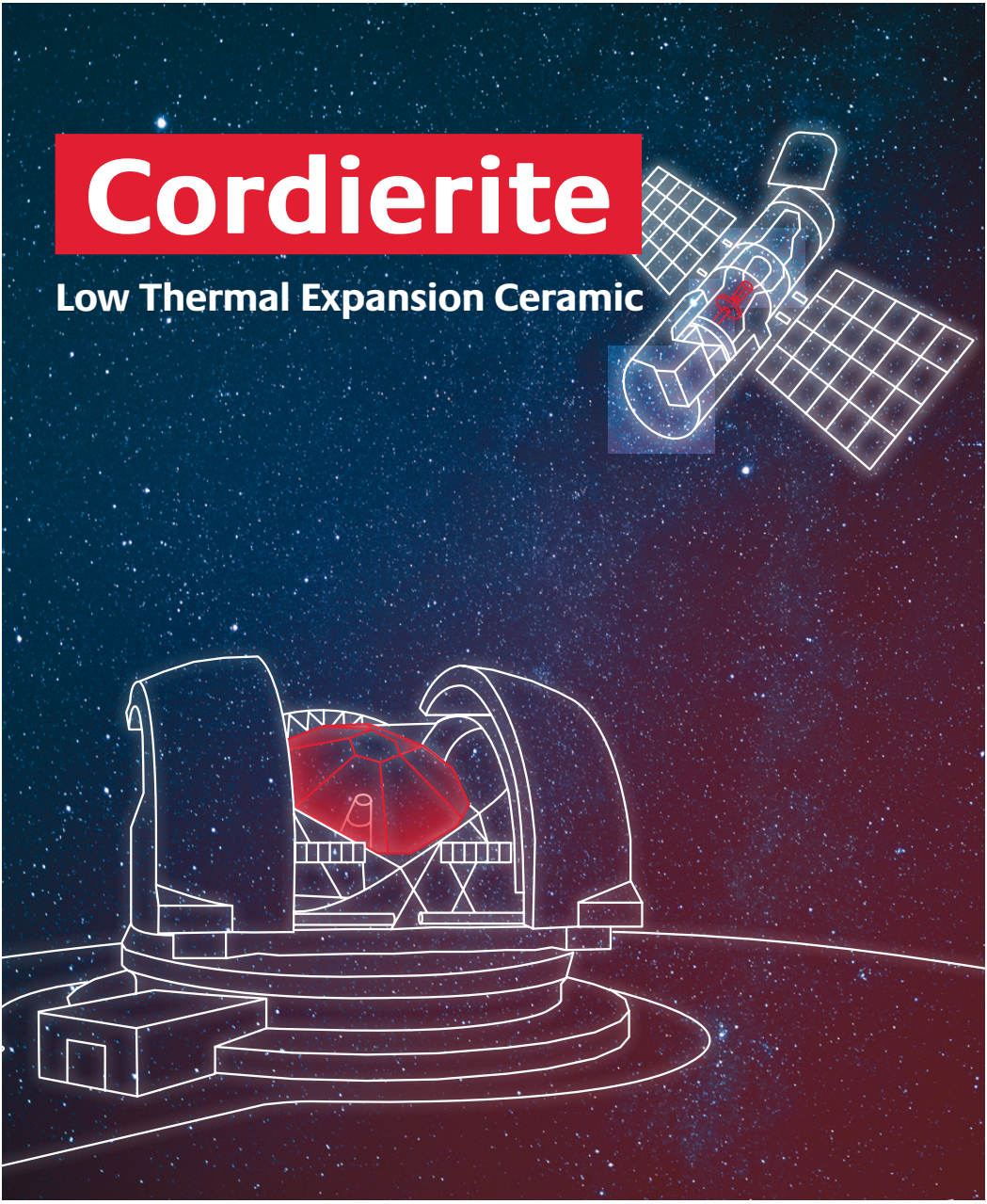
KYOCERA

Cordierite

Low Thermal Expansion Ceramic

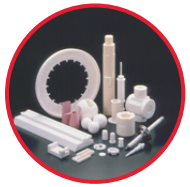


KYOCERA

KYOCERA – it all started with ceramics

Our first product was a U-shaped ceramic insulator used in early television picture tubes. It was made in a small suburban workshop in 1959 when 28 young colleagues started the company with big dreams. Today Kyocera is a highly diversified global enterprise with over 70,000 employees. The company is one of the world leaders in the manufacturing of ceramic components and products, with an extensive range of applications. Kyocera now provides over 200 kinds of ceramic materials including oxide, non-oxide and some special composites, with cutting edge technology and services designed to meet the individual needs. Our long-standing experience in the field of ceramics is applied in the production of very precise, high quality products used in multiple high-tech fields.

Our strength – wide variety of customized ceramic materials



ALUMINA

Alumina is the most widely used material among fine ceramics, and has the same sintered crystal structure (α-Al_2O_3) as sapphire and ruby. Its application is diverse due to its superb properties such as high insulation, high strength, high wear resistance and chemical resistance.

SILICON NITRIDE

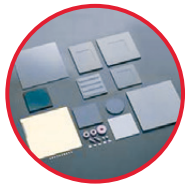
Silicon nitride (Si_3N_4) exceeds other ceramics in thermal shock resistance. As its strength does not deteriorate at elevated temperatures, it is appropriate material for automotive engine and gas turbine parts, including turbo-charger rotors, diesel engine glow plugs and hot plugs.

SILICON CARBIDE

Silicon carbide retains its strength at elevated temperatures as high as 1.400°C and features high corrosion resistance in fine ceramic materials. Applications include mechanical seals and pump parts.

ZIRCONIA

Zirconia ceramic offers high strength and toughness at room temperature in engineering ceramics. Before zirconia, ceramics were considered impractical for scissors or knife applications. With its excellent surface smoothness, zirconia is also used for pump parts.



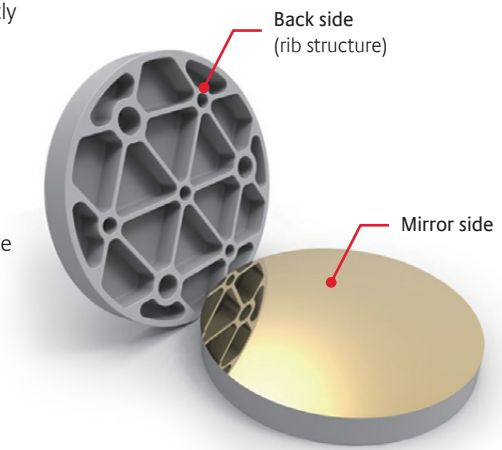
SPECIAL CERAMICS

Our portfolio also includes other ceramics such as aluminum nitride, single crystal sapphire, ferrites, dielectric ceramics and special materials like **cordierite**. Each of the materials has a customized application.

Space & Astronomy applications

CORDIERITE

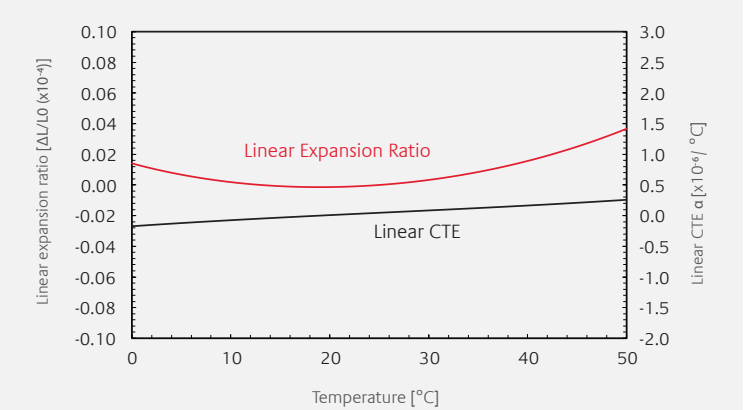
Cordierite is an extremely low thermal expansion ceramic which was developed over two decades back, and we have been constantly improving on its characteristics since.



CHARACTERISTICS

- **Minimal temperature deformation** due to dense cordierite ceramic with an extremely low thermal expansion rate
- **Approx. 70% weight reduction** when compared to low CTE glass* with a slim ribbed structure design featuring high rigidity
- **Rapid process time** even for complex designs due to good machinability

TEMPERATURE DEPENDENCY GRAPH <CORDIERITE CO720>



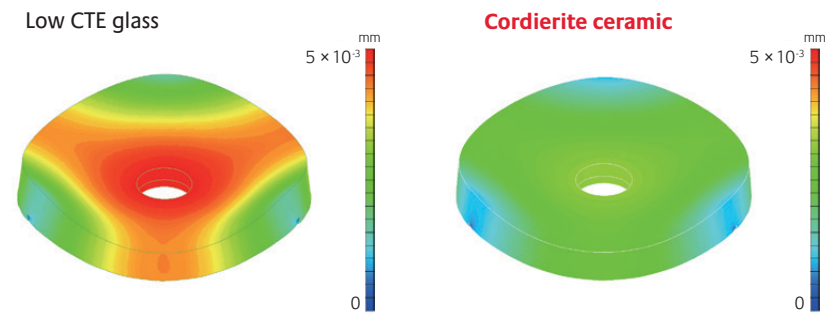
*based on Kyocera's research

MATERIAL CHARACTERISTICS COMPARISON WITH LOW CTE GLASS

Item	Unit	Low CTE glass	Ceramic < Cordierite CO720 >
Density	g/cm³	2.53	2.55
CTE**	ppm/K	0.02	0.02
Elasticity modulus	GPa	90	145
Specific rigidity	–	36	57

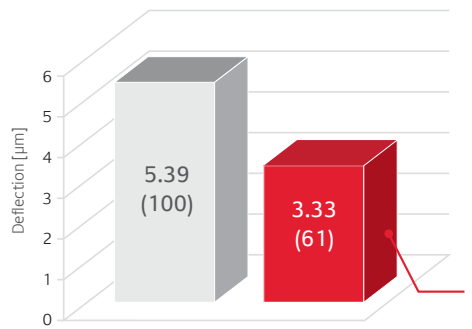
The values are typical material properties and may vary according to product configuration and manufacturing process.
**temperature dependency graph on page 3

DISPLACEMENT MAP***



3-POINT SUPPORTED DEFLECTION***

Low CTE glass vs. **Cordierite ceramic**



Comparison conditions:

- Product size: Φ1020 x 120mm (rib structure)
- Supported points: Outside 3 points
- Load: Self-weight

Approx. 40% improvement

***based on Kyocera's research

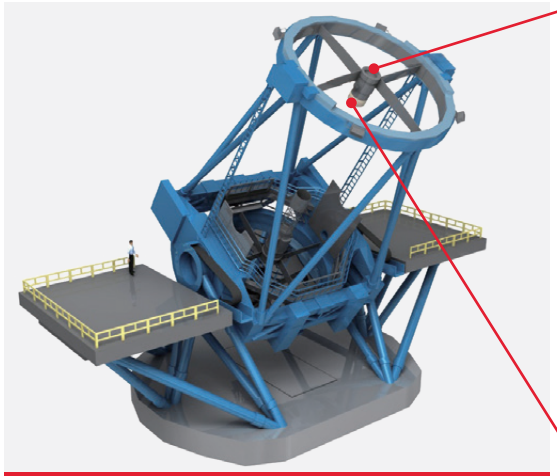
Camera lens spacer

Subaru Telescope is an 8.2-meter (320 in) optical-infrared flagship telescope operated by the National Astronomical Observatory of Japan (NAOJ), located at the Mauna Kea Observatory on Hawaii.

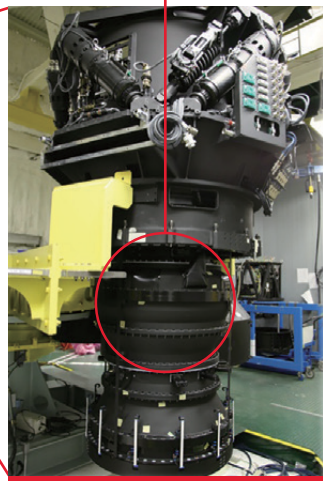
In 2012, when NAOJ installed a new super wide angle camera “Hyper Suprime-Cam (HSC)” into the SUBARU Telescope, there were two design requirements for adaptive optics. One was to make a larger lens aperture and the other was to make the lens lighter.

Kyocera’s cordierite was chosen as the best material to achieve the two design requirements for the lens support. Cordierite’s superior characteristics enabled a slim design with enough material strength and rigidity to support the lens structure as well as minimal deformation due to temperature fluctuations.

Lens support made by Kyocera
Low HSC module CTE ceramics
< Cordierite C0720 >



SUBARU Telescope support structure ©NAOJ



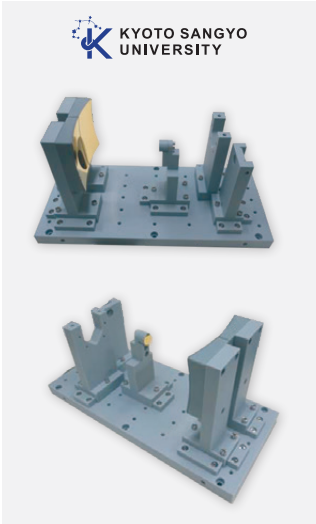
HSC module ©NAOJ

Optical systems including mirrors

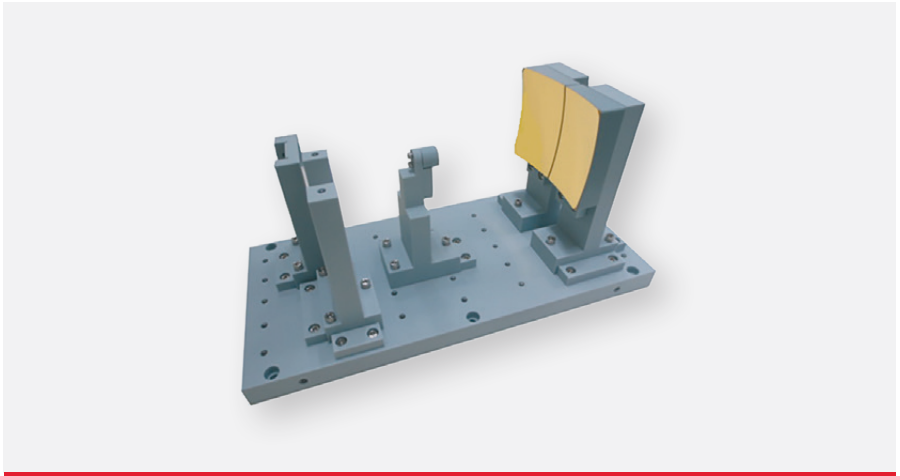
We have developed diffraction-limited off-axis reflective optical systems (mirrors, mirror holders, and optical benches) made entirely of cordierite materials, with Kyocera's high accuracy assembling technology.

Cordierite was used as it has a great "athermal property" whereby the optical performance does not degrade under varying temperature conditions owing to its monoclinic nature. We were able to process this extremely low thermal expansion ceramic to include cordierite mirrors coated with metal (Au), as seen in the pictures. Alternatively, larger cordierite mirrors of over 1 meter diameter, can be produced with a light weight design and the required surface roughness.

Such structures are expected to be installed in large telescopes (30 meters) and space telescopes in the coming years.



Optical bench from other perspectives



Optical bench

European Headquarters:

KYOCERA Fineceramics GmbH
Fritz-Mueller-Strasse 27
73730 Esslingen / Germany
Tel.: +49 (0)711 - 93 93 4-0
E-Mail: info.fc@kyocera.de
www.kyocera.de

Sales Office Neuss:
KYOCERA Fineceramics GmbH
Hammfelddamm 6
41460 Neuss / Germany
Tel.: +49 (0)2131 - 16 37-0
E-Mail: info.fc@kyocera.de
www.kyocera.de

Sales Office France:
KYOCERA Fineceramics SAS
Parc Icade Orly - Rungis • 21 rue de Villeneuve
94150 Rungis
Tel.: +33 (0)1 41 73 73 30
E-Mail: info.fc@kyocera.de
www.kyocera.fr

Sales Office UK:
KYOCERA Fineceramics LTD
Archipelago, Lyon Way
Frimley • Surrey GU16 7ER
Tel.: +44 1276 - 69 34 50
E-Mail: info.fc@kyocera.de
www.kyocera.eu