

# Ceramic bearings

Your essential  
guide to ceramic  
bearings



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BEARINGS

# An essential guide to ceramic bearings

Steel has long reigned supreme in the bearing world, as the traditional option for most bearing types. For some applications though, steel won't suffice.

At SMB Bearings, we know that determining the correct bearing type can be tricky, especially with so many bearing material variations on the market. In this guide, we will answer the most common questions related to ceramic bearings and their potential applications.

Before getting into the nitty gritty of ceramic bearing applications though, let's understand the different types of ceramic materials and how to differentiate between them.



*Chris Johnson*

Managing director,  
SMB Bearings



# Zirconia (CCZR)



Zirconia is fairly new on the ceramics market, having been developed in the 1960s. Its original creation was intended to produce thermal tile barriers for use on a space shuttle. Due to the vast temperature fluctuations experienced in space, the addition of zirconia tiles would allow the shuttle to re-enter the Earth's atmosphere safely. Cool stuff, don't you think?

## ZIRCONIA BEARINGS BOAST HIGH CORROSION RESISTANCE PROPERTIES, ESPECIALLY AGAINST ACIDS AND ALKALIS, MAKING THIS AN IDEAL MATERIAL CHOICE FOR CHEMICAL APPLICATIONS.

The surface of these bearings can degrade after prolonged exposure to hot water or steam and there has been evidence to suggest zirconia also suffers surface weakening in low temperatures, particularly in the presence of moisture.

Thankfully, this slight degradation doesn't have a detrimental effect on the bearing. They can still perform well at most temperatures. In fact, zirconia bearings can operate from temperatures as low as  $-190^{\circ}\text{C}$  to an impressive  $400^{\circ}\text{C}$ .

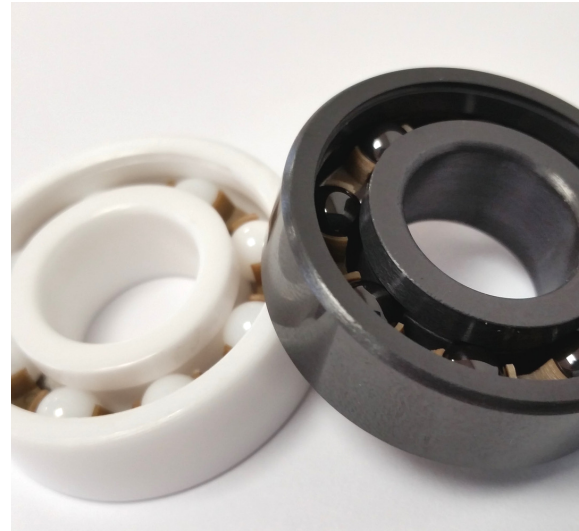
- ⚙️ Wide temperature range
- ⚙️ Nonmagnetic
- ⚙️ Electrically insulating
- ⚙️ Lower speed and load than steel
- ⚙️ Not suitable for low noise applications
- ⚙️ 75 per cent of the density of steel
- ⚙️ Higher flexural strength than other ceramics, making it more suitable for small shock loads
- ⚙️ Expansion similar to chrome steel and equal to 440 stainless steel
- ⚙️ Ideal for corrosive environments

# Silicon Nitride (CCSI)



Silicon Nitride provides the best ceramic material for higher speed applications. That said, these bearings cannot match the high speeds of precision steel bearings. So, if steel bearings are an option, consider those first.

Silicon Nitride has 40 per cent the density of steel. As a result, these bearings are 58 per cent lighter providing a weight saving benefit. Unlike some other ceramic materials, Silicon Nitride can carry similar loads to steel but, as with any ceramic material, it cannot handle shock loading.



- ⚙ Good corrosion resistance to water, saltwater, acids and alkalis
- ⚙ Wide temperature range, from -210°C to 800°C without cage
- ⚙ Nonmagnetic
- ⚙ Electrically insulating
- ⚙ Suitable for use in high vacuum applications
- ⚙ Not suitable for low noise applications
- ⚙ Very low thermal expansion, shaft or housing fits may be required for high temperature applications

**HIGH SPEED APPLICATION? SILICON NITRIDE BEARINGS SHOULD BE YOUR FIRST CHOICE OF ALL THE CERAMIC MATERIAL OPTIONS.**



# Silicon Carbide (CCSC)

Looking for corrosion resistance? Silicon Carbide is by far the superior option. This material also has the best high temperature performance of all the ceramics, withstanding impressive 1600°C when operating without a cage. Despite being the most brittle of the ceramic materials, Silicon Carbide is one tough cookie.

The bad news is that Silicon Carbide bearings are far less common than other ceramic bearing types. The raw material costs are high and it's difficult to machine. However, for some applications, nothing else will do.

- ⚙ Superior corrosion resistance
- ⚙ Nonmagnetic
- ⚙ Electrically conductive
- ⚙ 40 per cent the density of steel
- ⚙ Very low thermal expansion, shaft or housing fits may be required for high temperature applications
- ⚙ Brittle and cannot tolerate shock loads
- ⚙ Not supplied from stock



# Hybrid bearings



When most people think of ceramic bearings, they are actually referring to hybrid versions. Hybrid bearings sit between full ceramic and steel options. While they use ceramic balls, these bearings are paired with metal inner and outer rings. Using this combination allows for higher speeds than full ceramic options, as the less brittle metal rings are not as prone to sudden catastrophic failure under high speed or load.

Silicon nitride is the most popular for the balls in hybrid bearings. It has only 40 per cent of the density of bearing steel but is much harder giving greater wear resistance. Hybrid bearings are also capable of higher speeds due to the lower centrifugal force generated by the ceramic balls.

However, due to the lower elasticity of the balls, the contact area is smaller which causes a higher contact pressure. Often, this causes the raceways to wear faster.



**UNLIKE FULL CERAMIC, HYBRID BEARINGS SOMETIMES NEED LUBRICATION. THAT SAID, THEY MAY NOT NEED LUBRICATING TO THE EXTENT OF STEEL BEARINGS.**

Although the ceramic balls will still abrade the steel rings, hybrids will cope with marginal lubrication better than steel bearings due to the low friction coefficient and lightness of the balls.

Lubrication may not be required when using hybrid bearings at very low speeds. However, as these bearings are often selected for higher speed applications than full ceramics, suitable lubrication is advised.

A photograph of a person in a warehouse, wearing a black shirt and a silver watch, holding a clipboard and a pen. The person is standing next to tall, blue metal shelving units filled with cardboard boxes. The background is slightly blurred, showing more shelves and boxes. The image is partially obscured by a white diagonal shape on the right side, which contains the text.

# Frequently asked questions

Still confused? You're in the right place for answers.

# What are the advantages of ceramic bearings?

Ceramic bearings might be more expensive than steel, but provide reduced friction, reduced weight and have the potential to last much longer than the traditional stainless-steel offering, particularly in many harsh environments. That said, the application needs to warrant the increased price.

Full ceramic bearings are generally used in environments that are too hostile for steel such as extreme temperatures or use with corrosive chemicals or liquids.

Marine applications as a great example of when ceramics may be necessary. Ceramic bearings can provide excellent resistance to saltwater, prolonging the lifespan of the bearing in ocean environments.

However, full ceramic options are not recommended where heavy shock loads are likely, due to the bearings risk of cracking. In these instances, 316 stainless steel bearings might be a better option as long as the load is low.

# Can you lubricate ceramic bearings?

Full ceramic bearings do not need lubricant to operate. However, lubrication can be used to keep the ceramic material from wearing down prematurely and extend bearing life.

Hybrid bearings often need lubrication. Check out page six for our guide to hybrid bearings.

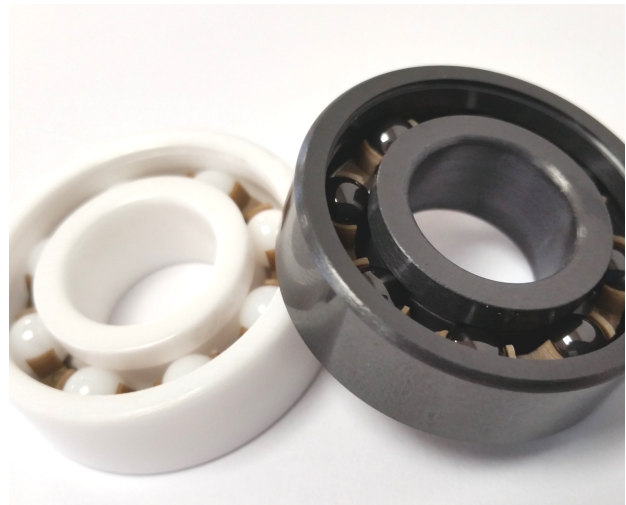




# Which is better, full ceramic or hybrid bearings?

You cannot compare the two without knowing the end application.

Full ceramic bearings have excellent corrosion resistance and can cope with very extreme temperatures but due to the more brittle nature of ceramics, the maximum speed is 20 per cent to 25 per cent of the all steel equivalent due to the risk of sudden failure caused by cracking at higher speeds. The maximum load of a full ceramic bearing is around 65 to 75 per cent of the load that a steel bearing can support.

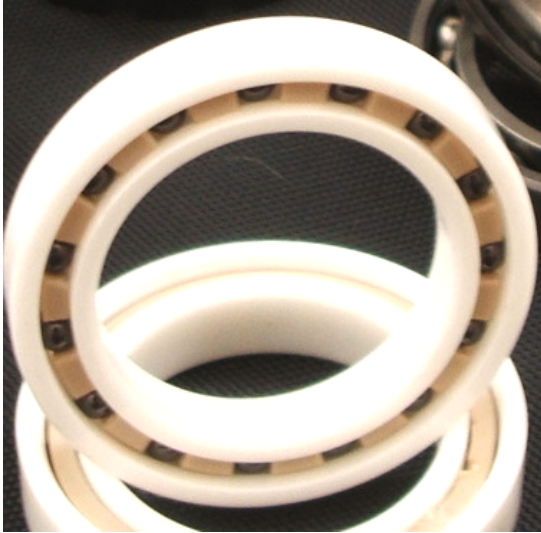


Hybrid bearings use steel rings and ceramic, usually silicon nitride, balls. This combination means that hybrid bearings can run at higher speeds due to the more forgiving nature of steel and the lower centrifugal force generated by the lightweight ceramic balls. However, they are limited in terms of corrosion resistance and extreme temperature capability by the material of the rings.

Shock or sudden impact loads should be avoided with both full ceramic bearings and hybrid bearings. The steel rings in a hybrid bearing will withstand shock loads much better than ceramic rings but, in the event of a sudden impact load, the much harder ceramic balls will make indentations in the steel raceways leading to rapid wear and early failure.

Ultimately, the better bearing depends on the application it is required for.

## Can ceramic bearings rust?



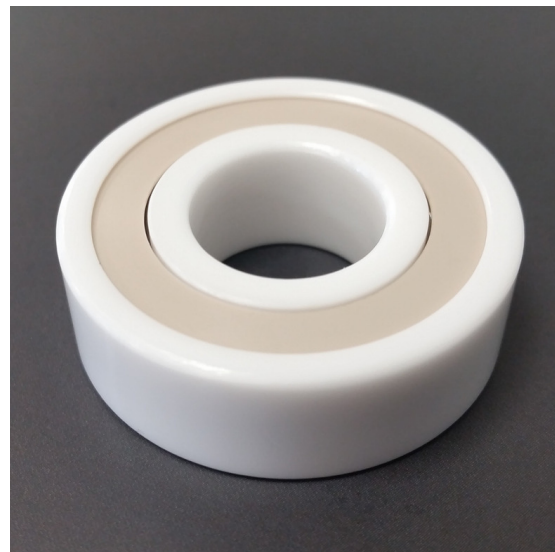
Choosing a full ceramic bearing will save you the headache of dealing with rust. These bearings are designed to be corrosion resistant and to be used for long periods of time in corrosive environments. Where even stainless-steel bearings would suffer with rusting, full ceramic bearings will not.

However, this is not the case for hybrid bearings – those with steel races but ceramic balls. While the ceramic balls of these bearings will not rust, the rest of the bearing will need to be maintained against rust.

## Can ceramic bearings shatter?

Yes. Full ceramic bearings have load ratings 25 to 35 per cent lower than steel bearings as the material is more brittle. Therefore, when put under too much pressure, ceramic bearings will shatter.

Before deciding to use full ceramic bearings, it is important to assess whether the bearing can handle the planned load. If not, a hybrid or stainless-steel version would be a better option.



# Should ceramic bearings always run without lubricant?

Full ceramic bearings do not require lubrication to run. Ceramic is non-porous and as a result, it is practically frictionless. Unlike stainless steel bearings, full ceramic bearings do not suffer heat build-up within the bearing and therefore do not need lubrication to help dissipate the heat.



Full ceramic bearings are the only type of bearing recommended to run dry at anything other than very low speeds. For other bearing materials, lubrication can be essential to the bearing's operation.

## How long will a ceramic bearing last?

The lifespan of a bearing doesn't necessarily relate to its material, but rather whether it is the correct type of bearing for the application.

Cheap bearings won't last as long compared to higher quality versions. More importantly, a bearing certainly won't last long if it is not suitable for the application at hand.

# Any other questions?

At SMB Bearings, we keep our product range specialised and clearly defined. This means we keep comprehensive stocks of ceramic bearings and offer excellent technical back-up.

Contact the team today to find the right bearing for your application.



[www.smbbearings.com](http://www.smbbearings.com)



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