

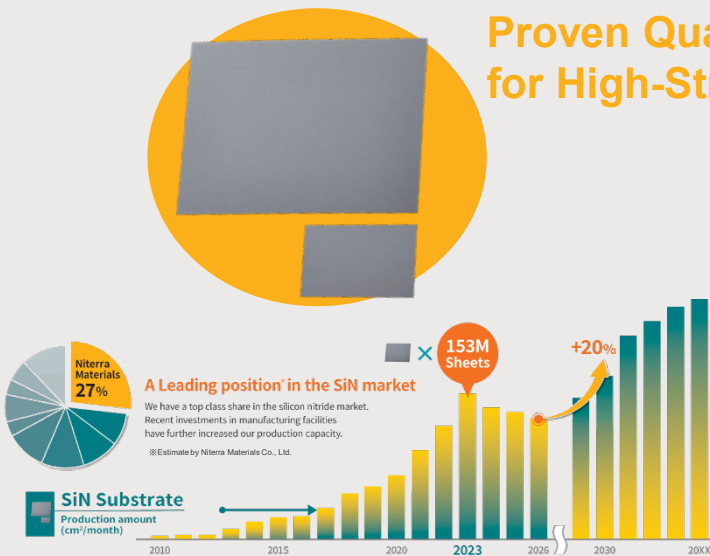
SILICON NITRIDE CERAMICS

Plain Substrates

Proven Quality, World-Leading Capacity. The Standard for High-Strength, High-Dissipation Substrates.

Typical values for properties of fine ceramics for electronics

Item	Measuring method	Unit		Silicon nitrides (Si ₃ N ₄)
				TSN-90
Density	JIS Z8807	RT	Mg/m ³	3.35
Specific heat	JIS C2141		J/kg·K	650
Thermal conductivity	JIS R1611		W/m·K	90
Coefficient of thermal expansion	JIS C2141	RT-500°C	×10 ⁻⁶ /K	3.4
Dielectric strength	JIS C2110-1	50Hz	kV/mm	25.0
Volume resistivity	JIS C2141	RT	Ω·m	1×10 ¹⁵
Dielectric constant	JIS C2141	1MHz		8.0
Dielectric factor	JIS C2141	1MHz	tanδ×10 ⁻⁴	8.0
3-point bending strength	JIS C2141	RT	MPa	680
Fracture toughness	JIS R1607	RT	MPa·m ^{1/2}	6.5
Young's modulus	JIS R1602	RT	GPa	300
Poisson's ratio	JIS R1602			0.27

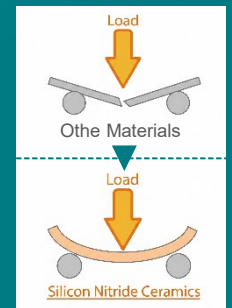


Benefit Points

High strength, high reliability

Silicon nitride ceramics have an excellent mechanical properties. It makes it possible to achieve items such as following which was difficult in the conventional material.

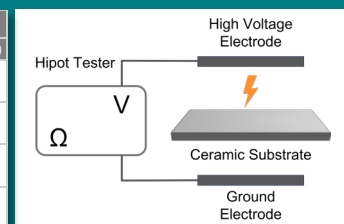
- Stack with high load
- Use under high vibration
- Screwing with holes etc ...



High dielectric strength

With high dielectric strength, our substrates provide superior resistance to electrical breakdown. This ensures long-term prevention of leakage even under the high-voltage, harsh environments of EVs and industrial inverters.

Item	Measuring method	Unit		Si ₃ N ₄
				TSN-90
Dielectric strength	JIS C2110-1	50Hz	kV/mm	25
Volume resistivity	JIS C2141	RT	Ω · cm	1×10 ¹⁵
Dielectric constant	JIS C2141	1MHz		8
Dielectric factor	JIS C2141	1MHz	tanδ×10 ⁻⁴	8



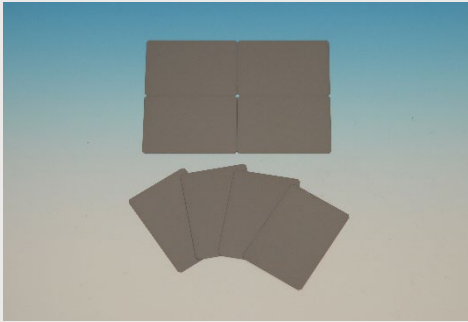
Low thermal expansion coefficient similar Si, SiC, and GaN

This material features a low Coefficient of Thermal Expansion (CTE) that closely matches those of Si, as well as wide-bandgap semiconductors like SiC and GaN. This compatibility minimizes thermal stress during temperature fluctuations, ensuring superior interfacial reliability between the chip and the substrate.

For more information:
<https://www.niterramaterials.co.jp/en/index.htm>



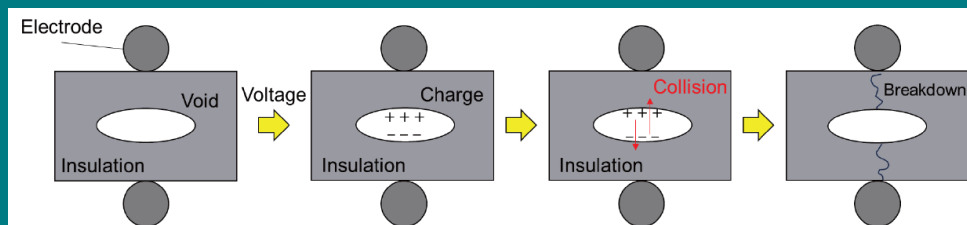
SiN Plain Substrates : High Durability (TSN-90HD) New



We have developed high durable Si_3N_4 (HD-SiN) as an insulating heat-dissipating substrate for use in power control units (PCUs) of electric vehicles (EVs) and hybrid electric vehicles (HEVs). The high durability was achieved by redesigning the material design and manufacturing process, with a particular focus on improving electrical insulation and mechanical properties.

Our Technology

We were improving electrical insulation properties and mechanical properties by redesigning the material concept and manufacturing process. Figure shows mechanism of dielectric breakdown. We focused on one of the causes of dielectric breakdown which is known as the accumulation of electric charge in voids, which causes partial discharge, chemical and physical reactions that progress and lead to dielectric breakdown. Thus, we aimed to develop a Si_3N_4 substrate with low porosity.

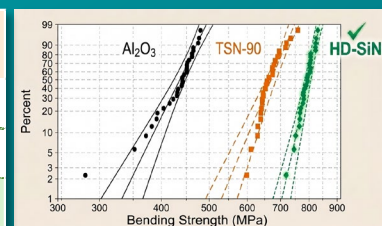


Benefit Points

▶ High strength, high reliability

By refining the grain size compared to conventional materials, HD-SiN achieves higher mechanical strength based on the Hall-Petch equation. The Weibull plot, which illustrates the probability of failure, also demonstrates that HD-SiN suppresses variations in strength, thereby confirming an improvement in reliability.

Sample	Shape Parameter	Scale Parameter
Al_2O_3	15	446
TSN-90	18	685
HD-SiN	36	801

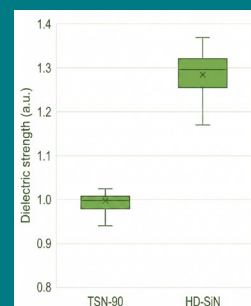


▶ High dielectric strength

The dielectric strength has achieved a significant improvement of approximately 30% compared to conventional materials. This is a direct result of thoroughly eliminating "voids," which are a primary cause of dielectric breakdown.

Realization of Low Porosity: By optimizing the amount of sintering additives and ensuring uniform shrinkage during the sintering process, the porosity has been reduced from 1.0% in conventional materials to 0.1%.

Mechanism: By suppressing charge accumulation and partial discharge within the voids, the overall insulation reliability of the material is enhanced.



For more information:

<https://www.niterramaterials.co.jp/en/index.htm>

