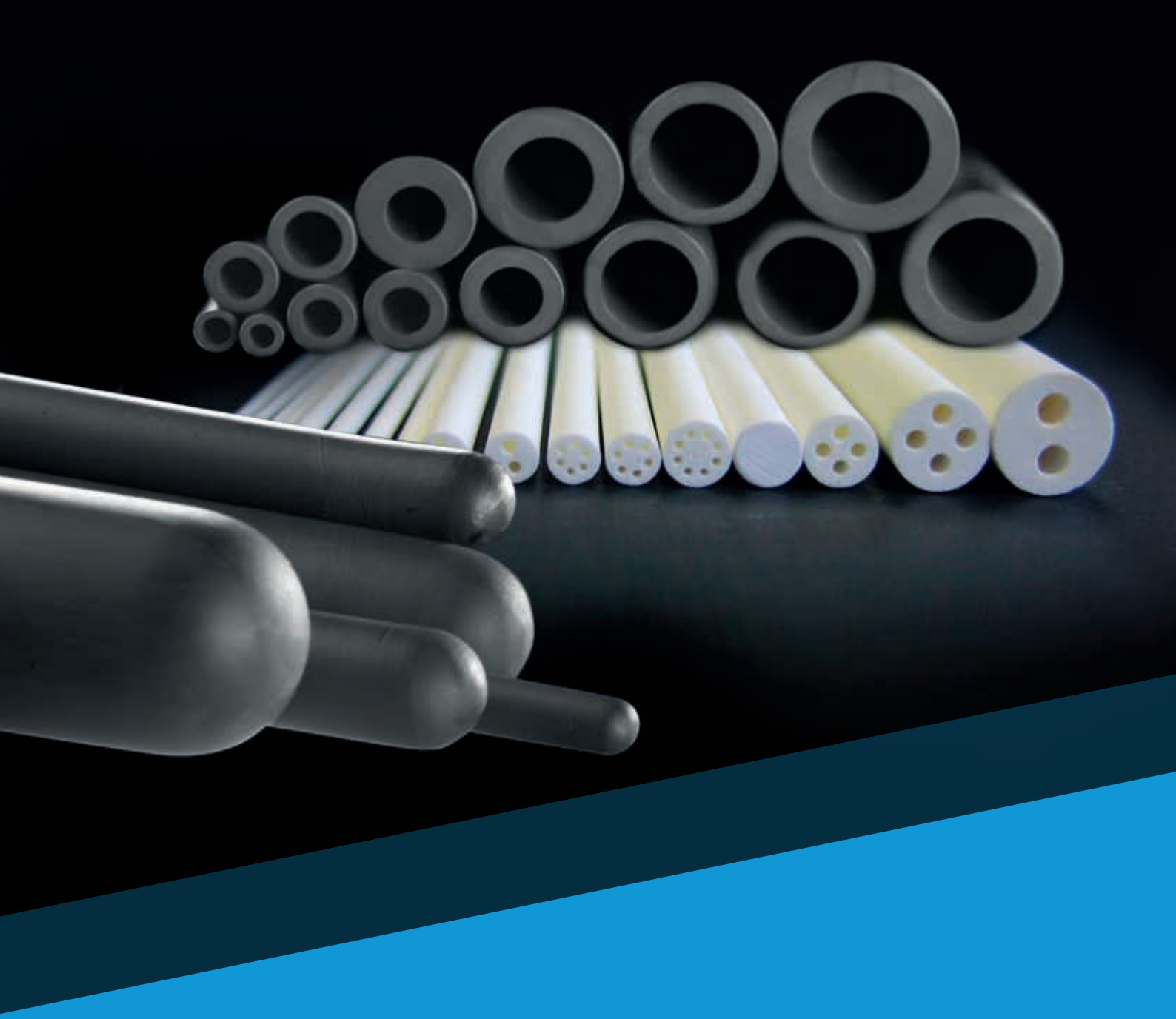


SAINT-GOBAIN PERFORMANCE CERAMICS & REFRACTORIES

CERAMIC TUBES & CRUSHABLE INSULATORS

FOR THERMOCOUPLES & GAS SENSORS

SCAN ME

TO DOWNLOAD

SAINT-GOBAIN

Derwent Top 100 Global Innovator 2023

Clarivate Analytics

SAINT-GOBAIN

top EMPLOYER GLOBAL 2023

1 in 4 products did not exist 5 years ago

170.000+ employees

2022 sales of **€ 51.2** billion

represented in **76** countries

-27% carbon emissions reduction (vs. 2017 on scope 1+2)

8 main R&D centres

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.

OUR PURPOSE

MAKING THE WORLD A BETTER HOME.

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.

SPECIALITY CERAMIC SOLUTIONS

CERAMIC TUBES & CRUSHABLE INSULATOR PRODUCTS

For over 30 years, Saint Gobain PCR 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)

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 1350°C	Gas analyzer probes Furnaces Kilns
Recrystallized Silicon Carbide	CRYSTAR® 2000	Resistant to flames Superior thermal shock resis-tance	Furnaces Kilns

MATERIAL PROPERTIES COMPARISON

Material	Sintered SiC	Nitride Bonded SiC			Siliconized SiC	Recrystallized SiC
Brand	**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	1650	1450	1450	1590	1350	1600
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
Flexual Strength, MPa **RT °C** **1450°C** **1600°C**	 280 270 300	 25 - -	 60 - -	 60 - -	 260 - -	 80 - -
Thermal Conductivity, 1000°C, W/mK	60	19	20	16	40	25
CTE, /°C	$4.0x10^{-6}$	$4.5x10^{-6}$	$5.1x10^{-6}$	$5.1x10^{-6}$	$4.5x10^{-6}$	$4.8x10^{-6}$

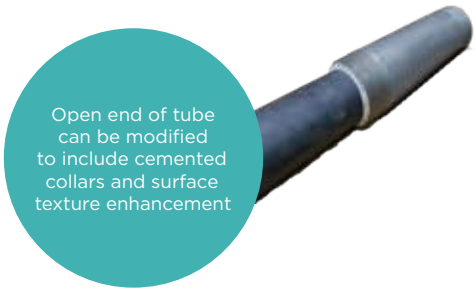
CLOSED ONE END TUBES

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 1650°C in oxidizing atmosphere)
- Excellent corrosion & abrasion resistance



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.

CLOSED ONE END TUBES

Flat & round designs available

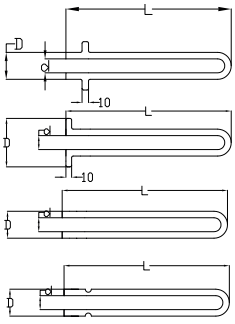
Nitride Bonded SiC tubes are an economic choice to thermocouple sensor OEMs. These tubes can be produced to a large range of diameters with several options for mounting. NBSiC does not contaminate non-ferrous melts, like cast iron tubes. It is also used for temperature measurement of heat treating furnaces.

NITRIDE BONDED SiC (NBSiC)

FEATURES: **NBSiC**

- High thermal shock resistance
- Max. service temperature up to 1450°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

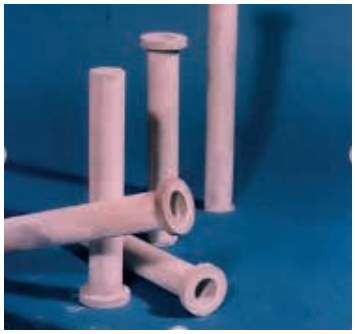
Type D has a groove

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 1100 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)

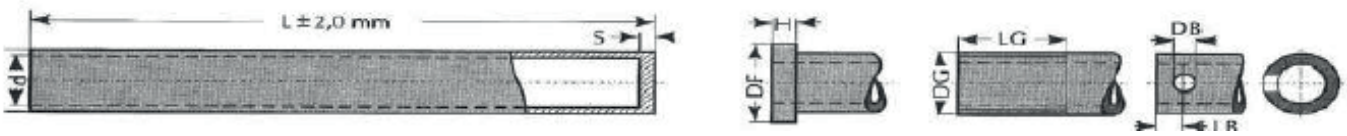
FEATURES: **SILIT® SK**

- 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.



CLOSED ONE END TUBES

CRYSTAR® 2000, Recrystallized SiC (99% SiC), can be used as thermocouple protection tubes, closed on one end. A wide range of diameters are available. Flanged tubes are also available.

RECRYSTALLIZED SiC (ReSiC)

FEATURES: **CRYSTAR® 2000**

- High service temperature (up to 1600°C)
- High thermal shock resistance

STANDARD DIMENSIONS OF CRYSTAR® 2000 TUBES*

OD (mm)	Wall thickness (mm)	Max. length (mm)
< 20	4	1000
21 - 30	5	2500
31 - 40	5	2800
41 - 50	5	3000
51 - 60	6	3000
61 - 70	6	3000
71 - 80	6	3000
81 - 90	6	3000
91 - 100	6	3000

* Technical data, right of modification reserved.

OPEN BOTH ENDS TUBES

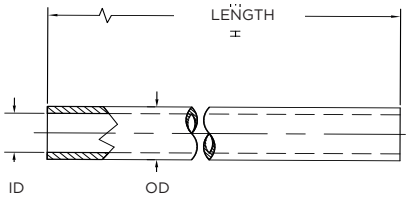
Gas sensors analyze combustion by-products and flue gases such as Oxygen, CO, CO_2, CH_4, NOx, SOx, H_2S from a wide range of industries including:

- Oil & Gas
- Coal
- Chemicals
- Glass
- Cement
- Pulp & Paper
- Steel
- Non-ferrous metals / alloys

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 1650°C and 1350°C respectively.

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



SIZE COMBINATIONS OF HEXOLOY® SE TUBES*

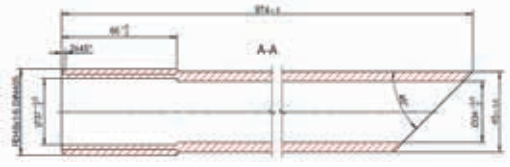
OD	ID	OD & ID Tolerance	Length (±1/8")
3/8"	1/4"	±.015"	standard up to 54" custom longer lengths available upon request
1/2"	0.380"	±.020"	
0.551"	0.433"	±.020"	
5/8"	3/8"	±.025"	
3/4"	1/2"	±.025"	
3/4"	0.570"	±.025"	
1"	1/2"	±.030"	
1-1/4"	3/4"	±.040"	
1-1/4"	0.922"	±.040"	
1-1/2"	1"	±.040"	

* 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.



MINERAL INSULATED METAL SHEATHED (MIMS) THERMOCOUPLE PROTECTION

Our high purity ALUNDUM® fused Al_2O_3 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.

Round thermocouple in an engine

Nuclear reactor

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.

A. Saint-Gobain insulators before swaging

B. Insulator sheathed and partially swaged

C. Finished thermocouple shaped for application

TYPICAL CHEMICAL ANALYSIS %

ALUNDUM® (fused Al_2O_3) Crushable Insulators AN 900		
	Typical	Minimum or Maximum
Al_2O_3	99.85%	99.65% Min
Fe_2O_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_2O	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_2O_3	0.08%	0.15% Max
CaO	0.24%	0.35% Max
Fe_2O_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.

10

CRUSHABLE INSULATORS

WALL & WEB THICKNESS

	Insulators OD		Hole Diameter ID		Bolt Circle Diameter	Wall / Web Thickness
Holes	Minimum	Maximum	Minimum	Maximum		
1	0.22″ 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	0.32″ 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)

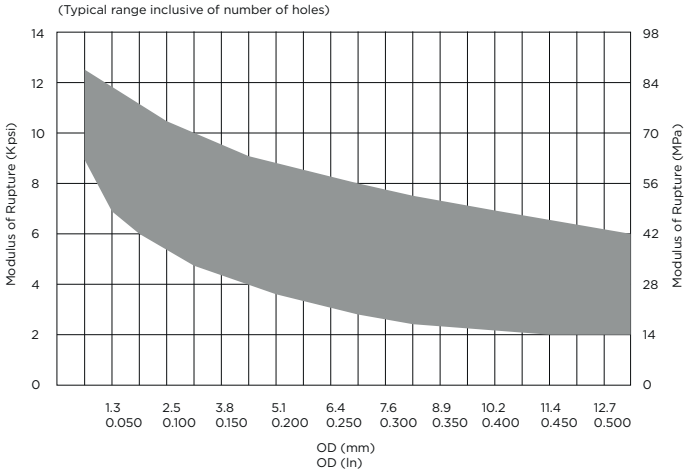
TWIST

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″

WARPAGE

OD Size	Maximum Camber**		Maximum Length
0.022” to 0.031” 0.56 mm to 0.7 9mm	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 2.77mm	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

MODULUS OF RUPTURE



* Technical data, right of modification reserved.
** Measured from maximum OD

OUR GLOBAL PRESENCE

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PERFORMANCE CERAMICS & REFRACTORIES

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