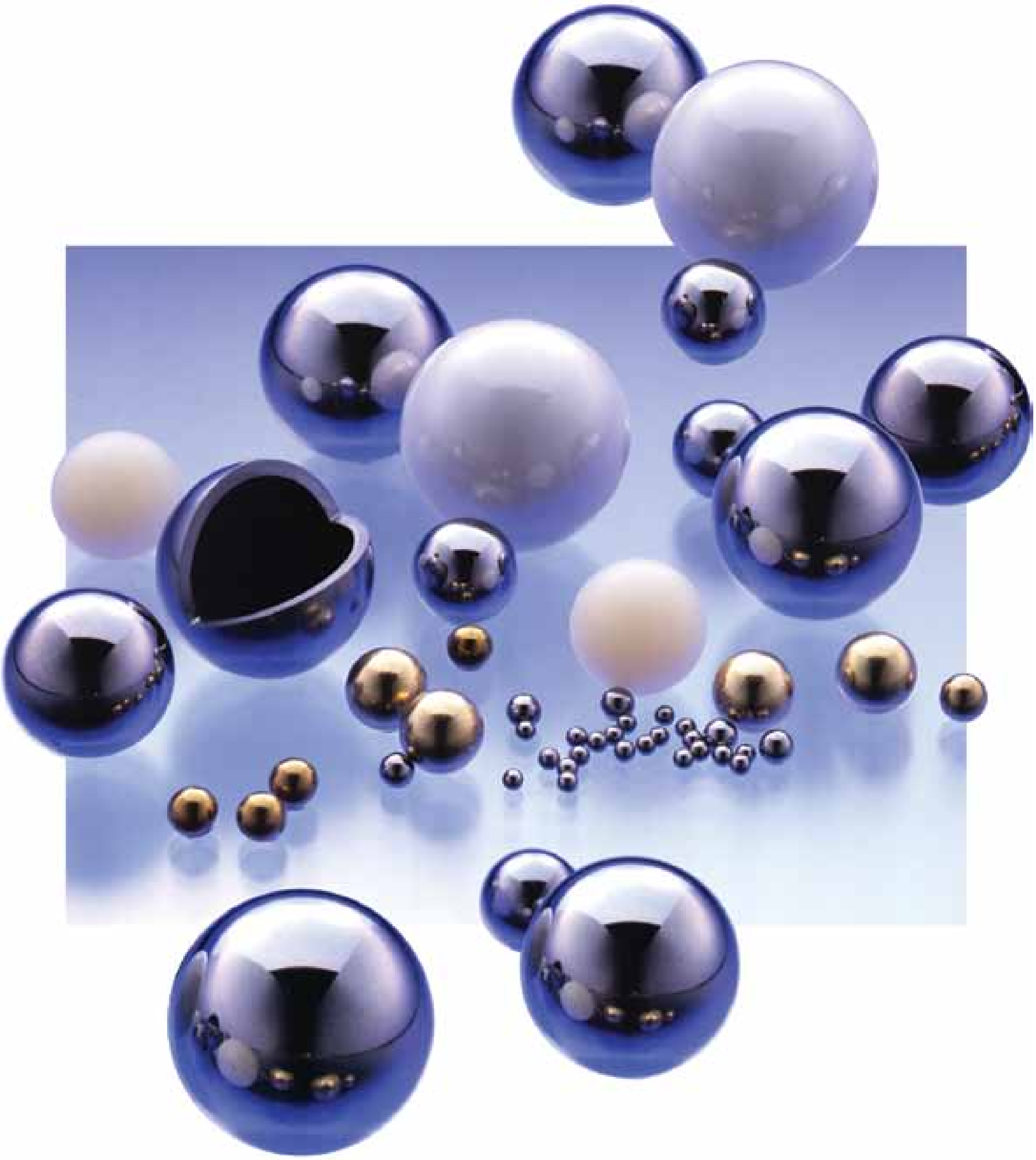
Selecting the Right



Precision Ball Material

FOR AGGRESSIVE ENVIRONMENTS

Jim Peta

Balls are a common mechanical component used in nearly all complex—and many simple—mechanical products. The critical nature of balls is illustrated by the fact that ball bearing factories were one of the primary targets for Allied bombers seeking to disrupt the German war industry during World War II. While the vast majority of balls are made of some type of steel, steel's relatively weak resistance to chemical attack means that applications involving aggressive environments generally require a more exotic material. This article will examine the major materials used to enhance balls to resist aggressive environments and help in selecting the right one.

Brass Balls

Brass balls provide excellent resistance to corrosion by water, including seawater, and also resist the corrosive effects of fuel oil, gasoline, butane, dry carbon oxide, benzene and similar chemical agents. However, it should be noted that brass can be unstable in the presence of acids and bases.

Another key advantage of brass balls is their cost, which is substantially lower than other corrosion-resisting balls. Brass balls have a Rockwell B hardness of 75 to 87, which makes them suitable for applications where the balls are only required to withstand a medium load. Brass provides excellent electrical conductivity, so it is well suited for many electrical applications. A silver coating is sometimes applied to brass balls to improve their electrical conductivity and corrosion resistance to even higher levels.

Brass balls' combination of resistance to corrosion from water and high hardness make them suitable for water valves, including high-pressure applications. Brass valves are even used in fire nozzles where they must withstand high

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Corrosion Resistance Properties

BALL MATERIALS	Industrial Atmosphere	Hydraulic Oils (Petroleum)	Fresh Water	Salt Water	Food Products	Fruit & Veg. Juices	Milk	Alcohol	HCl-40%	Sulfuric Acid-40%	Phosphoric Acid-40%	Nitric Acid-50%	Citric Acid	Ammonia Liquids
52100 CHROME	C	A	D	D	–	–	–	C	–	–	–	–	C	B
440C STAINLESS	B	A	C	C	B	–	A	A	D	D	A	A	A	A
302 STAINLESS	B	A	B	B	A	–	A	–	–	–	A	–	–	–
316 STAINLESS	B	A	A	A	A	A	A	A	D	D	A	A	A	A
BRASS	C	B	C	C	D	–	C	C	–	D	D	–	D	–
MONEL	C	A	A	B	D	C	C	A	D	–	C	–	–	A
NYLON	A	A	A	A	–	A	A	A	D	D	D	D	C	–
VITON®	A	A	A	A	A	A	A	A	A	A	A	A	A	D
CERAMIC	A	A	A	A	A	A	A	A	C	D	C	A	A	A
TITANIUM	–	–	–	–	–	–	–	A	C	C	–	A	A	–

Numbers indicating order of preference

A = excellent B = good C = fair D = poor – = test data not available

pressures and flow rates. Brass balls are frequently used in electrical equipment, most often in the role of connectors that make an electrical circuit. For example, brass balls are used in wireless power devices, data storage equipment, heating units and kitchen applications. Another common application is the use of brass balls in the pumps of sprayers used to apply fertilizer and pesticides to lawns and crops.

Monel Balls

Monel balls provide an even higher resistance to corrosion than brass balls. Monel is composed primarily of nickel and copper, and also has smaller amounts of other elements such as iron, silicon, manganese, carbon, aluminum, titanium and sulfur. Monel balls are impervious to the effects of fresh water, salt water, steam, petroleum products, ammonia, acids, many bases and calcium chloride. Monel also has a relatively high tensile strength of 79 to 90 Kpsi and yield strength of 24 to 40 Kpsi. Monel has a hardness of 85 to 95 Rockwell B, while its sister alloy, k-monel can be hardened to about Rockwell 27 C. K-monel also offers superior resistance to bases. On the other hand, monel balls are relatively expensive because of the difficulty involved in machining them.

Monel balls are frequently used in pump, valve and metering applications in water treatment and chemical plants because they resist attacks by a wide range of chemicals, and because their strength enables them to withstand high flows and pressures. In particular, monel balls' ability to withstand ammonia makes them particularly useful in wastewater treatment and chemical plants. Monel balls' corrosion resistance

enables them to provide longer life than chrome or stainless steel balls in water supply, wastewater and hydroelectric applications. They are used in meters that measure the flow of liquid and gases because their ability to withstand most any chemical makes for a more versatile instrument. Since monel balls are resistant to both petroleum oils and water, they are ideal for valves in the oil and gas industry. The added hardness of k-monel makes them well suited for use in bearings that must survive aggressive environments.

Tungsten Carbide Balls

Tungsten carbide is a homogenous mixture of tungsten carbide grains in a binder matrix, with cobalt being the most commonly used binder matrix. The tungsten carbide grains are fused into a solid matrix of cobalt metals under extreme heat and pressure in a process called sintering. There are many different grades of tungsten carbide available, making it possible to provide balls that are tailored for most any application. In general, a higher percentage of cobalt will provide a tougher but softer grade, while a lower percentage of cobalt will provide a harder but less tough grade.

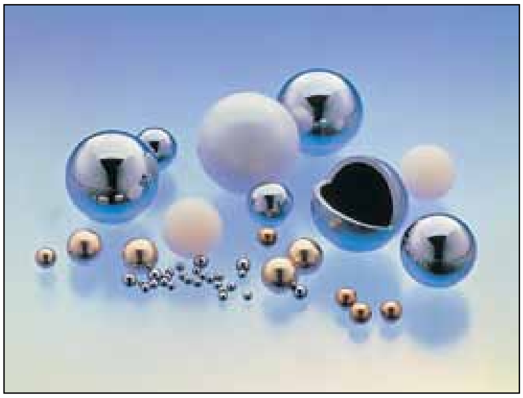
The hardness of tungsten carbide is evidenced by the fact that it is commonly used for tools used to cut steel and other metals, and for armor piercing ammunition. Its abrasion resistance and resistance to shock are both excellent. Tungsten carbide is also practically inert so it is able to resist corrosion in nearly any environment. But it should be noted that bases with a pH below 4 have a tendency to attack the binder. Tungsten carbide is also one of the most costly ball materials.

Naturally, tungsten carbide balls are used in applications where extreme hardness and wear resistance are required. Tungsten carbide balls are used in heavy machinery applications because of their wear resistance and strength. They are frequently used in the down-hole tool industry for hard banding, which refers to covering the outer surface of the lower portion of a tool with a wear material to enhance its life. Other common applications for tungsten carbide balls include ball screws, bearings, valves, flow meters, pivots, detents and tips. For example, tungsten carbide balls are often used as tips for ballpoint pens and instruments used to test the hardness of materials.

Ceramic Balls

Ceramic balls provide excellent corrosion resistance, abrasion resistance and resistance to high temperatures, along with exceptionally low weight. The melting point of silicon nitride, one of the most common ceramic ball materials, is 1,900°C compared to 1,370°C for stainless steel. Some types of ceramic balls are capable of withstanding temperatures in excess of 3,200°F. There is little or no increase in bearing friction as temperature increases in most applications. Ceramic balls also show very little deformation under pressure, as their hardness reduces the coefficient of friction, thus maximizing the amount of energy that is converted to work.

A number of different ceramic materials are used in ball applications. Silicon nitride balls provide excellent performance in applications involving high speeds, high loads and high temperatures. The material does not require lubrication in most applications, and is not magnetic. Aluminum oxide or alumina balls resist very high temperatures and can survive most corrosive materials, with the exception of hydrochloric or hydrofluoric acid and strong bases. Ruby sapphire balls provide the highest possible resistance to temperature and also excellent corrosion resistance. Zirconia balls provide excellent corrosion resistance.



Ceramic balls are often used in aircraft braking assemblies. These systems must be able to withstand a very high amount of heat and pressure, yet in any aircraft application weight is an important factor. Ceramic balls provide weight savings over hollow steel balls sufficient to save many thousands of dollars in fuel costs per year and per plane. Ceramic balls are also frequently used in wind turbines used to generate electricity because of their high strength and abrasion resistance, as well as their inherent insulating properties that prevent arcing.

Bioinert ceramics, such as alumina oxide and zirconia, also provide the important advantage of being non-reactive to biological organisms. Bioinert ceramics are used as load-bearing implants, such as implants for finger and toe joint replacement. One surgeon using a ceramic ball and socket to replace toe joints reported a success rate of 95% relief of pain and 80% for restoring mobility similar to comparable good joints.

Titanium Balls

Titanium balls are desirable for their low density, anti-corrosive properties, and high tensile and compression strength. Titanium isn't easy to form, but manufacturing processes have been developed that can make a 0.125-inch-diameter titanium ball round to within 10 millionths of an inch. High-performance bearings are one common application for titanium balls. Another application is medical implants such as hip implants. Titanium has a weight advantage over its main competitor in the implant field—Cobalt-Chrome-Molybdenum. But Cobalt-Chrome-Molybdenum generally offers longer life. Other applications include connectors for cables, check valves for pump sprayers and body jewelry.

Precision balls play a critical role in a wide range of equipment. Equipment that must survive in aggressive environments requires special ball materials that can survive chemical attack and other hazards. Brass, monel, tungsten carbide, ceramic and titanium provide excellent performance in the vast majority of these applications.

Work with a ball supplier who can help carefully examine the requirements of your application to select a material that will provide the required level of corrosion and temperature resistance at the right price.

For more information:

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