°C 50H)	1.20 mg/cm ² loss	0.50 mg/cm ² loss
Alkaline Durability (0.01N NaOH 50°C 15H)	0.01 mg/cm ² loss	0.02 mg/cm ² loss
Optical Properties		
Refractive Index (n_d)	1.531	1.474
Abbe-Number (v_d)	59	

Note: The listed data are standard values. Because of continuous product improvement, the various data listed may be subject to change without further notice.