Ceramic Ball Bearings

**ABSTRACTS:**

Want to save a million barrels of petroleum a year, simply by changing the bearings in your machines? It sounds too good to be true, but new materials now make more-efficient ball bearings possible. All-ceramic bearings’ lower density, friction, and lubrication needs let them last longer and save energy. Bearings use ceramics like silicon nitride (Si₃N₄), alumina (Al₂O₃), or zirconia (ZrO₂). Ceramic materials resist acids, alkalis, and salt. For these reasons, bearings using ceramic balls and races don’t need oil or grease.

**Introduction:**

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

Ceramic bearings have the normal steel balls replaced by white ceramic balls. The ceramic balls are made of solid silicon nitride. Ceramic silicon nitride balls are called ceramic but have nothing in common with household dish ceramics. They are called ceramic because it’s easier calling them ceramic then silicon nitride.
The ceramic silicon nitride ball is by far, smoother, harder, lighter and stronger than one made off steel. Si3N4 stands for the silicon nitride material and is black coloured, SiC stands for the silicon carbide material and also is black coloured, The ZrO2 stands for the zirconium dioxide, also known as zirconia or zirconium oxide, they are white coloured, a ZrO2 ball looks exactly like a pearl.

Ceramic ball bearings are often used in Rollerblades and skateboards and other applications where high speed and low friction is desired.
Key points:

- Ceramic bearings do not undergo cold welding or corrode, so they don’t need oil or grease to extend operating life.

- Ceramics have lower density, thermal expansion, and friction than steels, so they sap less energy.

- In tests, all-ceramic bearings consumed less than 25% of the power used by ceramic-metal-hybrid and all-metal bearings.

ADVANTAGES:

The following is a list of benefits of the ceramic silicon nitride ball bearing -

- **LIGHTER.** The ceramic ball is lighter than the steel ball. This means that the ball exerts less force outward against the outer race groove as the bearing spins. This reduction in outward force reduces the friction and rolling resistance.
  
The lighter ball allows the bearing to rev up faster, and uses less energy to maintain it speed.

- **HARDER.** The ceramic ball is harder than the steel ball. This gives you a bearing that will last up to 10 times longer than the steel ball bearing because it holds its finish better.

- **SMOOTHER.** The ceramic ball has smoother surface properties than the steel ball. This means less friction between the ball and bearing races giving you a faster spinning bearing.

- **THERMAL.** The ceramic ball has better thermal properties than the steel ball. The ceramic ball will not heat up like a steel ball. This helps avoid heat build up in the bearing, a primary culprit in skate and skateboard bearing performance degradation.

- **LUBRICATION.** The ceramic balls are impervious to oxidation, chemicals, and require essentially no lubricant. The bearings are lubricated with a very, very small amount of Aral Aralub oil, not a gel or grease.

Limitations

In some applications, we can see that the properties of the ceramic bearing would lead to an increased life compared to an all-steel bearing. However, this is not true of all cases. In normal-speed applications where true fatigue spalling of a raceway tends to be the failure mode, the hybrid ceramic design would not be expected to increase bearing life – rather, a significant decrease in the life would be expected. (The higher stiffness of the ceramic balls reduces the size of the ball/raceway contact patch under load, thus raising the contact stress compared to the all-steel design.) Therefore, potential applications for ceramic bearings need to be carefully weighed on a case-by-case basis.
Ceramic Bearings save Energy, Extend Life

A microscopic look at the surface finish of a metal bearing ball and race, shows peaks and valleys on both surfaces. Lubricants fill in these valleys with incompressible fluids like oil and grease. This prevents metal-to-metal contact between ball and race.

But if the peaks do touch, the contact area is so small that even a small force on the ball or race results in pressures exceeding 1,000,000 psi. This causes cold welding between the ball and the race.

Although system inertia easily breaks the weld, the formation and rupture of the weld generates heat. If this condition continually repeats, the fluid lubricant heats up and fails, eventually leading to the failure of the bearing itself.

Bearings that use ceramics like silicon nitride (Si₃N₄), alumina (Al₂O₃), or zirconia (ZrO₂) overcome this problem by eliminating cold welding; ceramic balls can't weld to ceramic races. Ceramic materials also resist acids, alkalis, and salt. For both these reasons, bearings using ceramic balls and races don't need oil or grease.

Data details

Bearing tests at Champion Bearings monitored speed and power consumption. Ceramic ball bearings are inherently low friction and don't require lubricant. Because lubricant adds viscous drag to the system, especially at low rpms, it can slow bearings down. Lubricant also requires seals and shields to hold it in place, and both of these can add to bearing friction. Noncontact labyrinth seals on the all-ceramic bearings keep out contaminants without imparting extra friction.

Once power is removed from the test rig, the bearings still take time to spin down to a stop. The ceramic bearings take about 10 times longer to reach 0 rpm because they have less friction in their system.

CONCLUSIONS:

Ceramic bearings are innovations that have taken the bearings market by storm. Ceramic bearings surpass traditional bearings in both use and longevity, making them an overall superior choice in RC ball bearings. Ceramic bearings are, as the name suggests, manufactured using a strong ceramic material. Ceramic bearings perform especially well in situations that involve high temperatures or a lot of friction, and also offer exceptional performance in high speed processes. Ceramic bearings are able to disperse the heat from friction rapidly while preserving the smooth ride that is required for speed in racing. Ceramics have lower densities, coefficients of friction, and coefficients of thermal expansion than steel. Consequently, ceramic ball bearings last longer, use less energy, and operate within a greater range of temperatures and environments than metallic bearings do. The ceramic balls are solid ceramic silicon nitride. A cheaper ceramic bearing uses steel balls with a thin ceramic layer. The elastic and thermal property difference between steel and ceramic cause the ceramic to split and separate from the steel portion of the ball on these less expensive look a likes. Avoid this type of ceramic ball bearing.

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2) http://www.bearingkinetics.com/ceramic-bearings.htm