

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

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)

Hot Pressed Silicon Nitride (HPSN)

HPSN is produced by uniaxially pressing silicon nitride powder (with sintering additives) while applying heat at the same time. A special type of press and die is required for this process. It produces a silicon nitride with excellent mechanical properties, however, only simple shapes can be produced. Because it is impossible to green-machine a component that is hot-pressed, diamond grinding is the only way to create complex geometries. Because of the high costs and difficulties associated with diamond grinding and hot-pressing, its use is typically limited to the production of simple components in small quantities.

Properties of HPSN

| Item | Unit | HPSN |
|-------------------------------|----------------------------------|---------|
| Density | g/cm ³ | 3.2~3.4 |
| Bending strength | Mpa | ≥900 |
| Fracture toughness | Mpa.m ^{1/2} | 6~8 |
| Hardness (HV) | Gpa | 15~17 |
| Thermal conductivity | W/m.k | 23~25 |
| Thermal expansion coefficient | ×10 ⁻⁶ /°C (0~1400°C) | 2.95~3 |

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.