Cerbec® silicon nitride balls outperform traditional all-steel bearing balls. With tailored material properties and finishing that maximize the benefits of using ceramics, Cerbec balls outperform in applications where steel balls degrade rapidly or where electrical insulation is required.

**Smother Surface, Better Geometry, & Inert Material**
- Decreased lube degradation
- No cold welding/adhesive wear
- Less friction
- Lower operating temperature
- Less wear
- Eliminates vibration-induced false brinelling

**Lower Total Operating Cost**
- Less wear equals longer bearing life
- Increased reliability reduces downtime and maintenance
- Reduced energy consumption

**Harder & Stiffer**
Cerbec balls are manufactured from a specially formulated CoorsTek silicon nitride. This unique material is 121% harder and 68% stiffer than traditional steel alloys, providing:
- Reduced ball/race contact area
- Less friction
- Resistance to hard particle contamination
- Higher rigidity
- Increased machine accuracy

**Lighter Weight**
Manufactured from high-quality silicon nitride, Cerbec balls are 58% lighter than steel alloys—lowering centrifugal force, reducing gyroscopic movement, and minimizing ball skidding. The lighter weight also causes less friction and lower raceway stress.

**Lower Thermal Expansion**
- Reduced contact angle change
- Stable running pre-load
- Minimal ball deformation

**Corrosion & Electrical Resistance**
- No electrical arcing through balls
- Increased durability in harsh environments
- Decreased raceway pitting

**Additional Benefits**
- Minimal lubrication required
- Reduced startup and running torque
- Lower noise and vibration
- Expanded design possibilities available to solve technical challenges
- Higher operating speeds possible

**Ceramic Balls for High-Performance and Severe-Duty Applications**
Cerbec Ball Processing
Cerbec bearing balls are produced utilizing high-purity raw silicon nitride materials with highly controlled milling preparation to guarantee consistent chemistry and particle size. Additionally, the Cerbec manufacturing process includes:

- Spray drying for flowability and packing density
- Forming to uniform compaction
- Pre-firing to remove binders
- Hot Isostatic Press (HIP) densification for proper microstructural development — resulting in greater hardness, toughness, and less rolling contact fatigue
- Lapping for consistent geometry, surface finish, and surface quality
- Quality control – Cerbec balls undergo an intensive final inspection to ensure incomparable quality

### ASTM F2094 Si₃N₄ BALL SPECIFICATION

<table>
<thead>
<tr>
<th>Grade</th>
<th>Allowable Ball Diameter Variation</th>
<th>Allowable Deviation from Spherical Form</th>
<th>Maximum Surface Roughness Ra</th>
<th>Allowable Lot Diameter Variation</th>
<th>Basic Diameter Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3C</td>
<td>0.08 (3)</td>
<td>0.08 (3)</td>
<td>0.004 (0.15)</td>
<td>0.13 (5)</td>
<td>+/- 0.51 (+/- 20)</td>
</tr>
<tr>
<td>5C</td>
<td>0.13 (5)</td>
<td>0.13 (5)</td>
<td>0.005 (0.20)</td>
<td>0.25 (10)</td>
<td>+/- 0.76 (+/- 30)</td>
</tr>
<tr>
<td>5 Steel For Comparison</td>
<td>0.13 (5)</td>
<td>0.13 (5)</td>
<td>0.02 (0.8)</td>
<td>0.25 (10)</td>
<td>+/- 1.0 (+/- 40)</td>
</tr>
</tbody>
</table>

Units of measure = micron (micro-inch)

### WHY CERBEC CERAMIC BALLS?

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical Steel</th>
<th>Cerbec Si₃N₄</th>
<th>Cerbec Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (g/cm³)</td>
<td>7.6</td>
<td>3.2</td>
<td>-58% Lighter</td>
</tr>
<tr>
<td>Hardness [Vickers]</td>
<td>700</td>
<td>1550</td>
<td>+121% Harder</td>
</tr>
<tr>
<td>Elastic Modulus [GPa]</td>
<td>190</td>
<td>320</td>
<td>+68% Stiffer</td>
</tr>
<tr>
<td>Thermal Expansion Coefficient, 1 X 10⁻⁶ / °C [RT to 1000°C]</td>
<td>12.3</td>
<td>3.7</td>
<td>-70%</td>
</tr>
<tr>
<td>Max Use Temp [°C]</td>
<td>320</td>
<td>1000</td>
<td>+680°C</td>
</tr>
<tr>
<td>Surface Finish, Grade 5 [micron]</td>
<td>0.02</td>
<td>0.005</td>
<td>+75% Smoother</td>
</tr>
</tbody>
</table>

CoorsTek engineers precision Cerbec balls in sizes ranging from large application bearings in wind turbines to micro-bearings in dental drills, with a diameter range from 50 mm (2 in) to 0.5 mm (0.02 in).
### Ceramic Silicon Nitride Typical Properties

<table>
<thead>
<tr>
<th>Material</th>
<th>NBD-200*</th>
<th>SN-101C**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sintering Aid</td>
<td>MgO</td>
<td>Y₂O₃; Al₂O₃</td>
</tr>
<tr>
<td>Density [g/cm³] (% Theoretical)</td>
<td>3.16 (&gt; 99.9%)</td>
<td>3.21 (&gt; 99.9%)</td>
</tr>
<tr>
<td>RT Flexural Strength [MPa]</td>
<td>&gt;900</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Weibull Modulus</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Elastic Modulus [GPa]</td>
<td>320</td>
<td>310</td>
</tr>
<tr>
<td>Poisson's Ratio</td>
<td>0.26</td>
<td>0.27</td>
</tr>
<tr>
<td>Vicker's Hardness HV10</td>
<td>1550</td>
<td>1550</td>
</tr>
<tr>
<td>Fracture Toughness [MPa m¹/²]</td>
<td>6</td>
<td>6.5</td>
</tr>
<tr>
<td>Thermal Expansion Coefficient (1 X 10⁻⁶ / °C [RT to 1000°C])</td>
<td>2.9</td>
<td>3.7</td>
</tr>
<tr>
<td>Thermal Conductivity ([W/m K] @ 25°C)</td>
<td>29</td>
<td>34</td>
</tr>
<tr>
<td>Electrical Resistivity [ohm-cm]</td>
<td>10⁴</td>
<td>10⁴</td>
</tr>
<tr>
<td>Dielectric Constant @ 1MHz</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Corrosion 5% HF Solution, 500 Hours Weight Loss/Surface Area [g/cm²]</td>
<td>0.68</td>
<td>0.10</td>
</tr>
<tr>
<td>Corrosion 5% HCL Solution, 500 Hours Weight Loss/Surface Area [g/cm²]</td>
<td>0.0002</td>
<td>0.0036</td>
</tr>
</tbody>
</table>

*NBD-200 typical for balls 3.175 mm (0.125") diameter or smaller

**SN-101C typical for balls greater than 3.175 mm (0.125") diameter

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### Applications

#### High Speed
- Machine tool spindles
- Dental handpieces

#### Extreme Temperatures
- Space satellites
- Electric motors and generators

#### Low Friction
- Bicycles, in-line skates
- Wheel, clutch, transmission bearings

#### Extremely Low Lube
- Turbomolecular pumps
- Jet engines and wing flap ball screw actuator

#### Lightweight
- Electric motors and generators
- Turbomolecular pumps
- Jet engines and wing flap ball screw actuator

Charts intended to illustrate typical properties. Property values vary with method of manufacture, size, and shape of part. Data contained herein is not to be construed as absolute and does not constitute a representation or warranty for which CoorsTek assumes legal responsibility. CoorsTek and Cerbec are registered trademarks of CoorsTek, Inc.

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Americas
+1 303 271 7100 tel
+1 855 929 7100 toll free in USA
info@coorstek.com

Europe
+49 160 530 3768
infoeurope@coorstek.com

Japan
+1 81 3 5437 8411
japaninfo@coorstek.com

China
+86 21 6232 1125
info_shanghai@coorstek.com

Korea
+82 31 613 2946
koreainfo@coorstek.com

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