



## BOOSTEC® SiC SILICON CARBIDE MATERIAL

SOLUTIONS FOR SPACE, ASTRONOMY,  
LASERS PROCESSES, SEMICONDUCTOR &  
OPTO-MECHANICS OEMS AND CHEMICAL  
INDUSTRIES



**Boostec® SiC**



# + BOOSTEC® SiC

## An outstanding material

Boostec®SiC is a polycrystalline technical ceramic of  $\alpha$  SiC type, obtained by pressureless sintering. This process leads to a silicon carbide that is completely free of non-combined silicon.

### Did you know?

- The very strong covalent Si-C bond gives Boostec® SiC exceptional physical properties that are particularly reproducible and stable over time,
- 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), Boostec®SiC shows no sensitivity to mechanical fatigue.
- Boostec®SiC mechanical properties (bending strength, modulus of elasticity, toughness) hardly change with temperature, from cryogenic environments close to absolute zero up to 1450 °C.
- Boostec® SiC is a non-magnetic material.
- Boostec® SiC is an excellent radio-frequency (RF) absorber.



### Extended design know-how and capabilities

Mersen Boostec offers assistance to its customers for the design of their SiC parts to ensure better feasibility, mitigate risks and also reduce costs and lead times



### BOOSTEC MANUFACTURING EXPERTISE

From the manufacturing of monolithic ceramics to the production of complex solutions, Mersen Boostec has developed over the years a unique expertise.

	CAPACITY
MONOLITHIC CERAMICS	Ø 1.30m x 0.60m 1.65m x 1.30m x 0.60m
CVD SiC COATING	up to Ø 1.50 m
BRAZED SiC/SiC	up to Ø 3.50 m
OPTICAL POLISHING	

	AVAILABLE ASSEMBLIES
OTHER SiC/SiC OR SiC/METAL SOLUTIONS	Epoxy gluing Bolting Shrink fitting



# 01

## SPACE & ASTRONOMY

Mersen Boostec provides SiC mirrors, SiC stable structures and also SiC focal plane hardware for telescopes to be used in space or on ground.

Application requests

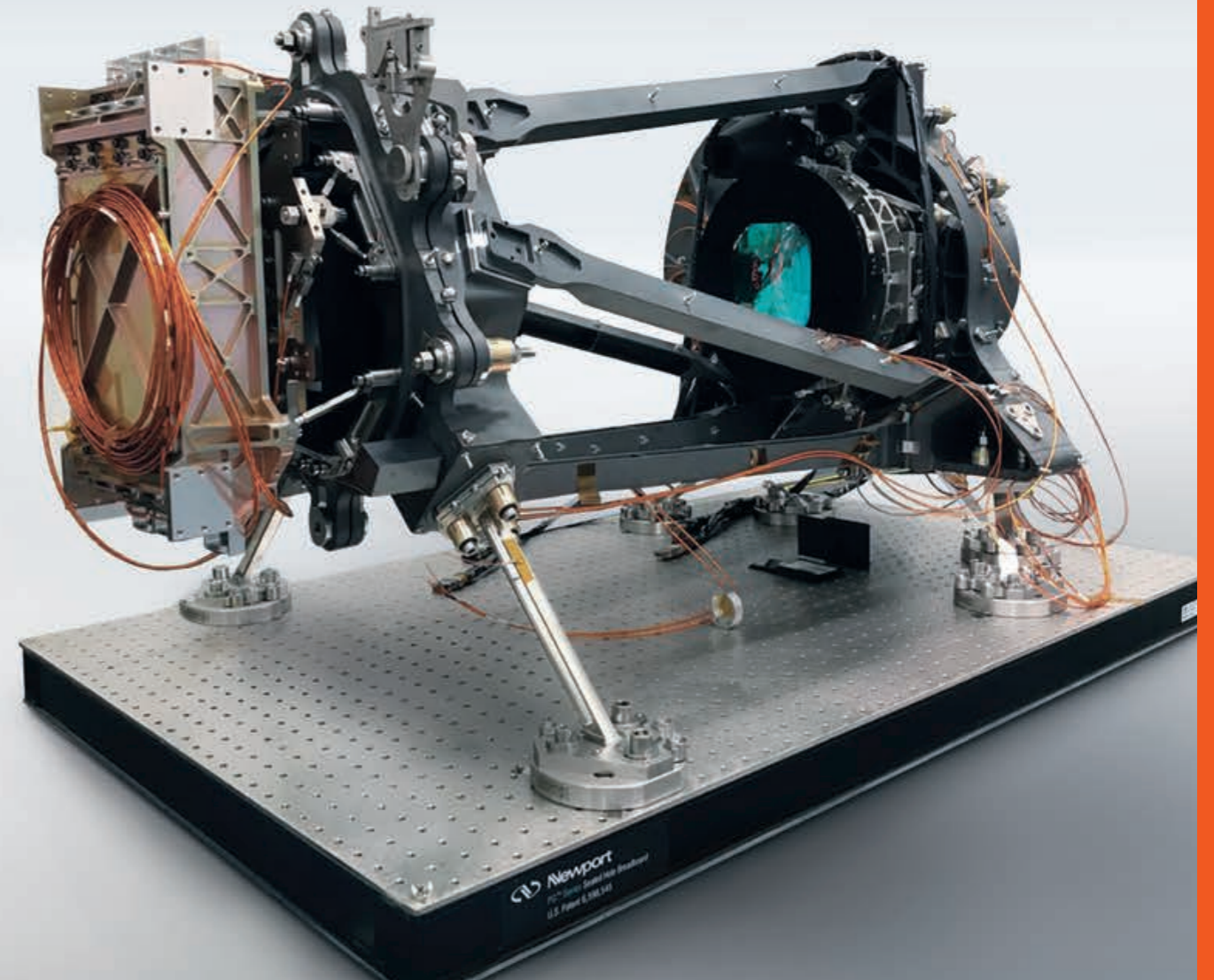
mechanical and thermal ultra-stable optics



### BOOSTEC® SiC SOLUTION

- High specific stiffness
- High thermal stability
- Qualification for space applications down to 30 K

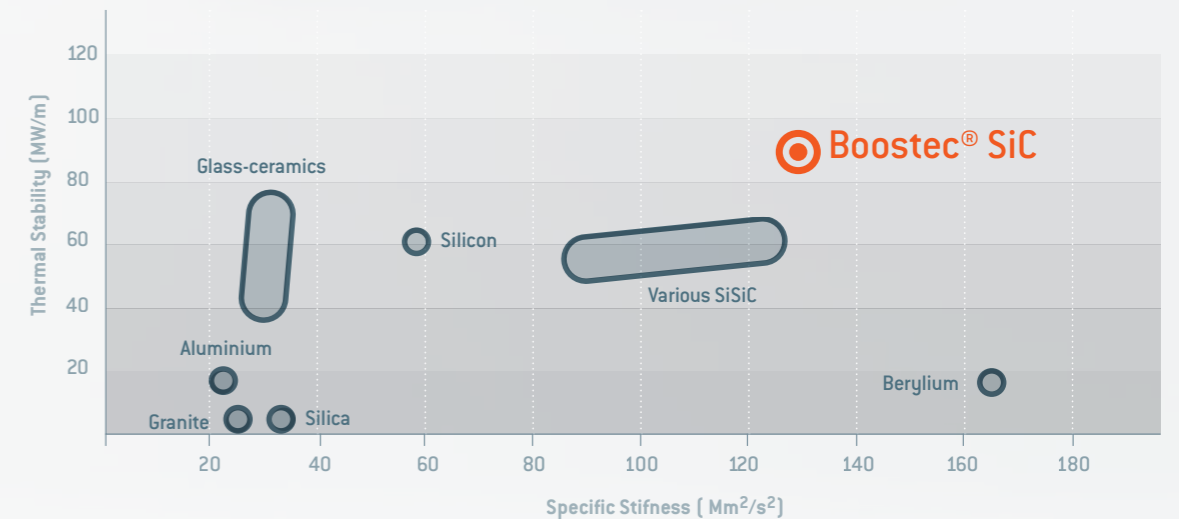
WITH ITS AIRBUS DEFENCE AND SPACE PARTNERSHIP, MERSEN BOOSTEC IS THE WORLD LEADER FOR SiC SPACE OPTICS.



EUCLID NISP INSTRUMENT - IMAGE COURTESY OF LAM

### AMONG OUR SUCCESSES

- HERSCHEL, GAIA AND EUCLID MISSIONS ON UNIVERSE SCIENCES
- SENTINEL-2 AND AEOLUS ESA MISSIONS FOR EARTH OBSERVATIONS
- NIRSPEC LARGE SPECTROGRAPH FOR NASA JAMES WEBB SPACE OBSERVATORY
- A WIDE RANGE OF KORSCH TELESCOPES FOR EARTH OBSERVATION AT EXPORT
- ESO EXTREMELY LARGE TELESCOPE: THE REFERENCE STRUCTURE OF ITS M4 ADAPTIVE OPTIC AND ALSO ITS FAST TIP/TILT M5 FOLDING MIRROR





# 02

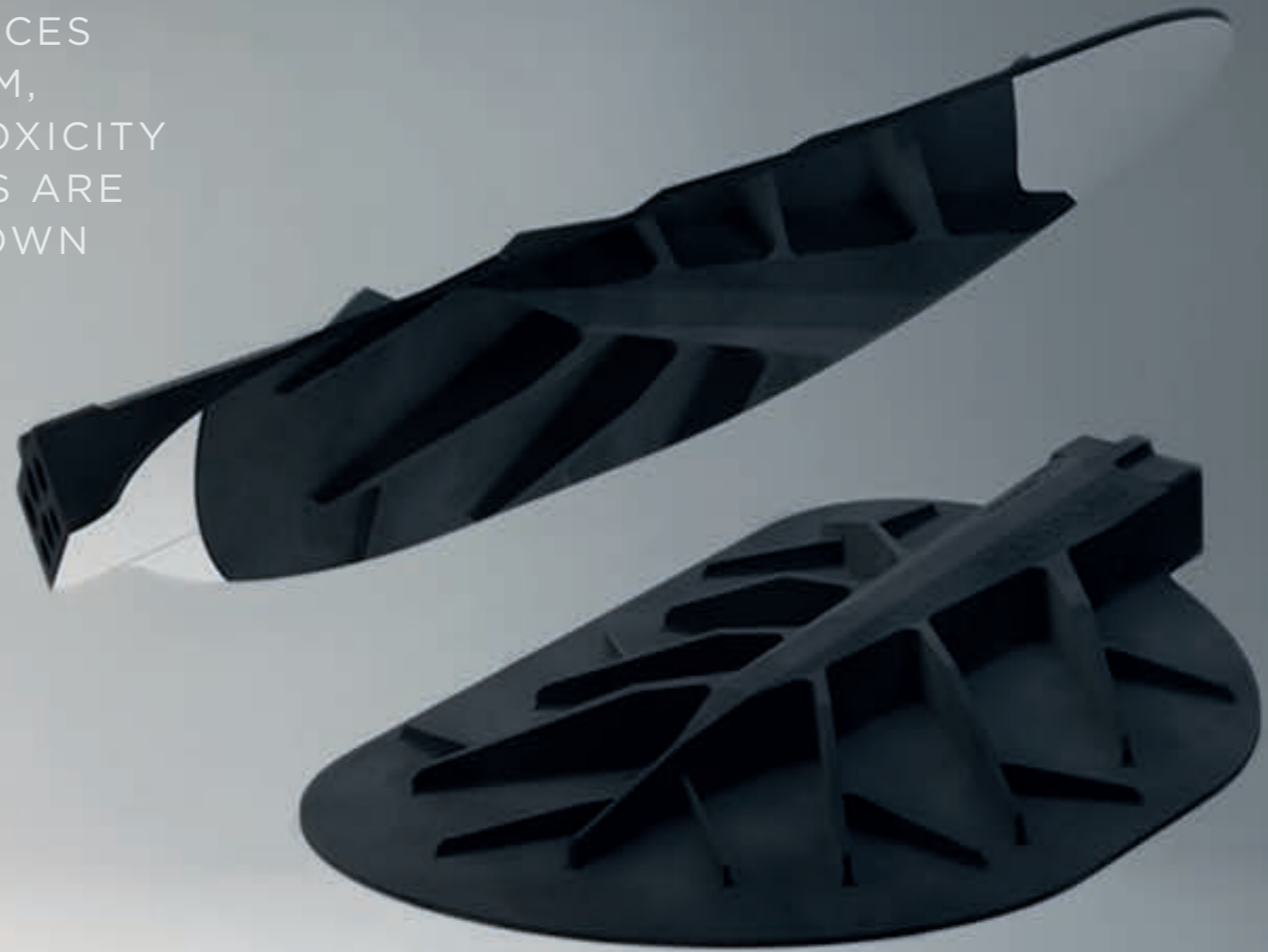
## LASER PROCESSES

### LASER GALVO SCANNING MIRRORS

Mersen Boostec provides standard and custom active mirrors from 10 to 500 mm apertures, with a range of high reflective coatings. In particular, standard generic XY laser galvo-scanning mirrors from 10 to 100 mm aperture are provided in pairs. Glued mounts are also proposed for all standard shaft sizes. These products are distributed under the trademark optoSiC®.



SiC REPLACES BERYLLIUM, WHOSE TOXICITY PROBLEMS ARE WELL KNOWN



### KEY ADVANTAGE OF OPTOSIC® OPTICS

- Low moment of inertia
- Low dynamic flatness Peak-to-Valley (PV)
- High resonance frequency
- Fast thermal stabilization
- Lightweight
- Integrated mechanical fasteners
- Standard and custom designs
- Corrosion and wear resistant
- Optically finished to state of the art surface specifications
- Outstanding optical surface quality
- Customized coating service

### MARKET SEGMENTS FOR OPTOSIC® HIGH-END SCANNING MIRRORS

#### LASER FOR MATERIAL PROCESSING

- Welding
- Cutting, Drilling
- Marking, Microlithography
- Additive manufacturing

#### LASER FOR INSTRUMENTATION

- Tracker systems
- Scanner systems, Lidars
- Military application
- Biomedical (ophthalmology)
- Imaging, Laser show



# 03

## SEMICONDUCTOR AND OPTO-MECHANICS OEMs

Mersen Boostec provides the silicon carbide ultra-stable structures that are now required by the semiconductor and optomechanical equipment.

Application requests:

**HIGH SPECIFIC STIFFNESS**  
(YOUNG'S MODULUS / DENSITY)

**HIGH THERMAL STABILITY**  
(THERMAL CONDUCTIVITY / COEFFICIENT OF THERMAL EXPANSION)



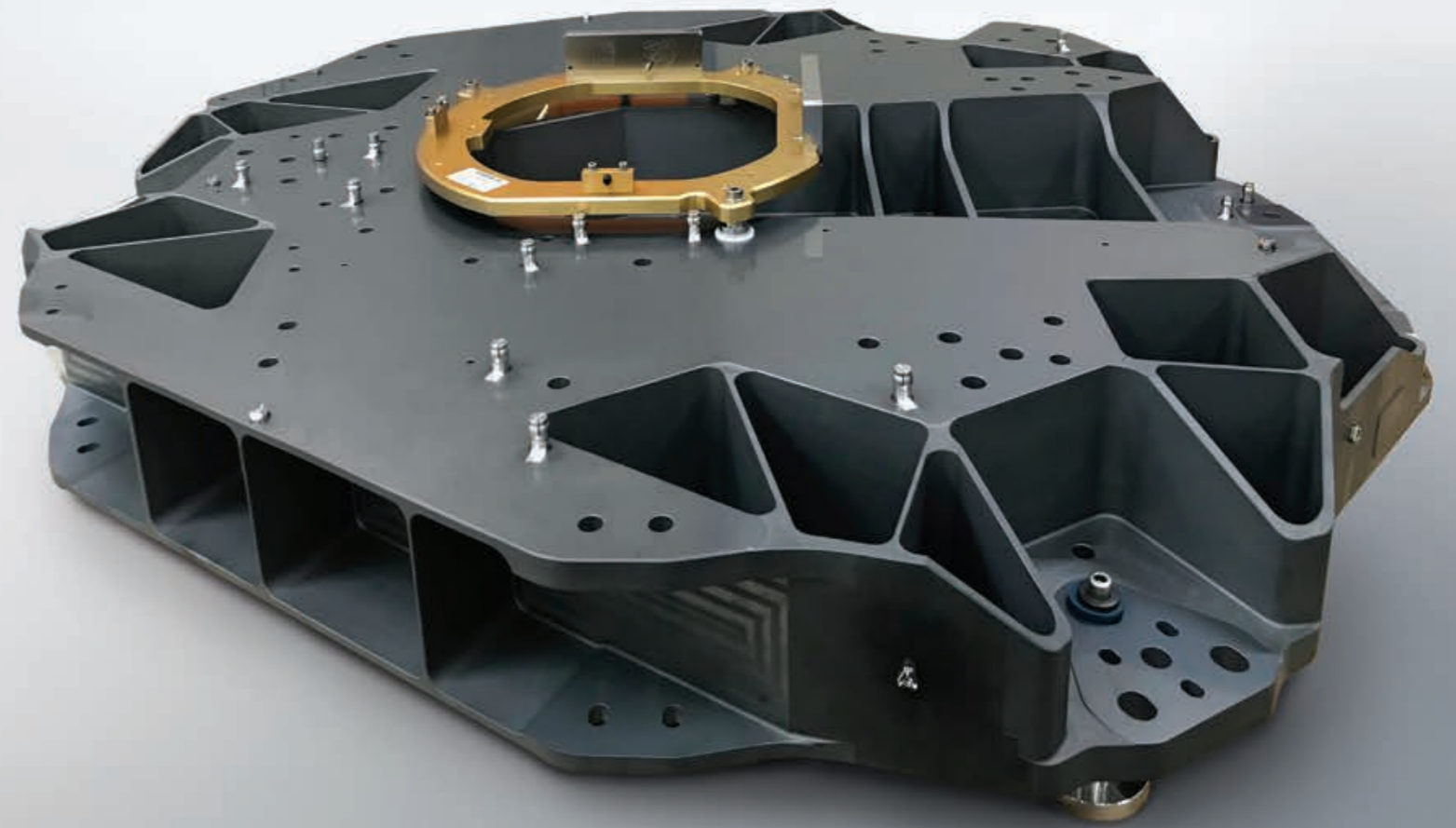
### BOOSTEC® SiC SOLUTION

- High mechanical strength and absence of mechanical fatigue
- Perfect isotropy of the SiC material
- Flawless polishable finish which can be used as optical reference
- Perfect stability over time
- Water and gas tight, no outgassing, no moisture absorption
- Wear resistance
- Excellent chemical inertia



### BOOSTEC EXPERTISE IN MANUFACTURING & DESIGN

- Unique experience in manufacturing 3-meter class ultra-stable structures.
- Possibility of integrated solution on a single part: air bearing system, cooling with internal channels, mirror.
- From monolithic SiC parts to possibly complex assemblies, Mersen Boostec manufactures highly stable benches, baseplates, beams, sliding structures for fast and accurate positioning, chucks.



### BOOSTEC® SiC SOLUTIONS ARE USED WHERE ULTRA-PRECISION IS REQUIRED, IN:

- Semiconductor industry processes
- EUV lithography machines
- Advanced measuring instruments for optical surfaces
- Ultra-high vacuum
- Scientific equipment

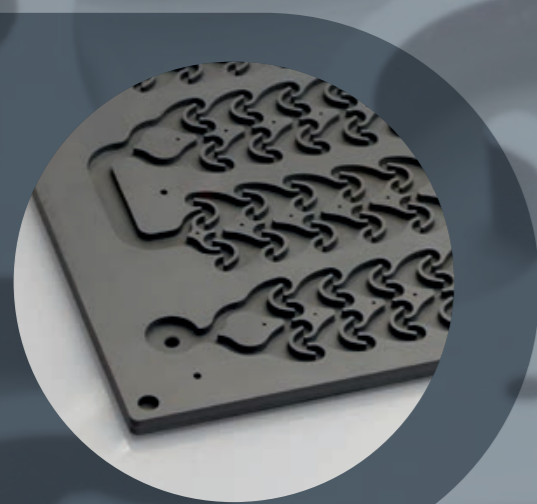


# 04

## CONTINUOUS FLOW REACTORS FOR THE CHEMICAL INDUSTRY

SiC modules for continuous flow reactor is a technological breakthrough in the chemical industry

Mersen Boostec develops and manufactures high-technology chemical reactors for continuous flow systems in cooperation with Corning SAS.

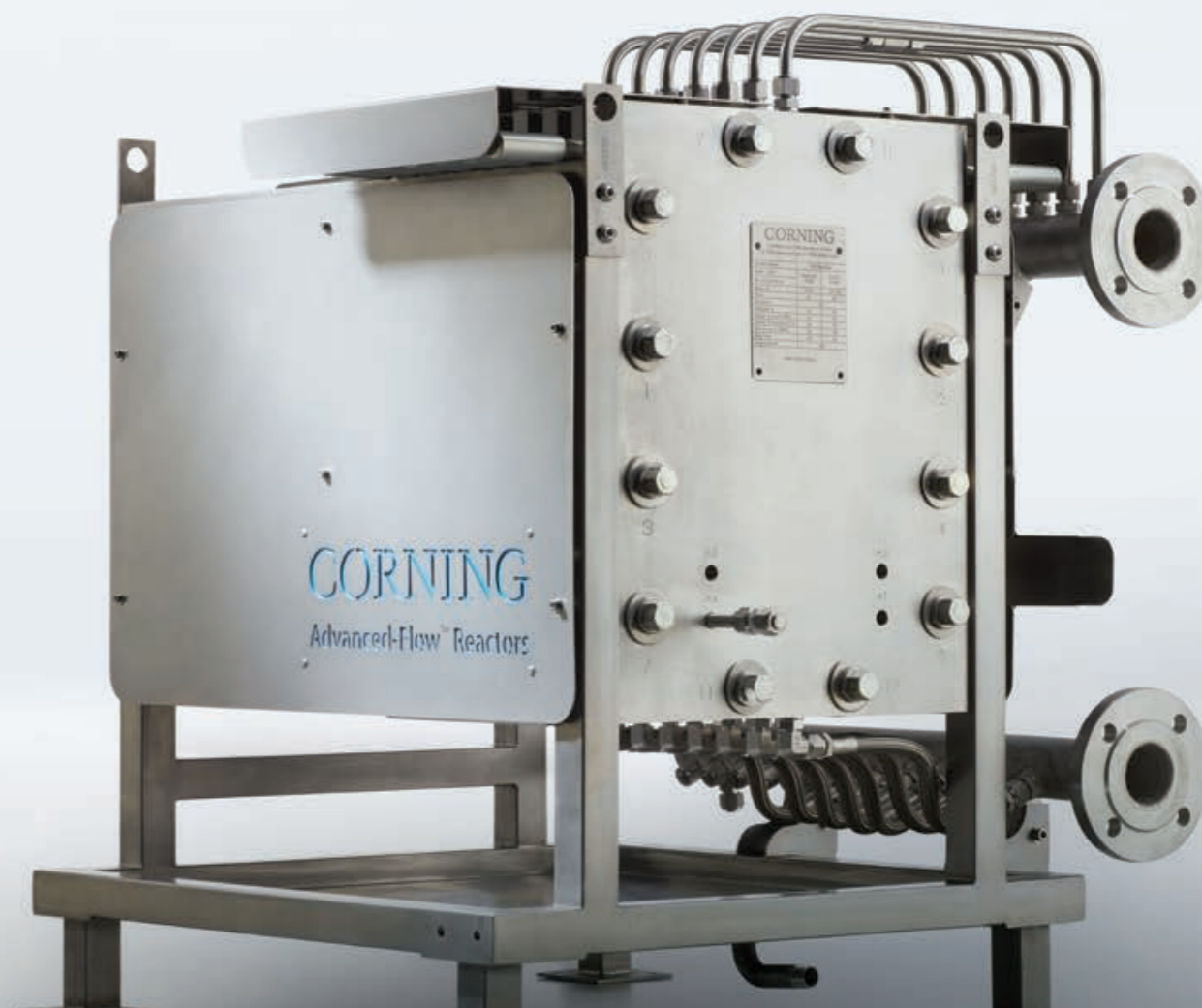


### KEY BENEFITS

- Production steps reduced for higher productivity and increased safety
- Improved chemical reactions
- Smaller footprint than traditional reactors
- Cost competitive solution

### TECHNICAL SPECIFICATIONS

- FLOW RATE 2 TO 8000 ml/min
- TEMPERATURE -60°C TO 200°C
- PRESSURE UP TO 18 BAR
- OPTIONS: ATEX CERTIFICATIONS, FDA, CGMP COMPLIANCE



Corning's global team helps customer design systems for a vast array of utilizations including lab applications, pilot processing and industrial production development for current processes and new chemical routes.

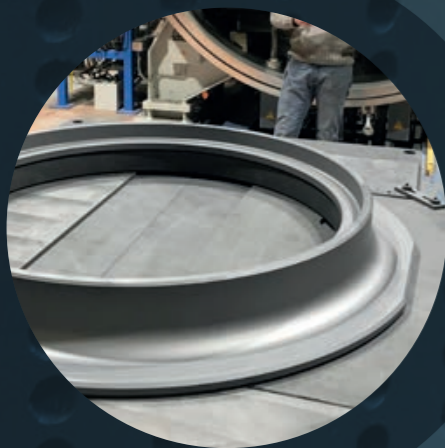


# 05

## HEAT EXCHANGERS FOR THE CHEMICAL INDUSTRY

SiC heat exchangers lead to optimized performance and are the first choice for applications in the pharmaceutical and fine chemicals industry.

It is a key solution for processes with high corrosion and for processes with high service rates (less maintenance). SiC heat exchangers are assembled as a stack of single elements which are then inserted into a metallic shell. Seals are placed between the individual blocks.



### KEY BENEFITS

- No particle emission, no contamination for high purity applications
- Most compact heat exchanger
- Solution suitable for extreme environment
- Easy maintenance



### OTHER EQUIPMENT

- SPECIFIC INJECTION TUBES AND NOZZLES FOR HIGH TEMPERATURE AND HIGH ABRASIVE MEDIA AND PROCESSES
- QUENCH RINGS FOR HIGH TEMPERATURE REACTORS
- SPECIFIC PROTECTION TILES, RINGS AND PARTS

### KEY MARKETS FOR BOOSTEC® SiC HEAT EXCHANGERS :

- Hydrofluoric acid, bromine
- Fine chemicals, specialty chemicals, condensers for API
- Enhanced processes
- Abrasive products inside a corrosive stream
- Extreme environment (Temperature, Pressure)
- Flash or forced evaporators, thermosyphons
- Heat recovery units



# + PROPERTIES BOOSTEC® SILICON CARBIDE

	Temperature	Typical value	Unit	
Theoretical density	20°C	3.21	10 <sup>3</sup> kg/m <sup>3</sup>	
Bulk density	20°C	3.15	10 <sup>3</sup> kg/m <sup>3</sup>	
Total porosity (fully closed)	20°C	1.5	%	
Coefficient of Thermal Expansion	-200°C	0.08	10 <sup>-6</sup> /°C	
	20°C	2.2	10 <sup>-6</sup> /°C	
	500°C	4.8	10 <sup>-6</sup> /°C	
	1000°C	6.0	10 <sup>-6</sup> /°C	
Thermal conductivity	-200°C	163	W/m.K	
	20°C	180	W/m.K	
	500°C	66	W/m.K	
	1000°C	39	W/m.K	
Specific heat	-200°C	42	J/kg.K	
	20°C	680	J/kg.K	
	500°C	1040	J/kg.K	
	1000°C	1180	J/kg.K	
Maximum thermal shock (ΔTc)		325	°C	
Maximum temperature of use	In air	1450	°C	
	in inert atmosphere	1800	°C	
Vickers hardness (500g load)	20°C	22	GPa	
Bending strength (DIN EN 2188-1&5)	Mechanical strength	20°C	400	MPa
	Weibull modulus	20°C	11	MPa
Tensile strength	20°C	210	MPa	
Compressive strength	20°C	3000	MPa	
K <sub>1C</sub> toughness (SENB method)	20°C	4	MN.m <sup>-3/2</sup>	
Young's modulus	-200°C to 1 000°C	420	GPa	
Shear modulus	-200°C to 1 000°C	180	GPa	
Poisson's ratio	-200°C to 1 000°C	0.16		
Electrical resistivity	- 0,01 V/mm	20°C / 200°C	10 <sup>5</sup> / 10 <sup>3</sup>	Ω.m
	- 100 V/mm	20°C	10 <sup>3</sup>	Ω.m
Emissivity	-200°C to 300°C	0.7		
Outgassing (ESA EC SS-Q-70-02A)	TML (Total Mass Load)	20°C / 200°C	0.01	%
	CVCM (Collected Volatile Condensable Materials)		0.0	%

# + TYPICAL CHEMICAL COMPOSITION

SiC	B	free C	SiO <sub>2</sub>	free Si	Fe	Al	Ca	K	Mg	Na
>98,5%	<0,5%	<0,2%	<500 ppm	<500 ppm	<500 ppm	<400 ppm	<30 ppm	<1 ppm	<1 ppm	<1 ppm

# Boostec® SiC manufacturing process







GLOBAL EXPERT IN ELECTRICAL  
POWER AND ADVANCED MATERIALS

**AMERICAS**

**MERSEN USA**  
Bay City, MI  
Greenville, MI  
St Marys, PA  
Columbia, TN

**MERSEN MEXICO**  
Monterrey

**MERSEN ARGENTINA**  
Buenos Aires

**MERSEN CHILE**  
Santiago

**MERSEN COLOMBIA**  
Bogota

**MERSEN BRAZIL**  
Sao Paulo

**EUROPE & AFRICA**

**MERSEN BENELUX**  
Schiedam

**MERSEN GERMANY**  
Suhl & Munich

**MERSEN FRANCE**  
Gennevilliers & Bazet  
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Barcelona

**MERSEN TURKEY**  
Gebze

**MERSEN ITALY**  
Milan & Malonno

**MERSEN NORDIC**  
Kista

**MERSEN UK**  
Teesside & Holytown

**MERSEN SOUTH AFRICA**

**ASIA & OCEANIA**

**MERSEN CHINA**  
Chongqing, Kunshan  
& Yantai

**MERSEN INDIA**  
Pune & Bangalore

**MERSEN JAPAN**  
Tokyo

**MERSEN SOUTH KOREA**  
Seoul

**MERSEN OCEANIA**  
Fairfield Victoria

**MERSEN TAIWAN**  
Taipei