

## 4.5 NiTi Alloy Ball Bearings

**Statement:** A new method for making small diameter, high-grade ball bearings consisting of nickel-titanium, NiTi, and hafnium, Hf, alloy that can produce high-quality ball bearings of any size, but most notably less than 0.25" (6.35 mm) in diameter.

**Problem:** The production of standard 60NiTi alloy ball bearings that are smaller than 0.375" (9.525 mm) in diameter has proven challenging for multiple reasons, the primary reason being that small parts made from NiTi alloys cool excessively before they can be quenched -- an important step in attaining high hardness.

**Solution:** To solve this problem, an advanced alloy consisting of NiTi and Hafnium, Hf, (57.6% Ni, 39.2% Ti and 3.2% Hf) was created. The balls made of this alloy are corrosion-resistant, shockproof, and have been rated at a grade 10 or higher on the Annular Bearing Engineering Committee (ABEC) scale (an industry accepted tolerance standard for bearings).

**Technology description:** The powder metallurgy process by which these high-quality NiTi-Hf ball bearings are manufactured combines many new techniques with several existing ones. First, a high purity NiTi-Hf powder is created through an atomization process and transformed into long, cylindrical rods through hot isostatic pressing. The rods are then cut into cylinders and machined into spheres somewhat larger than the desired finished ball size. Finally, the spheres are hardened through heat treatment and polished until the desired finished size diameter and surface finish (typically 1 micro-inch root mean square roughness) is achieved. The result is a non-corrosive, very hard, highly elastic yet remarkably strong ball bearing with unbridled potential.

**Benefits of the product:** Ball bearings made from new alloy offer many benefits, including:

- High Strength: Utilizes a shockproof alloy that can withstand tremendous loads and stresses without denting or other permanent deformation.
- High Hardness: Achieves a Rockwell hardness of HRC 58-60 enabling longer life and faster rotations.
- High Quality: Rated at a grade of 10 or higher on the ABEC scale.
- Corrosion-resistant: Fabricated using a nonmagnetic alloy containing no iron, and therefore cannot rust.
- Lightweight: Weighs 15-20% less than conventional steel ball bearings.

**Areas of application:** This technology has application in many fields where small size and extremely reliable devices are used, especially for engines, actuators, and joints. This includes:

- Industrial machinery.
- Automotive and marine transportation.
- Power industry.
- Medical equipment.