ZERODUR® – Zero Expansion Glass Ceramic

Applications

ZERODUR® has become a performance- and quality-benchmark in many spectacular applications within modern technology:

- Stages and mirrors for lithography equipment
- Mirror substrates for segmented and monolithic large astronomical telescopes
- Ultra light weighted mirror blanks
- Standards for precision measurement technology
- High precision mechanical parts, e.g. ring laser gyroscope bodies
- Reference standards for precision measurement technology and comet probes

Properties

ZERODUR® is a zero expansion glass ceramic with extraordinary properties for demanding applications in which geometrical shape and distance changes must kept smallest possible under temperature variations. The key properties of ZERODUR® are:

- Extremely low coefficient of thermal expansion (CTE) for a wide temperature range
- Excellent CTE homogeneity throughout the total volume
- Very low content of imperfections
- Wide range of precise geometrical shapes
- Extremely smooth surface with residual roughness below 1 nm
- Excellent chemical stability

All these properties are realized for small components as well as for astronomy telescope mirror blanks weighting several tons with extraordinary reproducibility.

Zero thermal expansion

ZERODUR® is an inorganic glass ceramic with 70 to 78 % of high-quartz micro-crystallites 30 to 50 nm in size, embedded in a remaining glassy phase. The micro-crystals contract when they are subjected to heating, whereas the glass itself expands. Size and number of the micro-crystallites are carefully adjusted to achieve an extremely low thermal expansion. At ambient temperature the net thermal expansion is nearly zero, achieved with an accuracy of down to 0 ± 20 ppb/K. Thanks to the careful temperature processing the thermal expansion of ZERODUR® is extremely homogeneous. About 5 ppb/K CTE homogeneity values have been achieved for 1.5 m class ZERODUR® blanks.

Properties	ZERODUR®
Density [g/cm³]	2.53
Young's Modulus E [GPa]	90.3
Poisson's Ratio μ	0.24
Knoop Hardness [HK 0.1/20]	620
Coefficient of thermal expansion α CTE (0 °C; 50 °C) [10^{-6}/K]	0 ± 0.10 (class 2) 0 ± 0.05 (class 1) 0 ± 0.02 (class 0)
CTE (0 °C; 50 °C) Homogeneity	< 0.01 – 0.03*10^{-6}/K
Heat Capacity c_p (20 °C) [J/(gK)]	0.80
Thermal Conductivity $\lambda_{90\,°C}$ [W/(mK)]	1.46
Max. Application Temperature [°C]	600

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