Mechanical Seal Ceramics

Face seal rings · Valves · Bearings
With their outstanding material properties, pump, appliance, and machine components made from high-performance ceramics offer new solutions through manufacturing techniques at the cutting edge of technology. Ceramics set ultimate standards in terms of wear resistance and durability, most especially under heavy loads or exposure in corrosive environments and heat.

Quality
Our QS 9000 and ISO 9001 based systems operate to the latest standards of quality management. With the aid of proven processes and closely monitored production cycles we can supply volume production parts as per customer specification to the same precision standards as samples and prototypes.
When and wherever fluids are being pumped, it is the face seal rings and plain bearings that undergo the most punishment, particularly if the medium is corrosive or abrasive. In fact, the durability and profitability of many items of plant and equipment hinge largely on the wear and corrosion resistance of these parts. Materials engineering therefore plays a major role in the seal ring industry. Whereas 20 years ago, steel or gray cast rings were used for such purposes, nowadays it is high-performance ceramics that do the same job. With their outstanding material and application properties, such ceramic parts have a service life extending many times over, even in aggressive media.
must possess lubricating properties. One well proven combination consists of ceramics to carbon graphite.

By mating alumina and silicon carbide we are able tune the sliding and sealing properties exactly to the actual operating environment. Combined bearings in high-performance ceramics are remarkable for their lightness, stiffness, low centrifugal forces, function and dry-running properties. CeramTec AG engineers develop face seal rings and bearings ranging up to 900 mm in diameter.
Possessing vast hardness and strength, good temperature, and excellent abrasion and corrosion resistance, silicon carbides are a very superior material, one that manifests its tribological superiority specifically under sliding conditions. Because of these properties, SiC face seal rings and plain bearings of various diameters are used for sealing purposes. Due to SiC’s mechanical and chemical resistance, these bearings can be immersed in the conveying medium, which itself performs the lubricating function. In this way, hermetically sealed pumps are used for conveying abrasive and corrosive liquids.

For pumping viscous media (f.e. sludges), these themselves can act as lubricants, thus dispensing with the need for lubricants (as required by metallic bearings) since the SiC seal is able to resist the abrasive substances.
Silicon carbide (SiC)

Silicon carbides are among the non-oxide ceramics; they are remarkable for their extreme hardness and wear resistance, properties that make them ideal for use in pumps and pump systems. This hardness is due to the bonding of the silicon and carbon atoms, this close bond also being the reason for the high Young’s modulus and low thermal expansion. Silicon carbide has good thermal conductivity combined with very low thermal expansion. Good chemical and thermal stability enable silicon carbides to work in aggressive media, at elevated temperatures, and while exposed to tribological stress.

Silicon infiltrated (SiSiC) and sintered silicon carbide (SSiC)

SiSiC is a silicon infiltrated silicon carbide with a three-dimensional matrix, in which the remaining pores are infiltrated with metallic silicon. It is specifically this matrix structure that gives the material its excellent mechanical properties and wear resistance. As firing shrinkage is very slight, large and complex seal rings can be produced to close dimensional tolerance. However, due to the metallic silicon’s melting point, working temperatures are limited to around 1400 °C. In highly alkaline environments, sintered silicon carbon (SSiC) is recommended since this stays stable in all chemical media. Unlike SiSiC, SSiC is pure silicon carbide and contains zero metallic silicon. However, the shrinkage that occurs may require the part to undergo machining in order to meet the specified tolerances.
<table>
<thead>
<tr>
<th>Material Characteristics</th>
<th>Units</th>
<th>Test Specification</th>
<th>Alumina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Name</td>
<td></td>
<td>Rubalit® A 1896</td>
<td>Rubalit® A 1999,5</td>
</tr>
<tr>
<td>Material</td>
<td></td>
<td>94% Al₂O₃</td>
<td>99% Al₂O₃</td>
</tr>
<tr>
<td>General characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulk density</td>
<td>g/cm³</td>
<td>DIN EN 623-2</td>
<td>3.71</td>
</tr>
<tr>
<td>Water absorption</td>
<td>%</td>
<td>DIN EN 623-2</td>
<td>0</td>
</tr>
<tr>
<td>Gas permeability</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mechanical Properties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexural strength</td>
<td>MPa</td>
<td>DIN EN 843-1</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DIN EN 820-1</td>
<td></td>
</tr>
<tr>
<td>Compressive strength</td>
<td>MPa</td>
<td>DIN 51067T1</td>
<td>3400</td>
</tr>
<tr>
<td>Young’s modulus</td>
<td>GPa</td>
<td>DINV ENV 843-2</td>
<td>330</td>
</tr>
<tr>
<td>Vickers hardness HV 0.5</td>
<td></td>
<td>DINV ENV 843-4</td>
<td>1520</td>
</tr>
<tr>
<td>Fracture toughness KIC</td>
<td>MPa m¹/²</td>
<td>DIN 51109</td>
<td>4.0</td>
</tr>
<tr>
<td>Weibull modulus</td>
<td></td>
<td>DINV ENV 843-5</td>
<td>&gt; 10</td>
</tr>
<tr>
<td>Poisson’s ratio</td>
<td></td>
<td>DINV ENV 843-2</td>
<td>0.23</td>
</tr>
<tr>
<td>Thermal and Electrical Properties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>W/mK</td>
<td>DIN EN 821-2</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear thermal expansion coefficient</td>
<td>10⁻⁶ K⁻¹</td>
<td>DIN EN 821-1</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8.3</td>
</tr>
<tr>
<td>Specific heat</td>
<td>kJ/kgK</td>
<td>DINV ENV 821-3</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistivity</td>
<td>Ω cm</td>
<td>IEC 672-1</td>
<td>&gt; 10¹⁴</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 10¹¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 10⁷</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>kV/mm</td>
<td>IEC 672-1</td>
<td>20</td>
</tr>
<tr>
<td>Dielectric constant</td>
<td></td>
<td>IEC 672-1</td>
<td>10 (10 MHz)</td>
</tr>
<tr>
<td>Dielectric loss factor</td>
<td></td>
<td>IEC 672-1</td>
<td>1·10⁻¹ (10 MHz)</td>
</tr>
<tr>
<td>Thermal shock resistance</td>
<td>°C</td>
<td>DINV ENV 820-3</td>
<td>150</td>
</tr>
<tr>
<td>Maximum usage temperature</td>
<td></td>
<td>DINV ENV 820-3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>°C</td>
<td></td>
<td>1450</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1450</td>
</tr>
</tbody>
</table>

The measured properties given above were determined for test samples and are applicable as standard values.
In order to profile ceramic substances certain parameters are indicated. The crystalline nature of these substances, statistical fluctuations in the composition of the substances and in the factors that impact on the production processes indicate that the figures quoted are typically mean values and hence the substance parameters quoted in this brochure are only standard, recommended or guide values that might differ given dissimilar dimensions and production processes.

<table>
<thead>
<tr>
<th></th>
<th>Zircona</th>
<th>Silicon Carbide</th>
<th>Silicon Nitride</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B 40</td>
<td>ZN 40</td>
<td>CD 101</td>
</tr>
<tr>
<td>99% Al₂O₃</td>
<td>ZrO₂-MgO</td>
<td>SiC-ZrB₂</td>
<td>SSIC</td>
</tr>
<tr>
<td>3.82</td>
<td>5.74</td>
<td>3.26</td>
<td>3.15</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zirconia</td>
<td>300</td>
<td>500</td>
<td>330</td>
</tr>
<tr>
<td>Silicon Carbide</td>
<td>2000</td>
<td>1600</td>
<td>2000</td>
</tr>
<tr>
<td>Silicon Nitride</td>
<td>360</td>
<td>210</td>
<td>415</td>
</tr>
<tr>
<td></td>
<td>1700</td>
<td>1240</td>
<td>2750</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>8.1</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>0.23</td>
<td>0.30</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>7.2</td>
<td>10.2</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>8.7</td>
<td>11.0</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>0.9</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>1·10⁻¹⁴</td>
<td>5·10⁻¹³</td>
<td>3·10⁻⁴</td>
</tr>
<tr>
<td></td>
<td>1·10⁻³³</td>
<td>5·10⁻²²</td>
<td>1·10⁻²</td>
</tr>
<tr>
<td></td>
<td>7900</td>
<td>27 (1 MHz)</td>
<td>29 (1 MHz)</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 (1 MHz)</td>
<td>1400</td>
<td>1400</td>
</tr>
</tbody>
</table>

**Indexes and parameters for ceramic substances**

In order to profile ceramic substances certain parameters are indicated. The crystalline nature of these substances, statistical fluctuations in the composition of the substances and in the factors that impact on the production processes indicate that the figures quoted are typically mean values and hence the substance parameters quoted in this brochure are only standard, recommended or guide values that might differ given dissimilar dimensions and production processes.
Rubalit® A 1896
An outstanding alumina with low density, good corrosion and wear resistance, very good electrical insulation and outstanding sliding properties. A polishing process opens the pores on the sliding surfaces, enabling the material to absorb lubricants and solid particles, thus making it the ideal mate for carbon, glass-fiber reinforced plastic, and sintered metals.

Rubalit® A 1999,5
Mechanically stronger, with superior thermal conductivity and greater corrosion resistance. Ultrapure alumina, which when mated with carbon, is especially suitable for plain bearings and face seal rings.

B 40
The ideal sliding mate, with the same properties as Rubalit® A 1896. A larger share of Al₂O₃ for superior chemical stability.

ZN 40
Zirconia is a ceramic with excellent surface quality and greater strength than alumina. The low Young’s modulus and the high resistance in sliding/wear applications combined with steel-like thermal expansion make this material the ideal mate for steel in high-temperature bearing applications.

Silicon carbide
Extremely hard, with excellent corrosion and thermal shock resistance. Outstanding sliding properties and superior thermal conductivity make this the ideal tribological mate.

SL 200 ST
A silicon nitride ceramic for mechanically stressed parts as well as elevated temperature applications. Remarkable for its strength and mechanical resistance plus thermal shock insensitivity. In contrast to the other silicon nitride materials, this is a gas-pressure sintered Si₃N₄ and hence possesses much superior mechanical properties such as greater flexural strength, fracture toughness and a higher Weibull modulus.
High-performance ceramics for plant and appliances

With such specific hallmarks as

- wear resistance
- corrosion resistance
- thermal shock resistance
- temperature stability

high-performance ceramics are moving into more and more applications.

From household appliances to medical equipment to industrial plant, ceramics and components add value and generate benefits. We achieve best possible results in product and system generation by working closely with our customers and through intelligent ceramics engineering. In this way, manufacturing costs are minimized right from the beginning. Test samples and prototypes are produced at our own pilot plant where they are tested and developed until ready for series production.
As part of our systems partnership approach, our experts are always available at your side. We advise you in the development of new products and technologies and in the constructive integration of ceramic parts and components. We decide the most suitable processes for making, samples, prototypes, batch and series production quantities. Our Project Management Team ensures efficient cooperation and a process driven system for maximum quality.

We analyze and decide:
CeramTec – the materials experts

We advise and develop:
CeramTec – the development experts

We manufacture and refine:
CeramTec – the production experts

Simultaneous engineering closes the time gap between idea and finished product
Our subsidiaries:

Czech Republic
CeramTec Czech Republic s.r.o.
Zerotinova 62
78701 Šumperk
Czech Republic
Phone: +420-538-367 190
Fax: +420-538-369 191
e-mail: ceramtec@ceramtec.cz
www.ceramtec.cz

Italy
CeramTec Commerciale Italiana
Via Campagnola, 40
24124 Bergamo
Italy
Phone: +39-035-32 23 82
Fax: +39-035-42 43 200
e-mail: ceramtec@ceramtec.191.it

North America
CeramTec North America Corp.
Laurens Operations
One Technology Place
Laurens, SC 29360
USA
Phone: +1-864-682-3215
Fax: +1-864-682-1140
e-mail: information@ceramtec.com
www.ceramtec.com

France
CeramTec AG
Innovative Ceramic Engineering
Bureau de Représentation en France
51, rue Pierre
92110 Clichy
France
Phone: +33-1-30 90 00 80
Fax: +33-1-30 90 00 23
e-mail: a.hainin@ceramtec.de
www.ceramtec.fr

Scandinavia
CeramTec
Innovative Ceramic Engineering
Swedish Sales Office
Klippian 1j
41451 Göteborg
Sweden
Phone: +46-31-12 48 00
Fax: +46-31-12 48 03
e-mail: hedlund@ceramtec.pp.se

China
Shanghai CeramTec
Innovative Ceramic Engineering Co., Ltd.
628, Kang an Road
Kang Qiao Industrial Zone
201315 Pu Dong Shanghai
PR China
Phone: +86-21-38 12 00 38
Fax: +86-21-38 12 00 38
e-mail: zhangxiaoanion@chemetall.com.cn

Great Britain
CeramTec UK Ltd.
Sidmouth Road Colyton
Devon EX24 6JP
England
Phone: +44-1297-55 27 07
Fax: +44-1297-55 33 25
e-mail: sales@ceramtec.co.uk

Spain and Portugal
CeramTec Ibérica
Innovative Ceramic Engineering, S.L.
Santa Marta, 23-25
08340 Vilassar de Mar (Barcelona)
Spain
Phone: +34-93-750 65 60
Fax: +34-93-7 50 18 12
e-mail: ceramtec@terra.es

Malaysia
Lot 17, Lorong Bunga Tanjung 3/1
Senawang Industrial Park
Negeri Sembilan
Malaysia
Phone: +60-6-6 77 93 00, 6 77 98 61
Fax: +60-6-6 77 93 88
e-mail: sales@ctmal.po.my

Taiwan
HERR CORPORATION
6F-11, No 22 Wu.chuan 2nd Road
HSN - CHUANG City
Taipei Taiwan
Phone: +886-2-2992244
Fax: +886-2-2992020
e-mail: her1@ms17.hinet.net

Korea
Olive Corporation
Hanshin Hue 104-304
Sangok-Dong 204-1
Bupjung-Ku
Incheon, Korea
Phone: +82-32-516-5221
Fax: +82-32-521-5221
e-mail: olivecorp@kornet.net

CeramTec AG
Innovative Ceramic Engineering
Mechanical Systems Division
Luitpoldstraße 15
D-91207 Lauf
Phone: +49 (0) 91 23/77-4 53
+49 (0) 91 23/77-5 94
Fax: +49 (0) 91 23/77-4 64
e-mail: mechanical_systems@ceramtec.de
www.ceramtec.de
A company of the mg chemical group Dynamit Nobel

This brochure is a general overview of our present state of knowledge and is intended to provide general information and general recommendations regarding our products and their uses. It is subject to change. It is expressly not a guarantee or warrantee of any specific properties of the products and/or materials described or their suitability for a particular application. Any existing industrial property rights must be observed. The quality of our products is assured under our Conditions of Sale.