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Material Properties

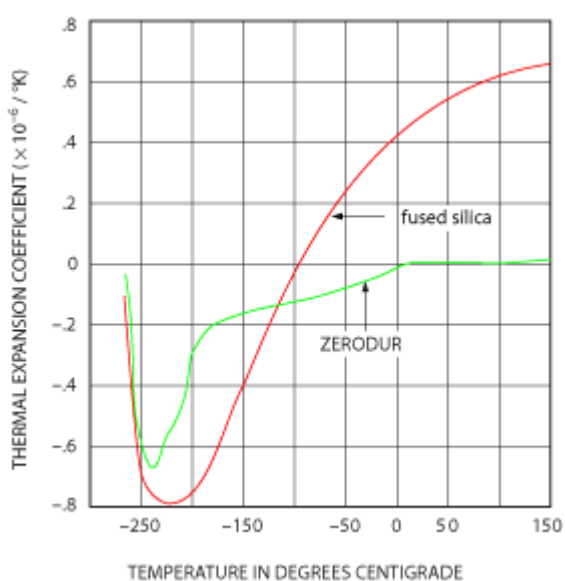
ZERODUR®

Many optical applications require a substrate material with a near-zero coefficient of thermal expansion and/or excellent thermal shock resistance. ZERODUR® with its very small coefficient of thermal expansion at room temperature is such a material.

ZERODUR, which belongs to the glass-ceramic composite class of materials, has both an amorphous (vitreous) component and a crystalline component. This Schott glass is subjected to special thermal cycling during manufacture so that approximately 75% of the vitreous material is converted to the crystalline quartz form. The crystals are typically only 50 nm in diameter, and ZERODUR appears reasonably transparent to the eye because the refractive indices of the two phases are almost identical. However, scattering at the grain boundaries precludes the use of ZERODUR for transmissive optics.

Typical of amorphous substances, the vitreous phase has a positive coefficient of thermal expansion. The crystalline phase has a negative coefficient of expansion at room temperature. The overall linear thermal expansion coefficient of the combination is almost zero at useful temperatures.

The figure below shows the variation of expansion coefficient with temperature for a typical sample. The actual performance varies very slightly, batch to batch, with the room temperature expansion coefficient in the range of $\pm 0.15 \times 10^{-6}/^\circ\text{C}$. By design, this material exhibits a change in the sign of the coefficient near room temperature. A comparison of the thermal expansion coefficients of ZERODUR and fused silica is shown in the figure. ZERODUR, is markedly superior over a large temperature range, makes ideal mirror substrates for such stringent applications as multiple-exposure holography, holographic and general interferometry, manipulation of moderately powerful laser beams, and space-borne imaging systems.



Comparison of thermal expansion coefficients of ZERODUR® and fused silica

ZERODUR® Constants

Abb?Constant: $v_d = 66$

Dispersion: $(n_f - n_c) = 0.00967$

Density: 2.53 g-cm^{-3} at 25°C

Young's Modulus: $9.1 \times 10^9 \text{ dynes/mm}^2$

Poisson's Ratio: 0.24 Specific Heat at 25°C: 0.196 cal/g-°C

Coefficient of Linear Expansion (20°C to 300°C) : $0.05 \pm 0.10 \times 10^{-6}/\text{°C}$

Maximum Temperature: 600°C

ZERODUR® is a registered trademark of Schott Glass Technologies.

Refractive Index of ZERODUR®

Wavelength (nm)	Fraunhofer Designation	Refractive Index <i>n</i>
656.3	C	1.5394
643.8	C'	1.5399
587.6	d	1.5424
546.1	e	1.5447
486.1	F	1.5491
480.0	F'	1.5497
435.8	g	1.5544

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