

SAINT-GOBAIN PERFORMANCE CERAMICS & REFRACTORIES

CERAMIC TUBES AND CRUSHABLE INSULATORS

FOR THERMOCOUPLES &
GAS SENSORS




SAINT-GOBAIN

SAINT-GOBAIN 2023

Derwent
Top 100
Global Innovator
2023

Clarivate
Analytics

top
EMPLOYER GLOBAL
2024



1 IN 4

PRODUCTS
did not exist 5 years ago



160,000

EMPLOYEES



47.9 BILLION

SALES IN 2023



REPRESENTED IN 76

COUNTRIES



-34%

CARBON EMISSIONS
REDUCTION
(vs. 2017 on scope 1+2)



MAIN R&D CENTRES

OUR PURPOSE

MAKING THE WORLD A BETTER HOME.

OUR MISSION

Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the well-being of each of us and the future of all.

WE ARE COMMITTED TO
ACHIEVING NET ZERO
CARBON EMISSIONS BY 2050

SAINT-GOBAIN

PERFORMANCE CERAMICS & REFRACTORIES

OUR MISSION

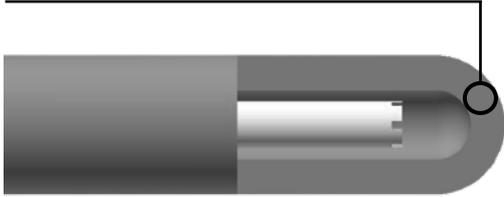
To design, develop and supply solutions and services for extreme operating industrial conditions. Our engineered ceramics and refractory products are manufactured to the highest industrial standards and deliver enhanced performance while minimizing environmental impact.

PIONEERING CERAMIC SOLUTIONS FOR EXTREME INDUSTRIAL APPLICATIONS AND A GREENER WORLD.

CERAMIC TUBES & CRUSHABLE INSULATOR PRODUCTS

For over 30 years, Saint Gobain Performance Ceramics & Refractories Business has been recognized as a leading supplier of products used for thermocouple protection, insulation and gas sensing probes.

CERAMIC TUBE



CRUSHABLE INSULATOR



Each type of product is available in a broad range of ceramic materials, formed into shapes using extrusion and / or slip casting methods, in a wide range of sizes.

KEY MARKETS & APPLICATIONS



ENERGY

Petro-chemical Incinerators,
Nuclear Reactors



BASIC MATERIALS

Steel, Glass, Cement



AEROSPACE & DEFENSE

Engines



CHEMICALS

Acids, Bases



NON-FERROUS

Primary & Secondary Aluminum,
Anode Baking Pits, Copper, Zinc

OUR MATERIALS DELIVER VALUE

With over 125 years of experience with silicon carbide, today we leverage production capability in North America, Europe and Asia to support customers globally.

MATERIAL CAPABILITY INCLUDES:

- Sintered Silicon Carbide (SSiC)
- Nitride Bonded Silicon Carbide (NBSiC)
- Siliconized Silicon Carbide (SiSiC)
- Recrystallized Silicon Carbide (ReSiC)
- Mullite
- Fused Alumina and Magnesia (crushable insulators)

THERMOCOUPLE PROTECTION

MATERIAL SELECTION GUIDE

Material	Brand	Benefits / Value Proposition	Application Recommendation
Sintered Silicon Carbide	HEXOLOY® SE	Excellent sag resistance Fast response time Chemically inert	Harsh conditions Petrochemical incinerators Basic materials Chemicals Furnaces
Nitride Bonded Silicon Carbide	CRYSTON® 789A N-DURANCE® REFRAX® 20E	Economical choice Large diameters High thermal shock resistance	Non-ferrous metals Heat treatment furnaces
Siliconized Silicon Carbide	SILIT® SK	Fully dense & gas tight High strength up to 1,350°C	Gas analyzer probes Furnaces Kilns
Recrystallized Silicon Carbide	CRYSTAR® 2000	Resistant to flames Superior thermal shock resistance	Furnaces Kilns

MATERIAL PROPERTIES COMPARISON

Material	Sintered SiC	Nitride Bonded SiC			Siliconized SiC	Recrystallized SiC
	HEXOLOY® SE	REFRAX® 20E	N-DURANCE®	CRYSTON® 789A	SILIT® SK	CRYSTAR® 2000
SiC, %	99	73	73	74	81	99
Maximum Use Temperature, °C in air	1,650	1,450	1,450	1,590	1,350	1,650
Density, g/cc	3.05	2.20	2.62	2.62	3.00	2.70
Apparent Porosity, %	6	28	16	16	0	15
Modulus of Elasticity, GPa	420	-	240	-	300	240
Flexural Strength, MPa						
RT °C	280	25	60	60	260	80
1,450°C	270	-	-	-	-	-
1,600°C	300	-	-	-	-	-
Thermal Conductivity, 1,000°C, W/mK	60	19	20	16	40	25
CTE, /°C	4.0x10 ⁻⁶	4.5x10 ⁻⁶	5.1x10 ⁻⁶	5.1x10 ⁻⁶	4.5x10 ⁻⁶	4.8x10 ⁻⁶

CLOSED ONE END TUBES

HEXOLOY® SE Sintered SiC thermocouple protection tubes are extruded and closed on one end. The closed end is typically round, however, for some diameters (ex. 1.5") the tip is pointed. HEXOLOY® SE tubes have thin walls and high thermal conductivity, enabling fast thermal response to the sensor.

SINTERED SiC

FEATURES: HEXOLOY® SE



Thin wall



High service temperature
(up to 1,650°C in oxidizing atmosphere)



Excellent corrosion & abrasion resistance



Open end of tube can be modified to include cemented collars and surface texture enhancement



STANDARD DIMENSIONS OF HEXOLOY® SE TUBES*

Longer custom lengths and large diameters are available upon request.

Custom Length-L (± 1/8")	OD	ID	Tolerance
6" - 27"	3/8"	1/4"	± 0.015
	5/8"	3/8"	± 0.025
	3/4"	1/2"	± 0.025
	1"	1/2"	± 0.03
	1-1/4"	3/4"	± 0.04
	1-1/4"	0.922"	± 0.04
	1-1/2"	1"	± 0.04
> 27" - 54"	3/8"	1/4"	± 0.015
	5/8"	3/8"	± 0.025
	3/4"	1/2"	± 0.025
	1"	1/2"	± 0.03
	1-1/4"	3/4"	± 0.04
	1-1/4"	0.922"	± 0.04
	1-1/2"	1"	± 0.04
Not recommended	Molten ferrous & nickel based metals		

* Technical data, right of modification reserved.

THERMOCOUPLE PROTECTION

FLAT & ROUND
DESIGNS
AVAILABLE



CLOSED ONE END TUBES

Nitride Bonded SiC tubes are an economic choice to thermocouple sensor OEMs. These tubes can be produced to a large range of diameters with several options for mounting. NBSiC does not contaminate non-ferrous melts, like cast iron tubes. It is also used for temperature measurement of heat treating furnaces.

NITRIDE BONDED SiC (NBSiC)

FEATURES: NBSiC

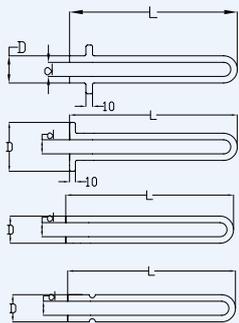


High thermal shock resistance

Max. service temperature up to 1,450°C*

Economic choice among different types of SiC

*Refrax® 20E: Atmosphere dependent



Type A has projections part way down from the open end

Type B has a flange

Type C is without a flange

Type D has a groove



Open end of the tubes can be fitted with metal sleeve, flange, groove or a collar.

STANDARD DIMENSIONS OF NBSiC TUBES*

	OD	ID	Length
N-DURANCE®	20 - 50 mm	8 - 26 mm	Up to 1500 mm
REFRAX® 20E	20 - 100 mm	WALL 4 - 10 mm**	Up to 1600 mm
CRYSTON® 789A	25 - 40 mm	12 - 27 mm	Up to 1500 mm

* Technical data, right of modification reserved. ** Dependent on length.



CRYSTON® 789A



N-DURANCE®



REFRAX® 20E

CLOSED ONE END TUBES

Silit® SK, Siliconized SiC, can be used as thermocouple protection tubes, closed on one end. A wide range of diameters (20 mm – 80 mm) can be produced with lengths up to 2000 mm. Tubes with flanges and / or holes are available.



SILICONIZED SIC (SISIC)

FEATURES: SILIT® SK



High oxidation resistance

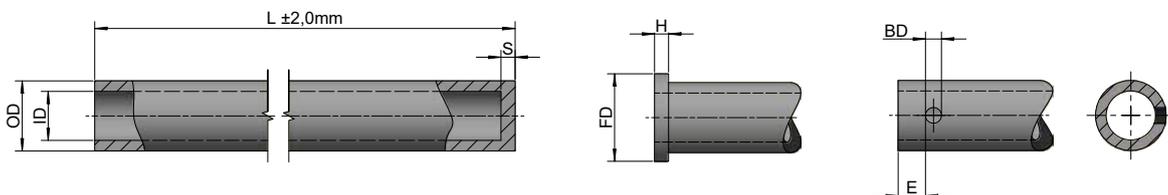
High strength & stability of shape stability

Fully dense & gas tight

STANDARD DIMENSIONS OF SILIT® SK TUBES*

Tube diameter		Flange diameter DF +/- 2.0 mm	Tolerance X mm	Standard length L ± 2 mm
OD ± Tolerance X mm	ID mm			
20	11	40	± 0.35	200 - 2000
25	15	45	± 0.40	250 - 1500
30	19	55	± 0.45	300 - 1750
34	22	55	± 0.50	400 - 1750
38	26	60	± 0.55	400 - 2000
40	28	60	± 0.55	500 - 2000
51	36	80	± 0.70	500 - 2000
55	42	80	± 0.90	500 - 2000

* Technical data, right of modification reserved.



GAS SENSOR SOLUTION

OPEN BOTH ENDS TUBES

Gas sensors analyze combustion by-products and flue gases such as Oxygen, CO, CO₂, CH₄, NO_x, SO_x, H₂S from a wide range of industries including:

 Oil & Gas

 Glass

 Steel

 Coal

 Cement

 Non-ferrous metals / alloys

 Chemicals

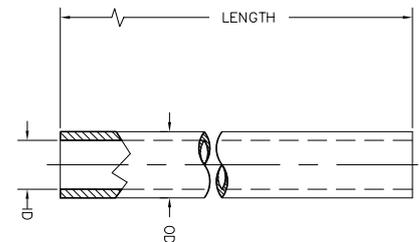
 Pulp & Paper

Due to the fact that combustion and flue gases involve high temperature, chemical attack and mechanical vibration, sensors need to be protected. We provide SiC tubes that possess all of the key thermal, chemical and mechanical properties that make them an excellent choice for protection of industrial gas sensors.

Our products for gas sensors include Hexoloy® SE Sintered SiC and Silit® SK Siliconized SiC. Both of these products are dense, gas tight, with high thermal conductivity and high mechanical strength at temperatures up to 1,650°C and 1,350°C respectively.

SIZE COMBINATIONS OF HEXOLOY® SE TUBES*

OD	ID	OD & ID Tolerance	Length (±1/8")
3/8"	1/4"	±.015"	standard up to 54" custom longer lengths available upon request
1/2"	0.380"	±.020"	
0.551"	0.433"	±.020"	
5/8"	3/8"	±.025"	
3/4"	1/2"	±.025"	
3/4"	0.570"	±.025"	
1"	1/2"	±.030"	
1-1/4"	3/4"	±.040"	
1-1/4"	0.922"	±.040"	
1-1/2"	1"	±.040"	



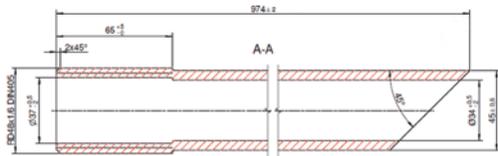
* Technical data, right of modification reserved.

SILIT® SK TUBES*

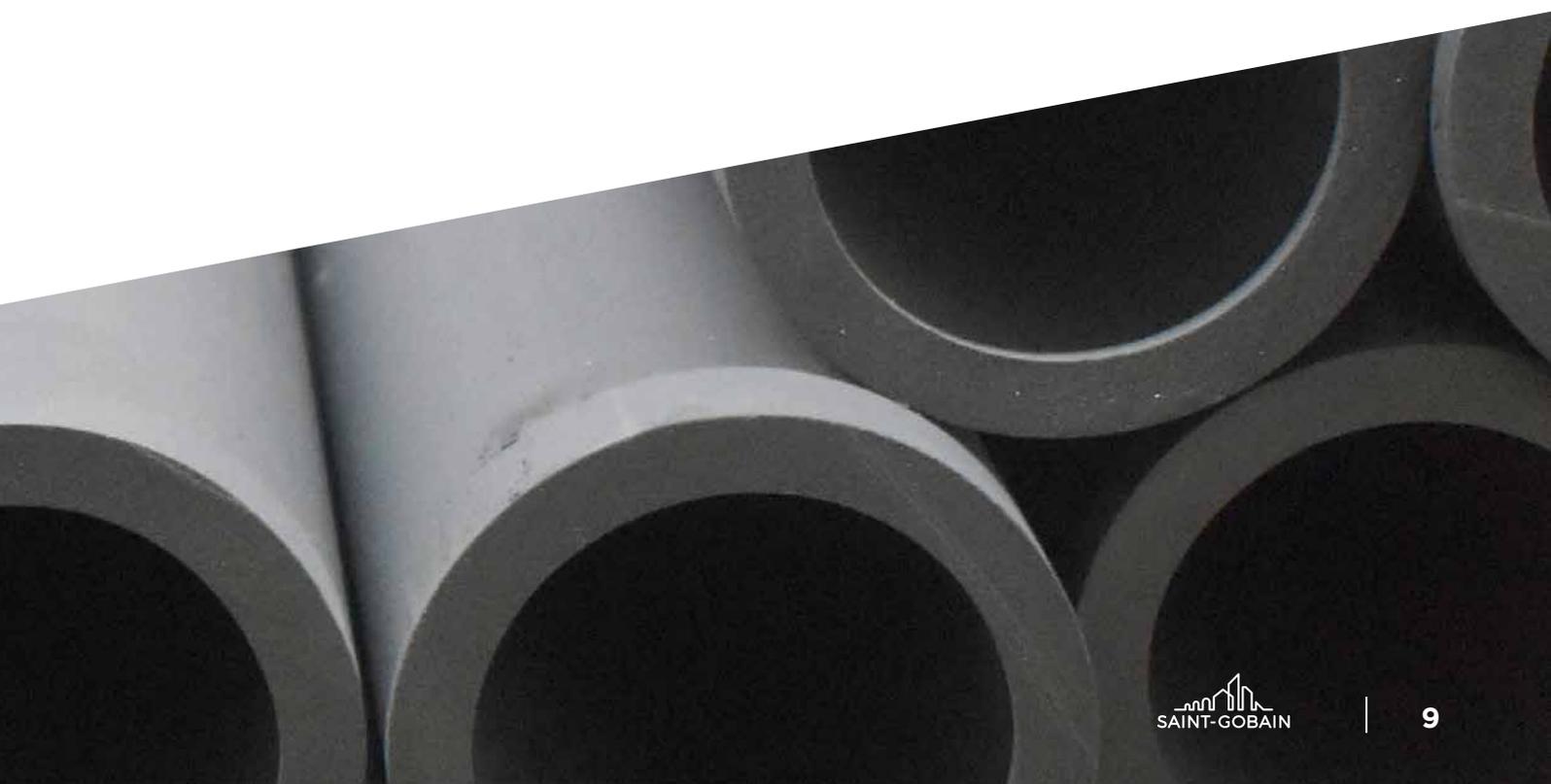
Tube diameter		Flange diameter DF +/- 2.0 mm	Tolerance X mm	Standard length L ± 2 mm
OD ± Tolerance X mm	ID mm			
20	11	40	± 0.35	200 - 2000
25	15	45	± 0.40	250 - 1500
30	19	55	± 0.45	300 - 1750
34	22	55	± 0.50	400 - 1750
38	26	60	± 0.55	400 - 2000
40	28	60	± 0.55	500 - 2000
51	36	80	± 0.70	500 - 2000
55	42	80	± 0.90	500 - 2000



* Technical data, right of modification reserved.



In addition, we offer Crystar® 2000 closed at one end tubes for use in front of the gas sampling probes, for dusty environments.



CRUSHABLE INSULATORS

MINERAL INSULATED METAL SHEATHED (MIMS) THERMOCOUPLE PROTECTION

Our high purity ALUNDUM® fused Al₂O₃ and MAGNORITE® fused MgO crushable insulators provide the electrical insulation resistance in swaged or drawn metal sheathed thermocouples.

The insulators can be “threaded” on thermocouple conductor wire and inserted inside seamless metal tubing. The entire assembly would be then swaged or drawn down to the desired dimensions. During swaging the insulators crush readily into a powder which is compacted around the thermocouple wires to provide electrical insulation resistance.



INSPECTION

- Mil. Std. 105E, 6.5 AQL, level II inspection
- 100 % inspected for contamination, cracks and warpage
- Inspection for twist, modulus or rupture (MOR), wall / web thickness, hole spacing and length



QUALITY CONTROL

Certifications are available on request for a nominal charge.



Round thermocouple in an engine Nuclear reactor



- A. Saint-Gobain insulators before swaging
- B. Insulator sheathed and partially swaged
- C. Finished thermocouple shaped for application

TYPICAL CHEMICAL ANALYSIS %

ALUNDUM® (fused Al ₂ O ₃) Crushable Insulators AN 900		
	Typical	Minimum or Maximum
Al ₂ O ₃	99.85%	99.65% Min
Fe ₂ O ₃	0.06%	0.10% Max
SiO ₂	0.02%	0.08% Max
CaO	0.02%	0.08% Max
MgO	0.02%	0.08% Max
ZrO ₂	0.0001%	0.08% Max
Na ₂ O	0.02%	0.06% Max
C	0.004 - 0.01%	0.01% Max
S	0.003%	0.005% Max
Cd	None Detected	0.001% Max
B	None Detected	0.001% Max

MAGNORITE® (fused MgO) Crushable Insulators MN 399A		
	Typical	Minimum or Maximum
MgO	99.48%	99.40% Max
SiO ₂	0.10%	0.13% Max
Al ₂ O ₃	0.08%	0.15% Max
CaO	0.24%	0.35% Max
Fe ₂ O ₃	0.10%	0.15% Max
C	0.01%	0.02% Max
B	0.001%	0.0025% Max
S	0.001%	0.005% Max
Cd	None Detected	0.001% Max

* Technical data, right of modification reserved.

WALL & WEB THICKNESS

Holes	Insulators OD		Hole Diameter ID		Bolt Circle Diameter	Wall / Web Thickness
	Minimum	Maximum	Minimum	Maximum		
1 	0.022" 0.5 mm	0.500" 12.7 mm	(0.07XOD) + 0.006" (0.07xOD) + 0.15 mm	0.5XOD 14.5 mm	NA	((OD/2) (BCD(2))-(ID/2))
2 	0.032" 0.8 mm	0.500" 12.7 mm	(0.07XOD) + 0.005" (0.07xOD) + 0.13 mm	0.28XOD 7.1 mm	(OD+ID)/3.00	((OD/2) (BCD(2))-(ID/2))
3 	0.061" 1.5 mm	0.500" 12.7 mm	(0.07XOD) + 0.003" (0.07xOD) + 0.08 mm	0.25XOD 6.4 mm	(OD+ID)/2.73	((OD/2) (BCD(2))-(ID/2))
4 	0.076" 1.9 mm	0.500" 12.7 mm	(0.07XOD) + 0.002" (0.07xOD) + 0.05 mm	0.21XOD 5.3 mm	(OD+ID)/2.41	((OD/2) (BCD(2))-(ID/2))
5 	0.90" 2.3 mm	0.500" 12.7 mm	(0.07XOD) + 0.003" (0.07xOD) + 0.08 mm	0.20XOD 5.1 mm	(OD+ID)/2.18	((OD/2) (BCD(2))-(ID/2))
6 	0.100" 2.5 mm	0.500" 12.7 mm	(0.07XOD) + 0.003" (0.07xOD) + 0.08 mm	0.20XOD 5.1 mm	(OD+ID)/2.00	((OD/2) (BCD(2))-(ID/2))

STANDARD MANUFACTURING CAPABILITIES & TOLERANCES

From	To	Tolerance (In)	Tolerance (mm)
0.022" 0.5 mm	0.056" 1.4 mm	+ 0.002" - 0.001"	+ 0.050 mm - 0.025 mm
0.057" 1.4 mm	0.090" 2.3 mm	± 0.002"	± 0.050 mm
0.091" 2.3 mm	0.125" 3.2 mm	+ 0.003" - 0.002"	+ 0.080 mm - 0.050 mm
0.126" 3.2 mm	0.250" 6.3 mm	± 0.003"	± 0.080 mm
0.251" 6.3 mm	0.375" 9.5 mm	± 0.004"	± 0.100 mm
0.376" 9.5 mm	0.500" 12.7 mm	± 0.006"	± 0.150 mm

From	To	Tolerance (In)	Tolerance (mm)
0.007" 0.18 mm	0.016" 0.41 mm	+ 0.002" - 0.001"	+ 0.050 mm - 0.025 mm
0.017" 0.43 mm	0.068" 1.73 mm	± 0.002"	± 0.050 mm
0.069" 1.75 mm	0.285" 7.24 mm	± 0.003"	± 0.080 mm

Length + 0.250", -0" (+ 6 mm, - 0 mm)

TWIST

Insulator Length	Maximum Tolerance
1" (25 mm)	4 - 1/3"
2" (51 mm)	8 - 2/3"
3" (76 mm)	13"
4" (102 mm)	17 - 1/3"

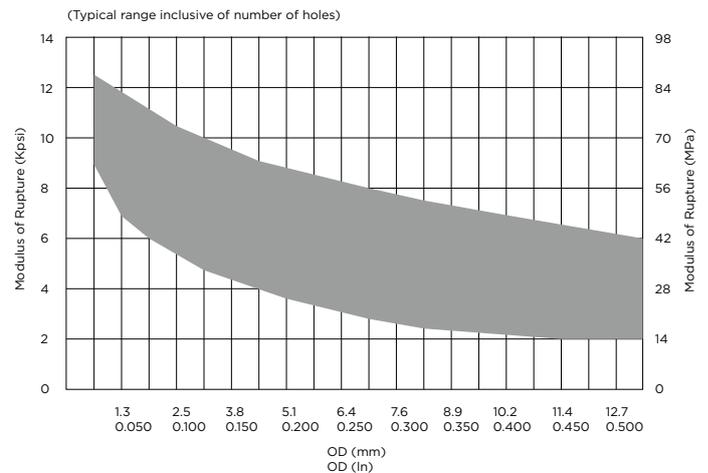
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OD Size	Maximum Camber**		Maximum Length
0.022" to 0.031" 0.56 mm to 0.79 mm	0.003 in/in.	0.080 mm/mm	1
0.32" to 0.049" 0.81 mm to 1.24 mm	0.003 in/in.	0.080 mm/mm	2
0.050" to 0.109" 1.27 mm to 2.77 mm	0.003 in/in.	0.080 mm/mm	3
0.110" to 0.500" 2.79 mm to 12.7 mm	0.003 in/in.	0.080 mm/mm	4

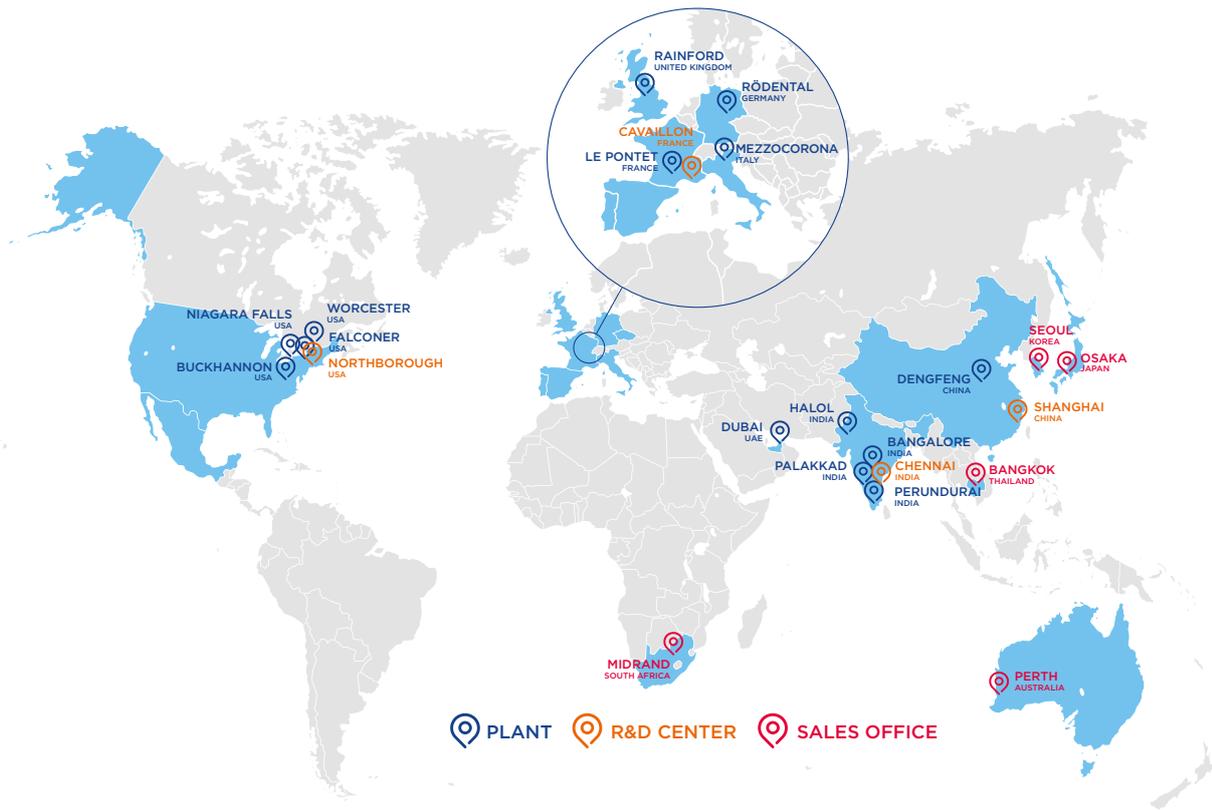
* Technical data, right of modification reserved.

** Measured from maximum OD

MODULUS OF RUPTURE



OUR GLOBAL PRESENCE



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