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About Silicon Nitride

Silicon Nitride has the most versatile combination of mechanical, thermal, and electrical properties of any technical ceramic material. It is a high performance technical ceramic that is extremely hard and has exceptional thermal shock and impact resistance. It surpasses most metals high temperature capabilities and has a superior combination of creep and oxidation resistance. Additionally, its low thermal conductivity and high wear resistance make it an excellent material that can withstand the toughest of conditions in the most demanding industrial applications. Silicon Nitride is an excellent choice when high-temperature and high-load abilities are needed.

Silicon Nitride Properties

- High strength over a large temperature range
- High fracture toughness
- Good flexural strength
- Mechanical fatigue & creep resistant
- Lightweight – Low density
- High hardness and wear resistance, both impingement and frictional modes
- Superior thermal shock resistance
- Low thermal expansion
- Electrical insulator
- Good oxidation resistance
- Good chemical corrosion resistance
- Wear resistant
- High stiffness

Silicon Nitride Applications

- Rotating ball & rollers bearings
- Cutting tools
- Engine components
- valves, rocker arm pads, seal faces
- Induction heating coil supports
- Turbine blades, vanes, buckets
- Welding & brazing jigs
- Heating Element components
- Crucibles
- Metal tube forming rolls and dies
- TIG / Plasma welding nozzles
- Weld positioners
- Precision shafts and axles in high wear environments
- Thermocouple sheaths & tubes
- Semiconductor Process Equipment

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Types of Silicon Nitride from VHANDY

There are several different methods used to produce Silicon Nitride, all producing materials with slightly differing properties.

- Gas Pressure Sintered Silicon Nitride (GPSN)
- Hot Pressed Silicon Nitride (HPSN)

Gas Pressure Sintered Silicon Nitride (GPSN)

This is the most popular method for producing high-strength and complex geometry silicon nitride components. The GPSN method uses a silicon nitride powder that has been mixed with sintering aids to promote liquid phase sintering (typically yttria, magnesium oxide, and/or alumina) as-well-as binders to improve the mechanical strength of green ceramic body. The powder is pressed into the desired form and green-machining can take place. The compacts are then placed into a furnace that has a pressurized nitrogen atmosphere to aid with densification and prevent the evaporation/decomposition of the silicon, nitrogen and additives.

Properties of GPSN

Item	Unit	GPSN
Density	g/cm3	3.20±0.02
Elastic Modulus	Gpa	300~320
Crushing Load Ratio	（25℃）%	30~35
Hardness	（HV）（Gpa）	1600-1800
Fracture Toughness	Mpa.m $^{1/2}$	6.0~7.0
Bending Strength	Mpa	650~750
Poisson's Ratio		0.25
Coefficient of Heat Expansion	$10^{-6}K^{-1}$	3.0~3.2
Weber Modulus		10~12
Thermal Conductivity	W.(M.K) $^{-1}$	15~20
Specific Resistivity		10^{18}
Magnetic		No

Silicon Nitride Machining & Grinding

Silicon Nitride can be machined in green, biscuit, or fully dense states. While in the green or biscuit form it can be machined relatively easily into complex geometries. However, the sintering process that is required to fully densify the material causes the Silicon Nitride body to shrink approximately 20%. This

shrinkage means that it is impossible to hold very tight tolerances when machining Silicon Nitride pre-sintering. In order to achieve very tight tolerances, fully sintered material must be machined/ground with diamond tools. This processes uses a very precise diamond coated tool/wheel to abrade away the material until the desired form is created. Due to the inherent toughness and hardness of the material, this can be a time-consuming and costly process.

Silicon nitride powder test report

Item	Data
Main Ingredient	Si_{total}>59%
	N>37%
Phase content	Phase α>92%
Particle size	D_{50}≤0.5μm
Impurity content	Si(separated)<1%
	O<1.5%
	Mg<0.003%
	Fe<0.16%
	Ca<0.22%
	Mn<0.075%
	Ti<0.025%

Note: This standard is implemented in accordance with American ASTM F2094-2004a.