

## Silicon Nitride Grinding Beads





# Silicon Nitride

Silicon Nitride is one of the hardest substances in the world. Its wear resistance and high temperature resistance properties make it the best suitable material as grinding balls/beads for high purity powders grindings.

### Higher grinding efficiency

Silicon-nitride media have a Vickers hardness of 14–18 GPa, versus 10–13 GPa for zirconia. The higher hardness of silicon nitride delivers faster size reduction and higher throughput.

### Extremely low wear (10ppm)

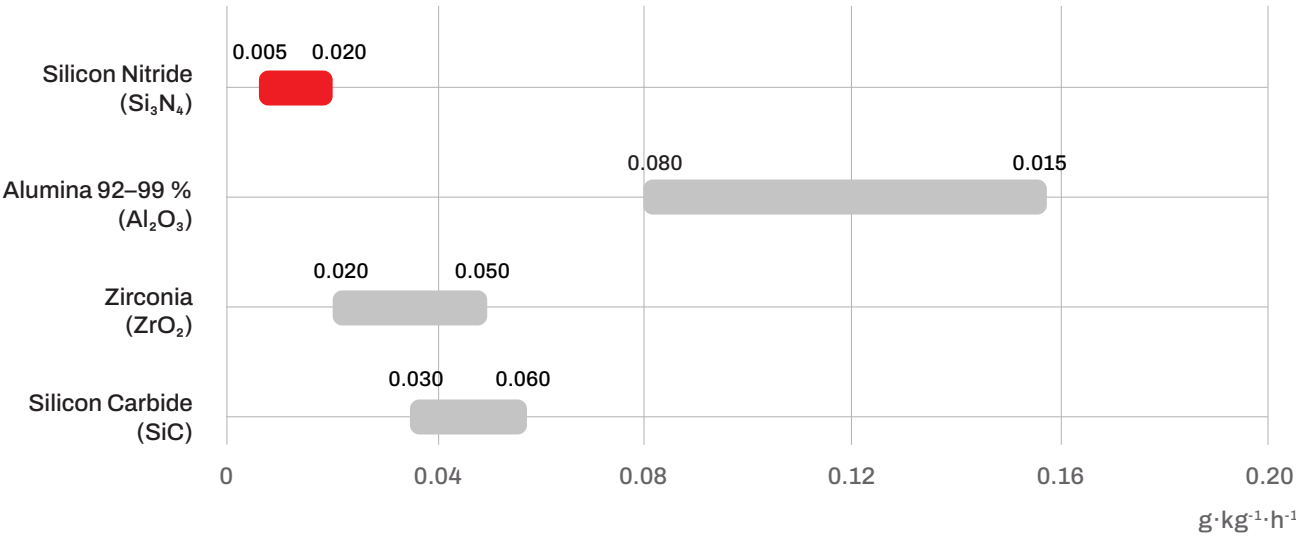
The 24-hour wear rate of silicon-nitride media is only 10ppm—effectively zero. This negligible wear reduces contamination of the product, enabling higher-purity ultra-fine powders and eliminating concerns over impurity pick-up. Consequently, switching to silicon-nitride media offers an economical route to upgrading high-purity, ultra-fine powder production.

## Technical Specifications

Density	3.25 kg/m³
Young's modulus	310 GPa
Compressive strength	3,500 MPa
Modulus of rupture	700-800 MPa
Vickers hardness	15 GPa
Fracture toughness	5-7 MPa·√m
Coefficient of linear expansion	3.4
Specific heat	800 J·kg <sup>-1</sup> ·K <sup>-1</sup>
Max operation temperature	1,050°C
Thermal conductivity	20 W/(m·K)
Thermal shock resistance	Good
Corrosion resistance	Good
Available size	0.1 - 30mm (others customizable)

## Wear Rate Comparison

Average wear as low as 0.01 g·kg<sup>-1</sup>·h<sup>-1</sup>



Grinding Balls  
10mm diameter



# Superior Performance

Silicon nitride grinding beads command a premium price due to several key performance advantages over steel and zirconia alternatives, particularly in advanced applications.

These advantages translate to reduced grinding costs in the long run due to extended bead life, less frequent replacements, lower energy consumption, and minimized material contamination. The higher initial cost is offset by these long-term benefits, especially in demanding, high-precision applications.

## Chemical Inertness

Its resistance to chemical attack ensures minimal contamination, essential for producing high-purity materials in sensitive industries like pharmaceuticals and electronics. This inertness also allows for use in corrosive environments.

## Exceptional Hardness and Wear Resistance

Silicon nitride's hardness, second only to diamond and cubic boron nitride, drastically reduces wear, extending the lifespan of the beads and minimizing contamination of the ground material. This is crucial for high-precision applications where purity is paramount, such as semiconductor manufacturing.

## High Thermal Stability

Silicon nitride withstands high temperatures without degradation, making it suitable for high-temperature grinding processes. This is particularly important in advanced ceramic and metal processing.

## Low Friction and Heat Generation

Reduced friction leads to lower energy consumption and less heat generation during grinding, improving efficiency and preventing damage to temperature-sensitive materials.

## High Strength and Toughness

This combination ensures resistance to fracture, even under high impact and stress conditions. This is critical for high-speed and high-load grinding operations.

## Technical Data Comparison

	Silicon Nitride	Zirconia	Alumina
Density (kg/m³)	3.25	6.02	3.7
Young's modulus (GPa)	310	210	370
Compressive strength (MPa)	3,500	2,500	2,600
Modulus of rupture (MPa)	700-800	1,240	379
Vickers hardness (GPa)	15	12.7	14.1
Fracture toughness (MPa·√m)	5-7	13	7
Coefficient of linear expansion (10 <sup>-6</sup> /K)	3.4	10.3	8.2
Specific heat (J/kg·K)	800	400	880
Max operation temperature (°C)	1,050	1,500	1,750
Thermal conductivity (W/m·K)	20	2.2	30
Thermal shock resistance	Excellent	Good	Good
Corrosion resistance	Excellent	Good	Good



# Case Study

## Electronic Industry

Electrically insulated

Silicon nitride is an excellent electrical insulator. This property is critical in applications where electrical conductivity must be avoided to prevent unwanted interactions between the grinding media and the materials being processed, particularly in the electronics industry.

This is especially important when grinding semiconductor materials or other sensitive electronic components, preventing damage to delicate devices and ensuring product integrity. The non-conductivity prevents short circuits or other electrical issues that could compromise the end product.

## Semiconductor Manufacturing

Minimizing contamination

The chemical inertness of silicon nitride is crucial for minimizing contamination in high-purity applications like semiconductor manufacturing because it prevents unwanted chemical reactions between the grinding beads and the processed materials.

Unlike reactive materials, silicon nitride does not leach ions or release impurities into the semiconductor materials being processed. This prevents the introduction of foreign atoms or molecules that could affect the semiconductor's electrical properties or performance. Maintaining the purity of semiconductor materials is essential to ensure the reliability and functionality of electronic devices.

The inertness of silicon nitride helps guarantee the integrity and quality of the final product by preventing contamination at a crucial stage of production.



## Pharmaceuticals and Cosmetics

Reduce energy consumption

Low-density silicon nitride grinding beads offer several advantages relevant to pharmaceutical and cosmetic manufacturing when compared to higher-density alternatives such as alumina and zirconia. Their lower mass translates to reduced energy consumption during milling, a significant factor in large-scale production. This is particularly important when processing sensitive materials, common in pharmaceutical and cosmetic industries, that might be degraded by excessive heat generated during higher-energy grinding.

The reduced wear associated with lower-density beads also minimizes contamination risk. In pharmaceuticals, this is crucial to maintain product purity and avoid introducing potentially harmful substances.

Similarly, in cosmetics, contamination can affect product texture, color, and stability, potentially impacting consumer appeal and safety. Lower density beads also contribute to a smoother grinding process, resulting in more uniform particle size distribution—important for both drug efficacy and the desired texture and appearance of cosmetic products. The lower energy consumption also leads to cost savings.



## **Ceramic Expert Industrial Know-how**

+86 (021)31255767

Monday - Friday

9:00 - 17:00

[info@sceramic.com](mailto:info@sceramic.com)

#3601 Dongfang Rd, Pudong District,  
Shanghai, P.R.China, 200125

[www.sceramic.com](http://www.sceramic.com)

Standard Ceramic Technology Co.,Ltd.

