

POCO

SUPERSiC® Materials

SUPERSiC is POCO's trade name for silicon carbide products. Within this family of silicon carbide materials there are a number of grades that have been tailored to offer semiconductor customers optimum performance for their application. These grades offer material solutions coupled with a unique manufacturing method that provides design flexibility, faster delivery times, lower cost of ownership, and higher quality than are typically seen in the production of conventional silicon carbide products.

CORE STRENGTH

POCO has been in the business of manufacturing premium graphites for over 40 years with a reputation for producing the best graphites in the world. The development of POCO graphite materials and post processing techniques has often been linked with changes in the semiconductor industry. POCO has built its reputation as a manufacturer of semiconductor grade materials by controlling the manufacturing process to deliver quality products that provide consistent performance year after year. POCO used this graphite expertise to refine its conversion process to develop multiple grades of SUPERSiC for semiconductor applications.

MANUFACTURING

All of POCO's materials and finished parts are produced at the North Texas manufacturing facility. POCO starts with a graphite material that has been designed and manufactured to be used as the precursor in the conversion process. This is not a commercially available grade of graphite. Parts are machined from this unique material to near net shape and then purified to less than 5ppm ash. The purified parts are then subjected to a proprietary process, converting the graphite to high purity silicon carbide.

ADVANTAGES OF POCO PROCESS

Customer parts are machined to near net shape while still in the graphite form, which is easier and less costly than machining in silicon carbide. There are no expensive molds or additional design costs associated with the POCO manufacturing process. Changes to existing parts can be achieved quickly and with minimum impact to the customer. No significant retooling is ever necessary, which allows design changes to occur in a timely manner. The bottom line is that prototypes can be placed in process in a time frame which meets the demanding requirements of the semiconductor industry. All this translates into lower cost of ownership.

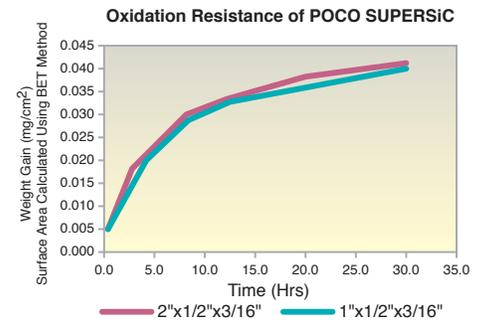
UNIQUE MATERIAL STRUCTURE OF SUPERSiC

The resulting SiC is stoichiometric β -SiC. Because there is no sintering operation, binding agents, or interfaces, the contamination levels in the converted SiC are typically below 10 ppm, as measured by LA-ICP-MS. The 1:1 ratio of silicon to carbon in the material matrix translates into a product that is impervious to acid attack. Sintered or slip cast silicon carbides, which backfill the voids in the SiC matrix with silicon, must be coated to protect the excess silicon from the common acids found in the semiconductor fab.

FULLY CONVERTED PARTS

SUPERSiC parts are fully converted by the POCO process. Our design specialists design for the conversion depth limitations of the process. Finished products are designed with features that reduce thermal mass while retaining high strength.

Oxidation Resistance



Oxidation resistance of SUPERSiC at 1200°C in an ambient environment. The surface area was calculated using the BET method, which takes into account the surface area of individual grains.

Purity and Mobile Ions

SUPERSiC is purer than conventional sintered Si/SiC materials. Independent user tests indicate that SUPERSiC is of equal or higher purity than quartz as measured by GDMS. Major semiconductor fabs using SuperSiC carriers found through various metrology tests, reduced atomic contamination at the wafer level.

Typical Purity of SUPERSiC

GDMS Elemental Data Analysis (ppm)		
Element	SUPERSiC	CVD SiC Coating
Na	<0.01	<0.01
Mg	<0.01	<0.01
Al	3.80	.015
K	0.08	<0.05
Ca	0.90	<0.05
Ti	0.25	<0.01
V	0.48	<0.01
Mn	<0.01	<0.01
Fe	0.37	0.30
Ni	2.00	0.51
Ci	<0.05	0.05
Zn	<0.05	<0.05

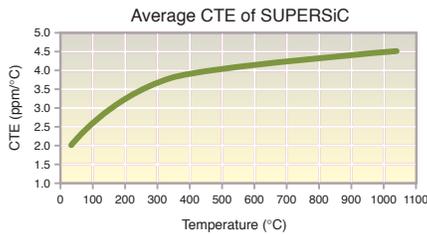
Reduced Particle Generation

A major semiconductor manufacturer performed a qualification study of particle generation comparing standard quartz to SUPERSiC. The SUPERSiC carriers reduced particle counts by 10-40%.

Better Film Adhesion/ Improved Yield

Deposited films, poly-silicon and silicon nitride contract and expand at the same rate as silicon carbide carriers due to a closer coefficient of thermal expansion (CTE) than quartz, which has a lower CTE. Typical run cycles between cleans using SUPERSiC carriers are 60-100% longer than quartz carriers.

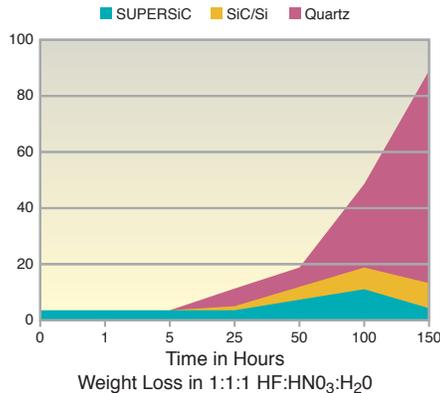
Semiconductor



$$CTE = -5.225E-12 T^4 + 1.671E-08 T^3 - 1.961E-05 T^2 + 1.087E-02 T + 1.706$$

Wet Chemistries

SUPERSiC is virtually unaffected by typical semiconductor wet chemistries.



SUPERSiC GRADES

SUPERSiC is the base silicon carbide material. The base silicon carbide has some porosity. Typical applications are high temperature anneals and drive-ins. Typical fab cleaning methods may be used.

SUPERSiC-3C is the base material with a 75 μm SiC coating that seals and eliminates the underlying porosity while smoothing the surface. Typical applications are CVD and LPCVD. Typical fab cleaning methods may be used.

SUPERSiC-P-3C uses the base material with slight surface SiC densification and adds a 75 μm SiC coating. This SiC coating seals and further smooths the surface. Typically used for the additional demands of the vertical diffusion LPCVD environment. Typical fab cleaning methods may be used.

SUPERSiC-Si subjects the SUPERSiC base material to an infiltration process which fills the open porosity of the silicon carbide with high purity silicon. This material may require a CVD SiC coating depending on the application.

SUPERSiC-Si-3C uses SUPERSiC-Si as the base material and adds a 75 μm SiC coating. This SiC coating seals and prevents acids from attacking infiltrated silicon. Typical applications are high temperature CVD and diffusion processes. Typical fab cleaning methods may be used.

SUPERSiC-SiC subjects the base silicon carbide material to an infiltration process which fills the open porosity of the silicon carbide with high purity silicon carbide. Typical applications are high erosion or strength applications such as etch or implant. Typical fab cleaning methods may be used.

TYPICAL MATERIAL PROPERTIES		BASE SUPERSiC
Apparent Density, ρ_a (g/cm ³)		3.13
Bulk Density, ρ_b (g/cm ³)		2.53
Total Porosity, P_t (%)		20
Open Porosity, P_{op} (%)		19
Total Impurity Level (ppm)		<10
Flexural Strength (MPa/ksi)		147/21.3
Electrical Resistivity ($\mu\Omega\text{cm}$)		7620
Tensile Strength (MPa/ksi)	Tension	129/18.7 (m=16)
	Diametral Compression	110/16.0
Elastic Modulus, E (GPa/msi)		214/31
Specific Stiffness, E/ρ_b (kN m/g)		85
Poisson's Ratio, ν		0.17
Dynamic Shear Modulus, G (GPa/msi)		96/14
Fracture Toughness, K_{IC} (MPa·m ^{0.5})		2.30
Hardness (kg/mm ²)		1992
Thermal Diffusivity, D (10 ⁻⁶ m ² /s)		92
Thermal Conductivity at RT, κ (W/m·K)		151
Instantaneous CTE, α_T (10 ⁻⁶ /K)		2.4



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