

# Thermal Expansion of ZERODUR®

Addition of three new tighter toleranced CTE grades: SPECIAL, EXTREME, TAILORED

For more than 40 years, ZERODUR®, the extremely low expansion glass ceramic from SCHOTT, enables extremely high precision for many challenging high technology applications such as IC and LCD lithography, high precision measurement and astronomy. Thanks to its ongoing development work, SCHOTT Advanced Optics has further improved its ZERODUR® properties and created an outstanding product that guarantees even higher precision.

This leaflet is dedicated to the most important property of ZERODUR®: its extremely low coefficient of thermal expansion (CTE). Three new CTE grades with tighter tolerances are now available that take this unique product's performance to new heights for our customers.

More Information is also available on the SCHOTT website:  
[www.schott.com/advanced\\_optics/zerodur](http://www.schott.com/advanced_optics/zerodur)

## Mean Coefficient of Linear Thermal Expansion

ZERODUR® is now available in the following different grades of the coefficient of linear thermal expansion (CTE) that range between 0°C to 50°C:

CTE Grades	CTE (0°C; 50°C)*
ZERODUR® Expansion Class 2	0 ± 0.100 ppm/K
ZERODUR® Expansion Class 1	0 ± 0.050 ppm/K
ZERODUR® Expansion Class 0	0 ± 0.020 ppm/K
ZERODUR® Expansion Class 0 <b>SPECIAL</b>	0 ± 0.010 ppm/K
ZERODUR® Expansion Class 0 <b>EXTREME</b>	0 ± 0.007 ppm/K
ZERODUR® <b>TAILORED</b>	Tailored ± 0.020 ppm/K (± 0.010 ppm/K upon request) Optimized for application temperature profile

\* CTE (0°C; 50°C) describes the mean coefficient of linear thermal expansion in the temperature range 0°C to 50°C.

## ZERODUR® **SPECIAL** and **EXTREME**:

The grades **SPECIAL** and **EXTREME** have a much tighter mean coefficient of thermal expansion for the temperature range between 0°C and 50°C compared to existing grades. These grades are achieved through optimized production control and using a new statistical measurement procedure that employs improved CTE metrology equipment while maintaining all other material properties and outstanding quality. This ensures maximum continuity with respect to the application heritage of ZERODUR®.



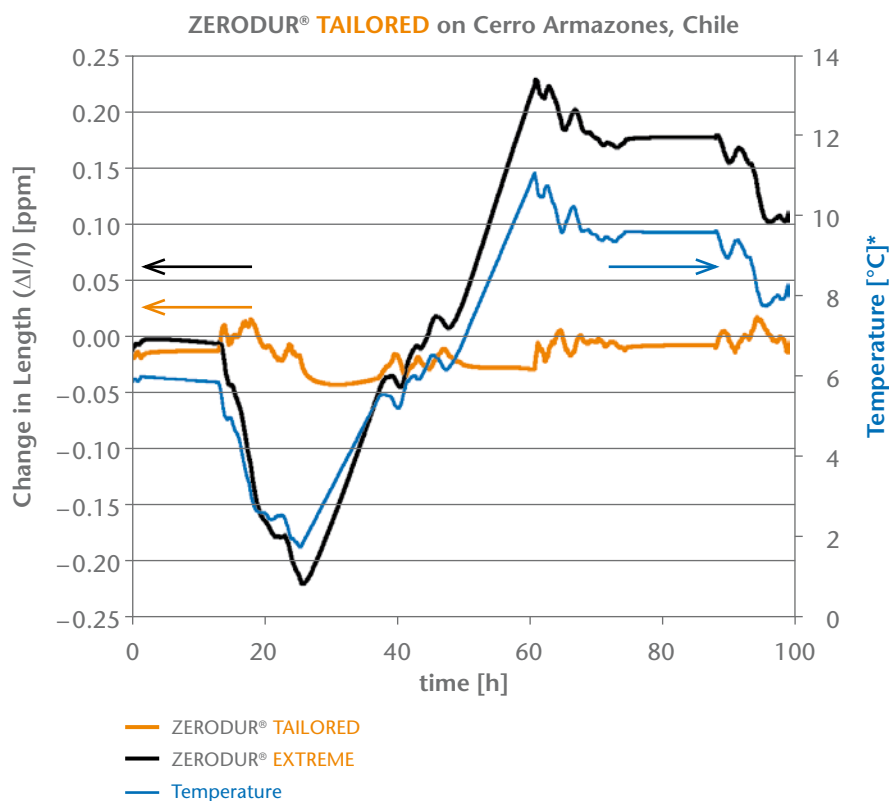
## ZERODUR® TAILORED

ZERODUR® TAILORED allows for optimized material to be provided that suits each individual customer's application temperature profile just perfectly.

The thermal expansion of glass ceramics is not only a function of temperature, but also of time. With a physical model developed by SCHOTT, it is now possible to simulate the thermal expansion behavior of ZERODUR® at any given temperature profile. This model allows for the thermal expansion behavior of ZERODUR® to be optimized for low temperature change rates at ambient temperatures or the temperature ranges at a typical telescope site.

The diagram below shows the typical temperature profile on the mountain top of the Cerro Armazones, the site planned for the E-ELT, the European-Extremely Large Telescope in the Atacama desert of Chile. The diagram also describes the thermal expansion of ZERODUR® TAILORED in comparison to ZERODUR® EXTREME. ZERODUR® TAILORED has much lower absolute thermal expansion for the given application temperature profile.

See also: Proceedings SPIE 7739 2010



\* Temperature data from: Public Database Server: <http://sitedata.tmt.org/>  
from June 1 and 4, 2008, air conditioned during the day



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