

Silicon Nitride Balls Enhance Bearing Performance

Background

Sometimes called “antifriction bearings,” ball bearings were invented several centuries ago as a technology to reduce friction between two moving parts. The importance of ball bearings is not to be understated, as they are used in a wide range of machines and devices in a variety of industries and applications. Traditionally, the balls have been made of steel. However, advanced materials offer even greater antifriction and performance benefits. Ball bearings made of silicon nitride not only provide a much lower coefficient of friction due to extreme smoothness, but come with many other advantages, including higher hardness, lighter weight, and increased corrosion resistance. Department of Energy funding, primarily through the Advanced Turbine Technology Applications Project and the Ceramic Technology Program at Oak Ridge National Laboratory, contributed significantly to the expansion of the state of the art of silicon nitride. In the wake of these advancements, logical technology transfer was carried out by industry to produce bearing-grade silicon nitride.

The Technology

Metals are primarily bonded by

non-directional electron sharing (metallic bonds) between neighboring atoms, resulting in a tightly packed and relatively dense structure. Silicon nitride, a type of structural ceramic, involves directional covalent bonds that result in high stiffness, high hardness, high electrical resistivity, low density, and low coefficient of thermal expansion. These inherent material characteristics provide the basis for performance enhancement of bearings by silicon nitride balls.

Commercialization

In the late 1980s, Saint-Gobain Ceramics established a manufacturing facility in East Granby, Connecticut, to manufacture CERBEC® silicon nitride balls. This new business was established from the earlier Saint-Gobain/Norton ceramic bearing R&D activity in the Northboro R&D Center. Initially, production costs for silicon nitride were high. However, new manufacturing



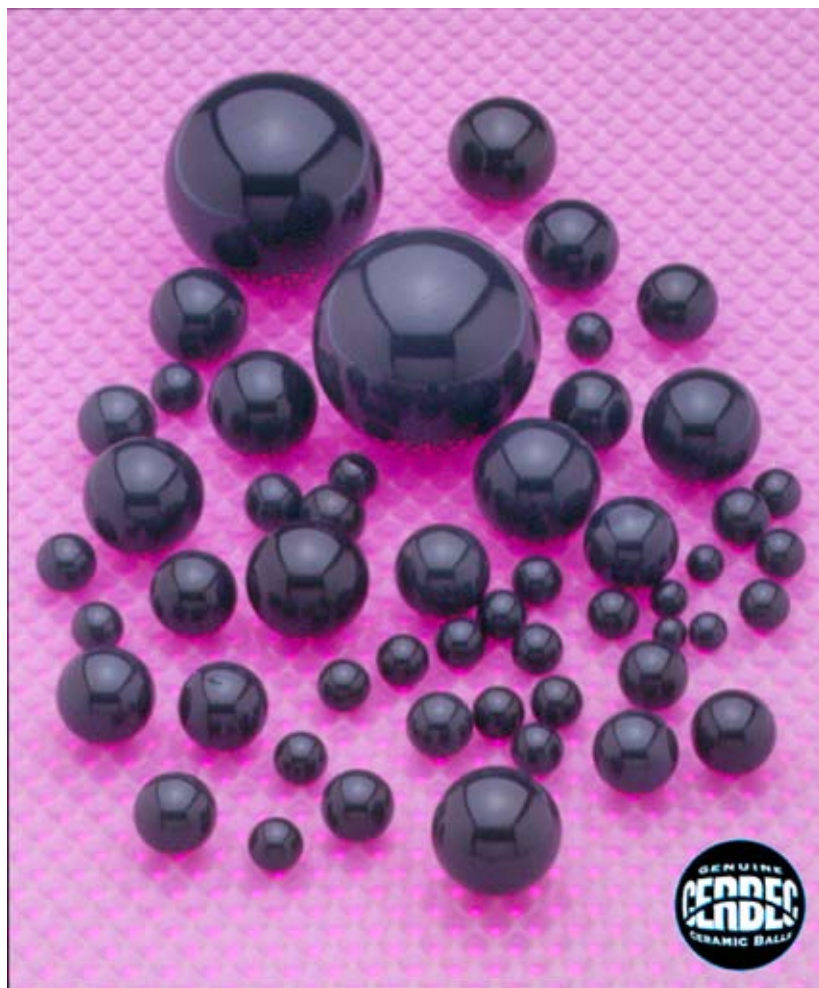
processes lowered the cost and have given rise to wide availability of the durable ceramic. Silicon nitride balls are now broadly commercialized. Not only do they see widespread use in the machine tool industry, but also in medical, dental, aerospace, processing, pumping, automotive, and sporting goods applications. Silicon nitride ball bearings are used in most of the wind turbines being deployed for renewable energy production. The very long blades in these turbines produce high stresses that require the advanced material.



Benefits

Compared to steel balls, silicon nitride balls are:

- 58% lighter;
- 121% harder;
- 68% stiffer;
- 75% smoother;
- and maintain usefulness in temperatures up to 1,000°C.



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