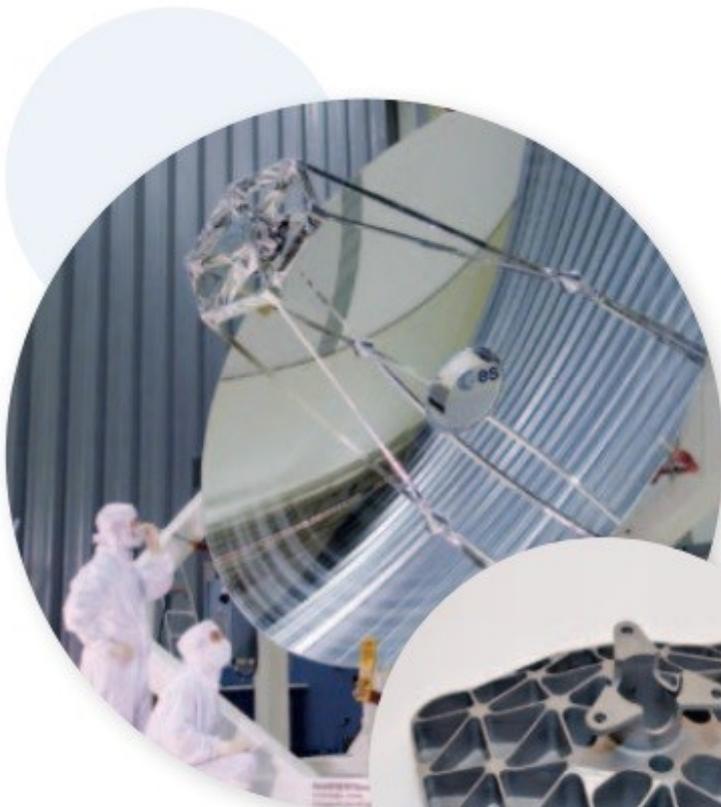


Sintered Silicon Carbide for space telescope mirrors and structures

Ref-Nr:



*Herschel Telescope
(image courtesy
of ESA / Astrium)*



*Light-weight mirror with central fixation
(image courtesy of Astrium)*

Technology abstract

Boostec Mersen has developed an expertise in innovative polycrystalline technical ceramic of alpha SiC type, such as continuous-flow reactors and heat exchangers, mechanical seals and bearings or components.

- Private group -

- Benoit Rivollet -

[Read more about this broker](#)

Technology Description

Boostec has developed an innovative polycrystalline technical ceramic of alpha SiC type, obtained by pressureless sintering. This process yields a pure silicon carbide with no traces of free silicon. Its low residual porosity is fine and completely closed, i.e. the material is perfectly water tight. The very strong covalent Si-C bond gives this innovative material exceptional physical properties that are particularly stable over time: high stiffness and hardness, low thermal expansion, high chemical and thermal stability... Its fine, homogeneous micro-structure is isotropic and virtually free of secondary phases, leading to perfectly isotropic, homogeneous and reproducible physical properties. In particular, no dispersion or anisotropy of its coefficient of thermal expansion is detectable with an extreme precision of $0.001 \cdot 10^{-6} \text{ K}^{-1}$. Unlike glasses, glass-ceramics and oxide ceramics, Boostec® SiC does not present a phenomenon of sub-critical cracking. Unlike toughened ceramics (silicon nitride, stabilised zirconia), it shows no sensitivity to mechanical fatigue. The mechanical properties (bending strength, modulus of elasticity,

toughness) of this advanced ceramic material hardly change with temperature, from cryogenic environments close to absolute zero up to 1450 °C. Finally, it is a non-magnetic, semi-conductor material.

This innovative material has interesting non space application such as continuous-flow reactors and heat exchangers for chemical and pharma-chemical equipments, mechanical seals and bearings or components for the semiconductor industry. Boostec is a recognised supplier for the space industry since it's the only company in the world capable of producing SiC parts of 3 meters in diameter and has recently been selected by the CNES to manufacture the optics and the structure of components on the next MicroCarb satellite. There are currently 15 "all Boostec® SiC" instruments operated in space by Boostec, including Herschel, the largest space telescope.

Innovations & Advantages

Of the industrial materials that might be considered, Boostec® SiC achieves the best compromise between the key parameters that are common to all these applications :

- Specific stiffness: Young's modulus / density
- Thermal Stability: thermal conductivity / Coefficient of thermal expansion
- Monophase material, highly homogeneous
- Micro-structure and thus physical properties perfectly isotropic,
- in particular the thermal expansion
- Perfect reproducibility of the thermal expansion from one item to
- another, from one batch to another
- High mechanical strength and absence of mechanical fatigue
- Total absence of outgassing and moisture absorption
- Perfect stability over time
- Insensitivity to radiation in the space environment
- Physical properties retained or even improved at cryogenic
- temperatures; qualification for space applications down to 30 K

- The optical face of the mirrors can be CVD coated with SiC to mask the fine residual porosities of the sintered SiC

Further Information

Density : 3.15 g/cm³

Young's Modulus : 420 GPa

Bending strength / Weibull modulus (coaxial double ring DIN EN 1288-1 & 5): 400MPa/11

Poisson coefficient : 0.16

Toughness (K_{1c}) : 3 MN.m^{-3/2}

Coefficient of thermal expansion : 2.2 . 10⁻⁶ K⁻¹

Thermal conductivity : 180 W.m⁻¹. K⁻¹

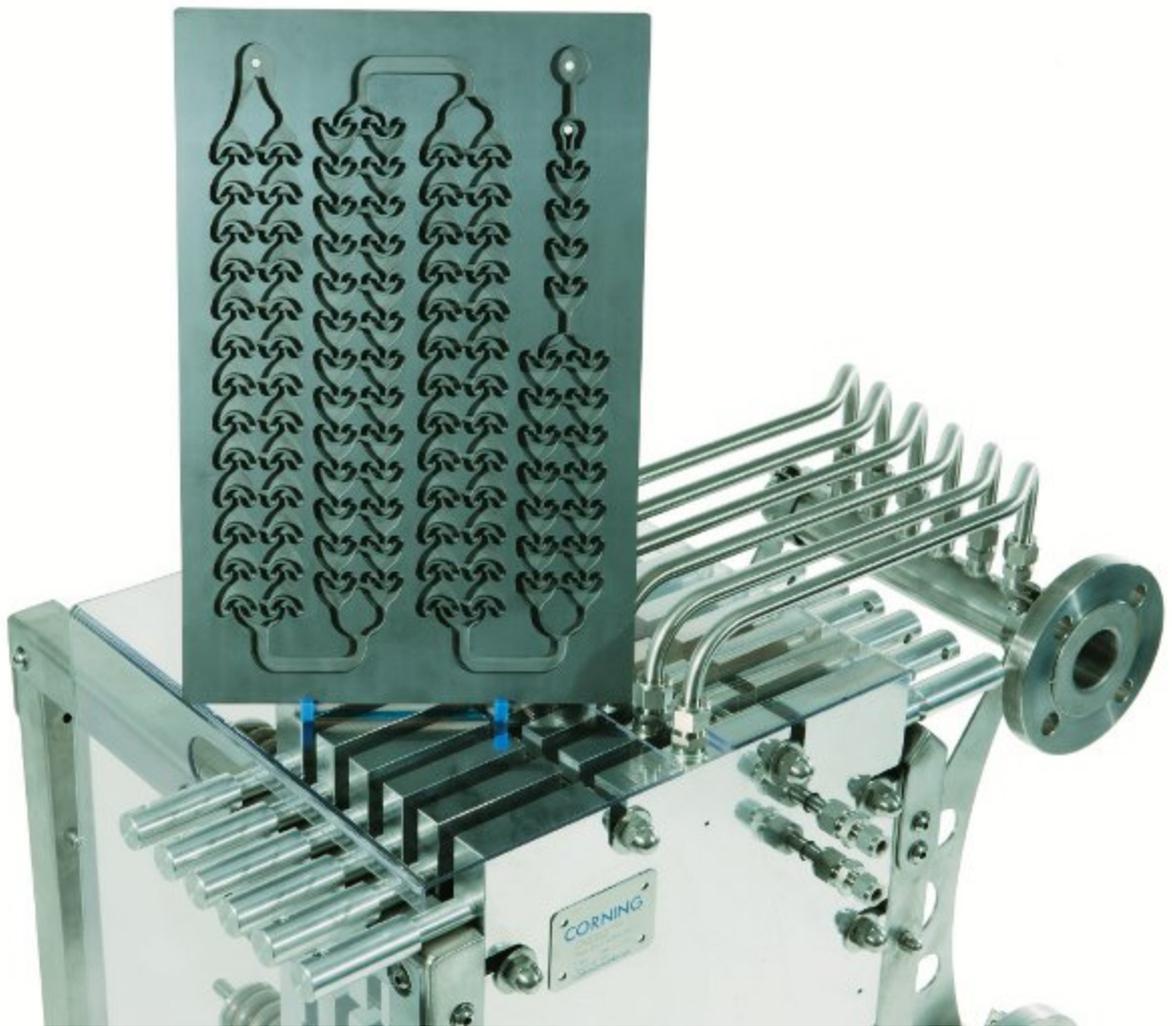
Electrical resistivity : 10⁵ ohm.m

Current and Potential Domains of Application

- **The semi-conductor industry** processes larger and larger silicon wafers that



SiC agile scan mirror



SiC continuous-flow reactor



SiC polybloc heat exchanger
