

公司简介:

北京中兴实强陶瓷轴承有限公司是一家专业生产陶瓷轴承和陶瓷球的民营企业，从1982年开始至今，历经30多年对陶瓷轴承材料及其加工工艺、装备的潜心研究和不懈努力，积累了丰富的生产实践经验。企业几经变革，已经成为在陶瓷轴承，陶瓷材料制品加工方面的国内领军企业。目前，能够生产：**SSiC、Si3N4、ZrO2、Al2O3**等多种高性能材料制品。

现代工程陶瓷材料，具有耐各种强酸、强碱、盐等腐蚀性介质的侵蚀，耐高温、耐磨损、结构重量轻、极限转速高、噪声低、电绝缘、高温下尺寸稳定、启动力矩小，可在润滑条件恶劣的工况下工作，具有较高的使用寿命，可广泛地应用于：航天、航空、航海、石油、化工、机械、汽车、机车、冶金、电力、轻纺、泵类、制药、食品机械、医疗器械、科研和国防军事技术等领域。是具有较大的社会和经济效益的新材料、高附加值的高科技产品。

目前，北京中兴实强陶瓷轴承有限公司生产的碳化硅**SSiC**、碳化硅加碳**SSiC+G**陶瓷材料制品，以其优良的耐腐蚀、耐磨损、耐高温、耐干运转、电绝缘、长寿命等特点，在化工、电子、医药等的设备制造及应用领域，尤其是在各种泵、阀的制造及应用领域，具有极为突出的市场应用前景。

我公司拥有**ZXSQ**和**CSQ**两个商标，七项发明及实用新型专利。

尤其是在各种泵、阀的制造及应用领域，具有极为突出的市场应用前景。如磁力泵、屏蔽泵、液下泵、齿轮泵用的滑动轴承组件；离心泵、液下泵、齿轮泵用的机械密封组件。高压往复泵的柱塞，计量泵的阀球等众多泵用零部件。

各种阀门如球阀、闸阀等阀门的阀芯、阀座等零部件，既可以采用不同材质的软密封结构，也可以采用同材质的硬密封结构，可在极其恶劣的工况条件下使用。

Brief introduction of company

Beijing ZhongXing ShiQiang Ceramic Bearing Co. Ltd. is the first enterprise in China, specialized in manufacturing ceramic bearing and ceramic balls. Since the year of 1982 we have accumulated abundant experience in the production over the past more than 30 years, devoting ourselves whole-heartedly to the research and development of ceramic bearing material, our processing

technique and improvement of our equipments. Having undergone several evolution and transformation, our company has now become the leading enterprise in China domestic market in the fields of ceramic bearing and ceramic material products. At present, our factory can manufacture products made of Si₃N₄, SiC, ZrO₂ and Al₂O₃, as well as cemented carbide and other kinds of high property material.

Modern engineering ceramic materials, resistant to all kinds of acid, alkali, salt and other corrosive media erosion, high temperature, wear-resistant, light weight structure, extreme high speed, low noise, electrical insulation, dimensional stability under high temperature, low starting torque, can work under very poor lubrication condition with long life, can therefore be widely used in aviation, aerospace, marine, petroleum, chemicals, machinery, automobiles, locomotives, metallurgy, electric power, textile, pumps, pharmaceuticals, food machinery, medical equipment, defense and military research and technology, and many other fields. They are value-added high tech products with large social and economical benefits.

Currently ZXSQ silicon nitride ceramic (Si₃N₄) has started to replace the traditional metal material in metallurgical industry, and possess broad market application prospect, due to its excellent resistance to high temperature, molten metal corrosion, thermal shock, electrical insulation, high thermal conductivity, long life and other good characteristics.

Our company logo is ZXSQ and CSQ, and possesses seven inventand patents for utility models.

It has a very prominent market application prospect, especially in the field of the manufacture and application of various pumps, and valves. Such as the sliding bearing used in the magnetic pump, canned motor pump, submerged pump, and gear pump; the mechanical seals used in centrifuge pump, submerged pump, and gear pump, plungers used in the high pressure reciprocating pump, and the valve ball used in the metering pump.

The valve core and valve seat in different kinds of valves can adopt soft sealing structure in different material, also can be hard seal structure with the same material. This can be used in extreme operating conditions.

常压烧结碳化硅陶瓷的应用简介

The introduction of the pressureless sintered silicon carbide

常压烧结碳化硅陶瓷，由于其具有：耐磨、耐腐蚀、高硬度、低密度以及较高的高温强度。因而，近十多年来，在国计民生的各个领域得到了日益广泛的应用。在航空航天、核工业、石油工业、化学工业、轻纺工业、食品工业等需要在高温、高速、耐腐蚀、真空、电绝缘、无磁、干磨擦等特殊环境下，作为一种新型陶瓷材料其不可或缺的替代作用正在被人们逐渐地认识，得到了广泛的应用。主要有以下几个方面：

In recent 10 years, the silicon carbide is becoming more and more widely used in the various fields of economy or life, with its properties of high wear resistance, corrosion resistance, hardness, low density and high temperature strength. As a new type of ceramic material, it has been gradually known and widely used in the area of aerospace, nuclear industry, oil, chemical industry, textile and food industry, which is in special conditions, such as high temperature, high rotating speed, corrosion resistance, vacuum, electrical insulation, non-magnetic, and dry friction, and other special. Basically see the following several aspects:

一、磁力泵组件 Parts of magnetic pump

随着精密化工产品的飞速发展，特别是国际标准ISO14000的进一步贯彻执行，杜绝跑、冒、滴、漏，对化工行业环境保护，尤其是对腐蚀性液体的输送提出了更高的要求。

磁力泵由于采用静密封代替机械密封、填料密封等动密封，因而泄漏更小，可靠性更高、使用寿命更长。对于磁力泵通长需要长时间的免维护，时间约为5-8年，这就对磁力泵轴系组件的选材提出了极为苛刻的要求。如泵中的泵轴、止推盘、轴套在装配后，必须耐磨损、耐腐蚀，且零泄漏。目前常压烧结碳化硅陶瓷已成为最适合的首选材料。

Along with the rapid development of the precision chemical products, especially with the further implement of the ISO14000, which completely eradicate escape, emitting, dripping, and leakage. The requirement of transporting corrosive liquid is becoming higher and higher at the base of protecting the environment.

Magnetic pump use static seal instead of motive seal like mechanical seal, packing seal, so the leakage is less, the reliability is higher, and the working life is longer. Usually, magnetic pump is maintenance-free pump for long time, approx. 5-8 years, it would present extremely rigorous requirement to the material of shaft system components. For example, pump shaft, thrust washer, bushings after the assembly, must be wear resistant, corrosion resistant, and zero leakage. At present, pressureless sintered silicon carbide ceramic has become the most proper material.

二、机械密封环 Mechanical seals

常压烧结碳化硅陶瓷的耐化学腐蚀性好、强度高、硬度高、耐腐蚀性能好、磨擦系数小、抗氧化、高温蠕变小、热稳定性好，因而是制造密封环的理想材料。由于材料基体组织致密，游离硅，游离碳含量极少，在高纯、超净、精细化工等领域中得到日益广泛的应用。工件表面的超精密加工，使其在组合配对时，磨擦系数比氧化铝陶瓷和硬质合金小，因而具有较高的PV值，特别适合于在输送强酸，强碱及耐腐蚀性液体的工况中使用。我公司生产的常压烧结碳化硅制品，具有密度高（3.10-3.20g/cm³）硬度高（HRA94），可多品种、成批量生产各种形状复杂的机械密封环，如平环、单面台阶环、多级台阶环等。

Pressureless sintered silicon carbide ceramic has well corrosion resistance, high strength, high hardness, wear resistance, and small friction coefficient, antioxidant, small creep high temperature, and good heat stability. So it's the ideal material for the production of seal rings. This material is becoming more and more popular in the industry of high purity, ultra-clean, and fine chemistry, because of its fine and close construction, small content of free silicon and free carbon. Under the ultra-precision machining of the surface, its friction coefficient is smaller than the aluminum ceramic and cemented carbide during the combination and matching. Thus it has high PV value, and is particularly suitable for the conditions of strong acid, alkali and corrosion resistance liquid. The pressureless sintering silicon carbide of our company possesses high density(3.10-3.20g/cm³), and high hardness(HRA94). We can produce all kinds of seals ring in complicated shape with mass production, such as flat seals, seals with one side step, and multistage steps,etc.

三、喷砂嘴 Nozzle

作为替代硬质合金、氧化铝陶瓷材料的后起之秀，常压烧结碳化硅材料已经成为仅次于碳化硼陶瓷，是喷砂行业用量最大的材料。氧化铝陶瓷喷嘴的价格虽然低廉，但由于硬度低，耐磨性较差，只能用于喷砂工作量不大的场合。实际使用中，常压烧结碳化硅陶瓷的使用寿命是氧化铝陶瓷的4-7倍，更多用于比重大的硬质合金的替代产品。

As a replacement of cemented carbide and Aluminum oxide ceramic, Pressureless sintered silicon carbide has become the largest dosage material only second to boron carbide in the sand blasting industry. Although Aluminum oxide nozzle's price is low, but due to the low hardness, poor wear resistant, so it's only can be used in the situation of low workload. In the actual service, working life of pressureless sintered silicon carbide is 4-7 times of Aluminum oxide ceramic, more used as a replacement of high density cemented carbide.

其它方面，如在陶瓷球阀的阀芯组件，板式换热器中的组板，军工用的陶瓷装甲等诸多领域，碳化硅材料产品也都应用颇为广泛。

In other parts, such as valve core in ceramic ball valve, the sheet in the plate heat exchanger, and

ceramic armor in military industry, the SSiC (Silicon Carbide) material has been widely used and more and more popular.

不锈钢磁力泵 Magnetic drive pump

滑动轴承作为磁力泵的的支撑、回转单元，是至关重要的传动部件。

碳化硅SSiC具有优良的耐腐蚀、耐磨损等特性，是泵用滑动轴承的最佳选材之一。

不锈钢磁力泵的主要应用工况：

●应用于物料介质的腐蚀性一般，能耐不锈钢材料腐蚀的，如有机物类、酸、碱、盐类的介质，此类工况可采用碳化硅SSiC（烧结）滑动轴承作为标准配置。

●应用于物料介质的腐蚀性一般，能耐不锈钢材料腐蚀的，且易汽化的介质，此类工况可采用碳化硅 SSiC 加碳的滑动轴承作为标准配置。

对设计的要求：

●碳化硅 SSiC 材料具有虽然具有诸多的优良特性，但是任何材料都有相应的缺点，那就是脆性。因此必须要扬长避短，使其发挥优势才能得到良好的应用。本公司可以帮助客户对泵用滑动轴承组件的结构进行优化设计，使其发挥最佳效能！

因而，碳化硅SSiC滑动轴承作为磁力泵的标准配置，被国内外各大磁力泵企业所采用。

Magnetic drive pump (steel) 字体加粗

Sliding bearing is a crucial transmission part, as the support and rotary unit of magnetic pump.

With the excellent corrosion resistance, wear resistance and other properties, silicon carbide (SSiC) is one of the best sliding bearing material for the pumps.

Main application of the stainless steel magnetic drive pump字体加粗

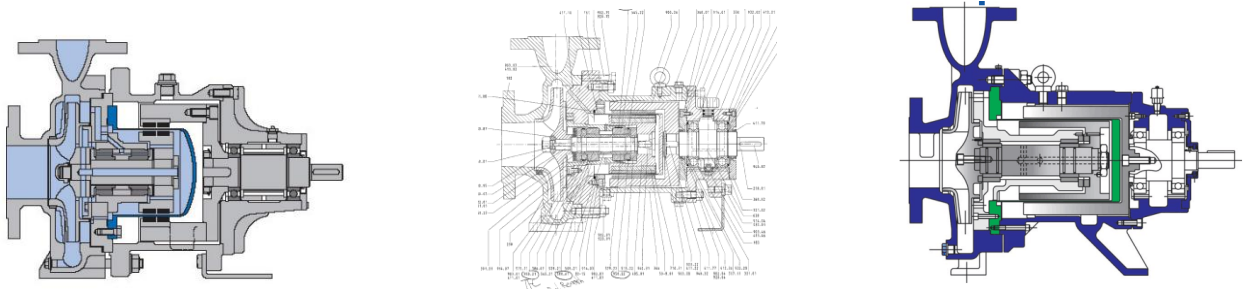
- It is used in common corrosive condition, such as the medium of inorganic matter, acid, alkaline and salt. In such condition, SSiC (sintered) is taken as standard sliding bearing.
- It is used in common corrosive condition, and the medium easy to vaporized. In such condition, SSiC +C is taken as standard sliding bearing.

Design requirement 字体加粗

- Although SSiC material has many good properties, but it's also have disadvantage, which is fragility. Therefore we should make full use of its advantage to get the best application. Our company can optimize and design the pump sliding bearings for the customers, and to realize the best performance.

The SSiC sliding bearing is taken as standard part in magnetic pump, and used by many magnetic pumps in domestic or foreign enterprises.

Magnetic Drive Pump(Stainless Steel)



衬氟磁力泵

滑动轴承作为磁力泵的支撑、回转单元，是至关重要的传动部件。

碳化硅SSiC具有优良的耐腐蚀、耐磨损等特性，是泵用滑动轴承的最佳选材之一。

衬氟磁力泵的主要应用工况：

●应用于物料介质的腐蚀性极强，而温度又不超过260℃，如无机物类、强腐蚀性的弱酸、碱类的介质，此类工况可采用碳化硅SSiC（烧结）滑动轴承作为标准配置。

对设计的要求：

●碳化硅 SSiC 材料具有虽然具有诸多的优良特性，但如何使碳化硅 SSiC 泵轴、轴套、口环、推力环等零件，与衬氟的泵壳等零部件的固定、连接、包覆等结构设计就成为了关键，本公司可以帮助客户对泵用滑动轴承组件的结构进行优化设计，使其发挥最佳效能！

因而，碳化硅SSiC滑动轴承作为磁力泵的标准配置，被国内外各大磁力泵企业所采用。

Magnetic Drive Pump(Teflon Lined)

Sliding bearing is a crucial transmission part, as the support and rotary unit of magnetic pump.

With the excellent corrosion resistance, wear resistance and other properties, silicon carbide (SSiC) is one of the best sliding bearing material for the pumps.

Main application of the Teflon Lined Magnetic pump 加粗

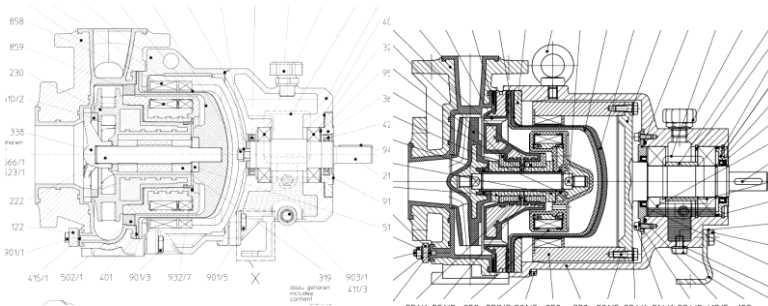
● It is used in the medium of strong corrosion, and the less than 260 °C temperature, such as inorganic matter, and weak acid, alkaline with strong corrosion. In such condition, SSiC(sintered) is taken as standard sliding bearing.

Design requirement 加粗

- Although SSiC material has many good properties, the most important thing is how to make the SSiC shaft, bushing, thrust ring and other parts fix, connect and clad with the pump case. Our company can optimize and design the pump sliding bearings for the customers, and to realize the best performance.

The SSiC sliding bearing is taken as standard part in magnetic pump, and used by many magnetic pumps in domestic or foreign enterprises.

Magnetic Drive Pump(Teflon Lined)



屏蔽泵

滑动轴承作为屏蔽泵的的支撑、回转单元，是至关重要的传动部件。

碳化硅SSiC具有优良的耐腐蚀、耐磨损等特性，是泵用滑动轴承的最佳选材之一。

屏蔽泵的主要应用工况：

- 应用于物料介质的腐蚀性一般，可耐不锈钢材料腐蚀的，如有机物类、酸、碱、盐类的介质，此类工况可采用碳化硅SSiC（烧结）滑动轴承作为标准配置。
- 应用于物料介质的腐蚀性一般，可耐不锈钢材料腐蚀的，且易汽化的介质，此类工况可采用碳化硅SSiC加碳的滑动轴承作为标准配置。

对设计的要求：

- 碳化硅 SSiC 材料具有虽然具有诸多的优良特性，但是任何材料都有相应的缺点，那就是脆性。因此必须要扬长避短，使其发挥优势才能得到良好的应用。本公司可以帮助客户对泵用滑动轴承组件的结构进行优化设计，使其发挥最佳效能！

因而，碳化硅SSiC滑动轴承作为磁力泵的标准配置，被国内外各大屏蔽泵企业所采用。

Canned motor pump

Sliding bearing is a crucial transmission part, as the support and rotary unit of canned motor pump.

With the excellent corrosion resistance, wear resistance and other properties, silicon carbide (SSiC) is one of the best sliding bearing material for the pumps.

Main application of Canned motor pump 加粗

- It is used in common corrosive condition, such as the medium of inorganic matter, acid, alkaline and salt.

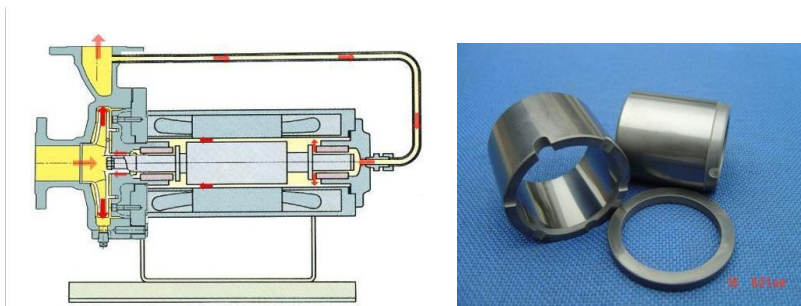
In such condition, SSiC(sintered) is taken as standard sliding bearing.

- It is used in common corrosive condition, and the medium easy to vaporized.

Design requirement 加粗

Although SSiC material has many good properties, but it's also have disadvantage, which is fragility. Therefore we should make full use of its advantage to get the best application. Our company can optimize and design the pump sliding bearings for the customers, and to realize the best performance. The SSiC sliding bearing is taken as standard part in magnetic pump, and used by many canned motor pumps in domestic or foreign enterprises.

Caned Moter Pump



齿轮泵

滑动轴承作为齿轮泵的支撑、回转单元，是至关重要的传动部件。

碳化硅SSiC具有优良的耐腐蚀、耐磨损等特性，是齿轮泵用滑动轴承的最佳选材之一。

主要应用工况：

- 齿轮泵作为高粘度且具有腐蚀性的介质输送的流体，需在高温的工况下常用的泵；
- 齿轮泵作为计量等用途的泵；
- 特别是特种塑料的输送，使用效果绝佳。有着其他泵无可比拟的优势。

按照结构形式的不同分为：内啮合、外啮合两种：因各自的结构不同而采用不同形式的碳化硅SSiC滑动轴承

Gear Pump

Sliding bearing is a crucial transmission part, as the support and rotary unit of gear pump.

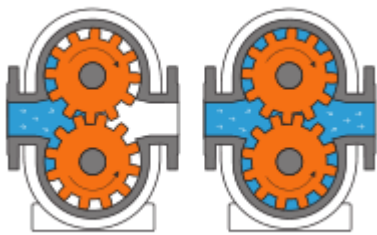
With the excellent corrosion resistance, wear resistance and other properties, silicon carbide (SSiC) is one of the best sliding bearing material for the pumps.

Main applications 加粗

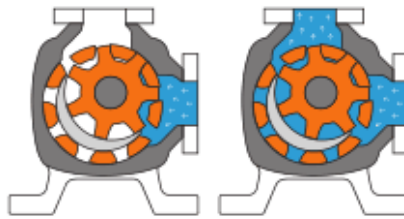
- The gear pump can be used to transport the liquid with high viscosity and corrosion, and commonly used in high temperature.
- The gear pump can be used for metering.
- The gear pump has the good advantage which other pump can't compare, especially for the transport of special material.

According to the structure difference, it can be divided into: external gear pump and internal gear pump. As the structure of pump is different, the SSiC sliding bearing used is also different.

外啮合齿轮泵



内啮合齿轮泵



Gear Pump

液下泵 Submerged Pump

滑动轴承作为屏蔽泵的支撑、回转单元，是至关重要的传动部件。

碳化硅SSiC具有优良的耐腐蚀、耐磨损等特性，是泵用滑动轴承的最佳选材之一。

Sliding bearing is a crucial transmission part, as the support and rotary unit of submerged pump.

With the excellent corrosion resistance, wear resistance and other properties, silicon carbide (SSiC) is one of the best sliding bearing material for the pumps.

主要应用工况: Main applications

●液下泵主要是输送各种酸、碱、盐等腐蚀性介质，因而轴承的耐腐蚀性很重要；

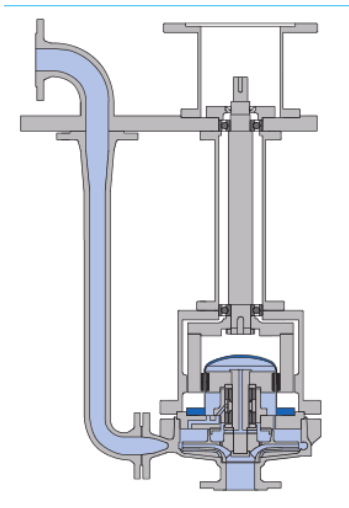
The submerged pump mainly transmit all kinds of acid, alkali, salt and other corrosive medium, thus the corrosive resistance of bearing is very important.

●液下泵主要输送带颗粒的污水、泥浆等介质，因而轴承的耐磨性很重要；

The submerged pump mainly transport the medium with particles of sewage and mud, thus the wear resistance of bearing is also very important.

因而，碳化硅SSiC滑动轴承作为液下泵的标准配置，被国内外各大液下泵企业所采用。

The SSiC sliding bearing is taken as standard part in submerged pump, and used by many submerged pumps in domestic or foreign enterprises.



Submerged Pump

机械密封环 Mechanical Seals

机械密封是一种旋转机械的轴封装置，它是由至少一对垂直于旋转轴线的端面在流体压力和补偿机构弹力（碟力）的作用及辅助密封的配合下保持贴合并相对滑动构成防止流体泄漏的装置。

一般由两个环片组成，即动环、静环。在很大压力下仍然能以较小的阻力，仍能实现互相旋转运动。

Mechanical seal is a kind of shaft sealing device rotating the machinery, it is formed by at least a pair of end face perpendicular to the rotation axis, and under the force of fluid pressure and compensation

institution elastic force (stone force) ,and with the cooperation of the auxiliary seal, the faces keep seat and the relative sliding, to prevent the fluid leakage.

Generally it consists of two segments, namely rotating ring and static ring. These rings can still realize rotary motion for each other with smaller resistance, under the much more pressure.

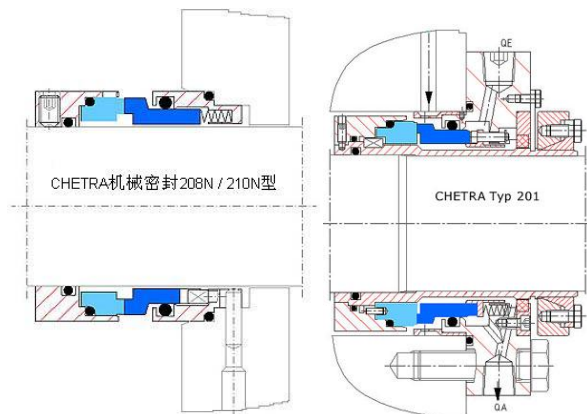
主要应用工况: **Main applications**

该动环、静环一般采用一对纯 SSiC 环, 或采用一个 SSiC 环与一个 SiC 加 C 的环的组合方式

- 动环、静环采用: 一对纯 SSiC 环, 适用于强腐蚀的介质;
 - 动环、静环采用: 一个 SSiC 环与一个 SiC 加 C 的环, 适用于易汽化的介质;
- 是目前化工行业主流的密封组合

The rotating ring and static ring is generally formed by the group of pure SSiC rings, or one SSiC and the other is SiC+C material.

- Rotating and static ring: a pair of pure SSiC rings, applicable for strong corrosive medium.
- Rotating and static ring: a SSiC ring, and a SiC+C, applicable for the medium easy to vaporized.



标准式 (Standrard type)

集装式(Integrated type)

Sealing Ring

球阀 Ball Valve

球阀具有接触面积大, 密封严密、少泄露等优点。

球阀分为浮动式、固定式两种

The ball valve has the advantage of large contact area, tight seal, and less leakage, etc. It can be divided two kinds: floating type and stationary type.

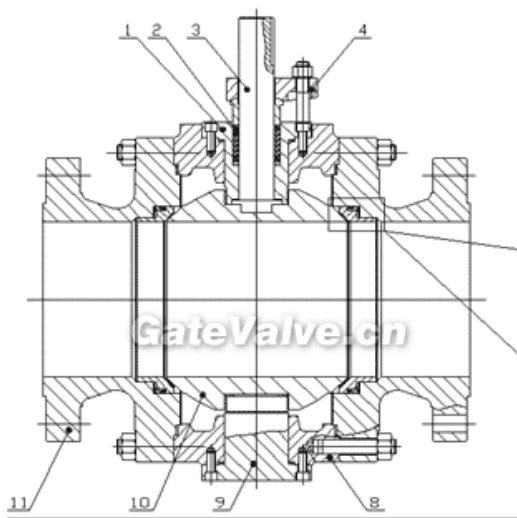
主要应用工况: **Main applications**

- 球阀 主要应用于强腐蚀物料的输送; 如酸、碱、盐等介质

The ball valve mainly transmits strong corrosive material, such as acid, alkali, salt and so on.

●球阀 主要应用于高耐磨物料的输送；如硅粉、煤粉等介质

The ball valve is mainly used for transmitting high wear-resisting material, such as silicon powder, coal dust and so on.



Ball Valve



陶瓷材料在其他泵类产品中的应用

The applications of ceramic material in other pumps.

陶瓷材料由于其具有良好的耐腐蚀、耐磨、耐高温、绝缘性好等优点，在其他众多的化工泵领域中都有所应用。

主要材料：SSiC 碳化硅、ZrO₂ 氧化锆、Al₂O₃ 99.5%氧化铝

The ceramic material has the excellent advantage of corrosion resistance, wear resistance, high temperature, good insulation and other properties.

Main material: SSiC(Silicon Carbide), ZrO₂(Zirconium Oxide), Al₂O₃ 99.5%(Aluminum Oxide).

陶瓷转子 Ceramic Rotor

转子泵中的陶瓷转子 The ceramic rotor used in rotor pump



1、陶瓷柱塞 Ceramic Plunger

高压往复泵中的陶瓷柱塞 Ceramic plunger used in high pressure reciprocating pump



2、陶瓷阀球 Ceramic Valve ball

计量泵中的陶瓷阀球 The ceramic valve ball used in metering pump



3、陶瓷齿轮 Ceramic gear

齿轮泵中的陶瓷齿轮 The ceramic gear used in gear pump

磁力泵用内外磁转子

Inner and outer magnetic coupling used in magnetic pump

我司专业对外承接磁力泵用，内外磁转子的加工制造。

拥有独特的一次性进行大批量零件的打压测漏技术

Our company professionally undertakes the processing and manufacturing of the inner and outer magnetic coupling. And we also possesses the unique suppression of leak detection technology one-off for large quantity parts.

Magnetic Coupling

内磁转子(Inner magnetic coupling) 外磁转子(Outer magnetic coupling)



陶瓷材料特性表

Silicon Carbide Ceramic Material Basis Capability List

项 目	Items	单位 Unit	SSiC Silicon Carben	SSiC+G SiliconCarben+G
密度 d	Density	g/cm ³	3.10-3.13	2.90-3.00
硬度 Hv	Hardness Hv1	Kg/mm ²	>2550	>2350
弹性模量 E	Young's Modulus	GPa	410	400
抗弯强度 σRT	Bending Strength	MPa	400-490	230-360

抗压强度	Compressive Strength	MPa	>2500	>2250
断裂韧性 K_{IC}	Fracture Toughness	MPam ^{1/2}	4-5	5-5.5
泊松比	Poisson's Ratio		0.16	0.15
热膨胀系数 α	Coefficient of Linear Expansion	10 ⁻⁶ /k	4.0	4.2
晶粒度	Crystal Size	μm	< 5	10-50
气孔率			<3%	1-14%
烧结方式: 常压烧结 S-SiC Pressureless Sintering				

对设计的要求: Design requirement

● 碳化硅 SSiC 材料虽然具有诸多的优良特性, 但是任何材料都有相应的缺点, 那就是脆性。因此必须要扬长避短, 使其发挥优势才能得到良好的应用。本公司可以帮助客户对泵用滑动轴承组件的结构进行优化设计, 使其发挥最佳效能!

Although SSiC material has many good properties, but it's also have disadvantage, which is fragility. Therefore we should make full use of its advantage to get the best application. Our company can optimize and design the pump sliding bearings for the customers, and to realize the best performance.

● 碳化硅 SSiC 材料与不锈钢材料在高温时的线膨胀系数不一致, 而引发诸多问题, 如高温时轴的膨胀, 会使轴套而破损! 再如高温时轴承座、止推盘座的膨胀, 会使碳化硅 SSiC 滑动轴承与轴承座松脱, SSiC 止推盘与止推盘座松脱, 导致泵轴被卡死或轴承损坏后的碎片, 磨穿屏蔽套而损伤到屏蔽电机等部件。而此采用波浪形金属膨胀环来充当热膨胀的缓冲媒介则为极佳的解决方案。

Coefficient of linear expansion of Silicon carbide material is different from stainless steel material, which causes many problems, for example, expansion of shaft in the high temperature, will make the bushings damaged! Expansion of bushing seat, thrust washer seat, will make SSiC bushings and its seat getting loose, SSiC thrust washer and its seat getting loose, which leads to block death of the pump shaft, or the fragment of damaged bearing wear through shielding can, then damage the shielding motor etc. So using the wave metal expansion ring as the buffering media of heat expansion, is a superb solution.

