

# Engineering ceramics

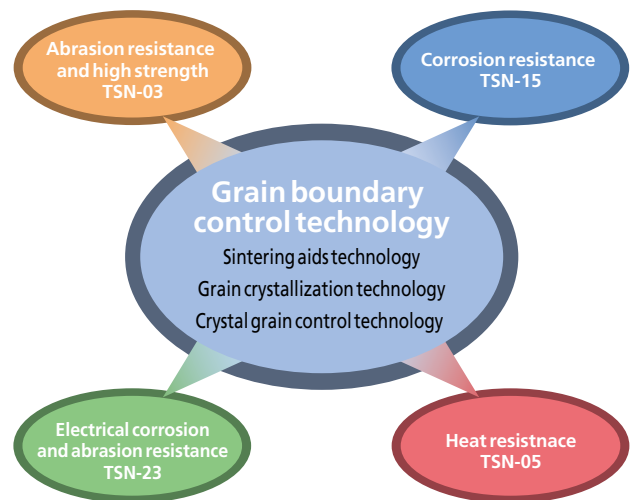
## Silicon nitride (Si<sub>3</sub>N<sub>4</sub>) ceramics

Among many ceramic materials, namely zirconia, silicon carbide and alumina, which are known to be used as engineering fine ceramics, we persistently produce silicon nitride ceramics as the only material for engineering ceramics.

We have well understood excellent properties such as high thermal conductivity and high strength of nitride ceramics from early-stages of the research. Then we have developed a grain boundary control technology and applied it to make Silicon nitride ceramics into stable, high-performance, high-functional materials and components.

Silicon nitride ceramics will show their well-balanced mechanical properties under high-speed rotation, high-speed sliding and high vacuum as they have good abrasion resistance, good corrosion resistance, high rigidity. We are looking forward to meet customer's diversified requirements with our silicon nitride ceramics.

### High performances of silicon nitride ceramics



## Typical values for properties of engineering ceramics

Item			Unit	Silicon nitrides(Si <sub>3</sub> N <sub>4</sub> )			
				TSN-03	TSN-08	TSN-15	TSN-23
Density			Mg/m <sup>3</sup>	3.23	3.27	3.17	3.27
Mechanical and thermal properties	Hardness	Hv (500g)		1,500	1,600	1,500	1,500
		Bending strength by JIS1601 three points bending strength	RT	MPa	1,000	1,000	900
	1000°C		MPa	750	900	750	700
	1200°C		MPa	450	850	450	400
	Compression strength	RT	MPa	5,000	4,500	3,500	4,000
	Young's modulus	RT	GPa	308			313
	Poisson's ratio			0.29			0.28
	Fracture toughness	K <sub>1c</sub>	MPa <sup>1/2</sup>	6-8	6-8	6-7	5-7
	Specific heat		J/kg·K	680	680	670	680
	Thermal conductivity		W/m·K	20	20	28	25
Coefficient of thermal expansion	RT-800°C	×10 <sup>-6</sup> /K	3.0				
Thermal shock temperature difference	(ΔT <sub>c</sub> )	°C	800	900	600	700	
Electrical properties	Dielectric strength	50Hz	kV/mm	>14			
	Volume resistivity	25°C	Ω·m	>10 <sup>12</sup>			
Corrosion* resistance	Acid		Good	Good	Excellent	Excellent	
	Alkali		Good	Good	Good	Good	
Features			High strength Abrasion resistant Corrosion resistant	Heat resistant Abrasion resistant Corrosion resistant	Corrosion resistant High strength Abrasion resistant	Abrasion resistant Corrosion resistant (Electrical corrosion)	
Recommendatory applications			Bearings Engine parts Mechanical parts Heat-resistant and abrasion-resistant parts	Mechanical parts Refractory tools	Bearings Chemical parts Abrasion resistant parts	Bearings Engine parts	

\*Corrosion resistances were measured under following conditions.

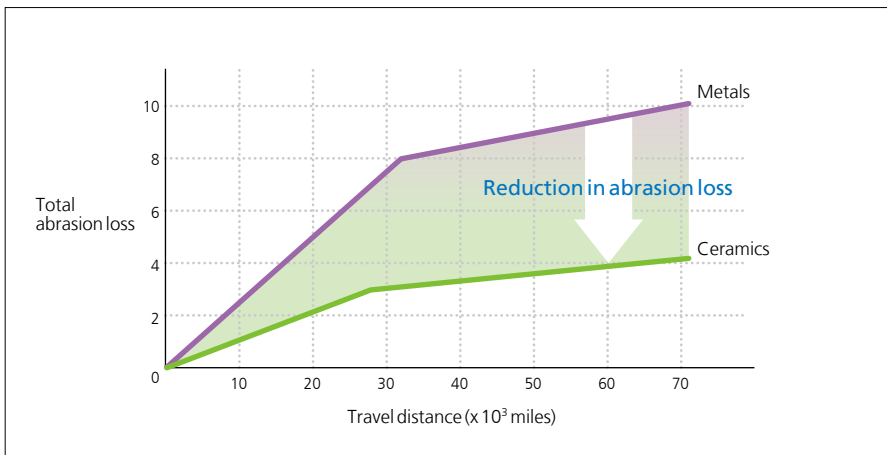
Acid; 96 hours immersion at RT in 36% HCl, 95% H<sub>2</sub>SO<sub>4</sub> and 60% HNO<sub>3</sub> Alkali; In 5% NaOH and 40% NaOH

## Silicon nitride ( $\text{Si}_3\text{N}_4$ ) ceramics for automobiles

We have started joint development with Cummins Engine Company, Inc., one of the biggest diesel engine manufactures, since 1987 and have lots of successful experiences in practical application of silicon nitride fine ceramics mainly in the field of abrasion resistant parts for diesel engine fuel system. Thanks to their light weight, high abrasion resistance and excellent corrosion resistance, silicon nitride ceramics can make environmentally friendly engine parts that help complete the combustion required by world-wide exhaust gas regulations. We are very sure to offer ceramic products that have superior cost performance and are manufactured on a basis of the experiences of over twenty years both in product technology and material technology.



### Comparison of abrasion loss between metals and ceramics



## Silicon nitride ( $\text{Si}_3\text{N}_4$ ) ceramics for industrial facilities

We offer a variety of ceramics parts for industrial facilities taking advantage of their superior properties of abrasion resistance, thermal resistance, thermal shock resistance and poor wettability with molten metals. We are supplying silicon nitride center bulbs, contact collets, masks and so on to semiconductor manufacturing facilities that keenly require low dusting and long life components.

### [Application examples]

- Jigs for semiconductor manufacturing facilities

