National Aeronautics and Space Administration

Materials and Coatings

Hard, Corrosion-Proof Nickel-Titanium Material for Use in Mechanical Components

Shock-resistant material eliminates corrosion and polishes to a smooth surface finish

NASA's Glenn Research Center has developed a new method for producing a shock- and corrosion-proof superelastic intermetallic material — NiTiNOL 60 (60NiTi) — for use in ball bearings and other mechanical components. These superelastic materials can withstand tremendous loads and stresses without permanent deformation or denting. At the same time, the nickel-titanium alloy is immune to corrosion and rust, unlike mechanical components made from iron or steel. In addition, the material does not chemically degrade or break down lubricants, a common problem with existing bearing materials. This material is best suited for oil lubricated rolling and sliding contact applications requiring superior and intrinsic corrosion resistance, electrical conductivity, and non-magnetic properties.

BENEFITS

- Corrosion-proof—intrinsically immune to rust
- Shock-proof—elastically endures large strains (beyond 5 percent), making it highly resistant to excessive and unexpected loads
- Hard—offers high hardness when properly heat treated, yet can be readily machined prior to final heat treatment
- Durable—can be pre-stressed to further resist wear
- Lightweight—weighs 15 percent less than steel
- Tribochemically benign—is compatible with existing liquid lubricants
- Easy to manufacture—can be manufactured to very high levels of precision with regard to final dimensions and surface finish

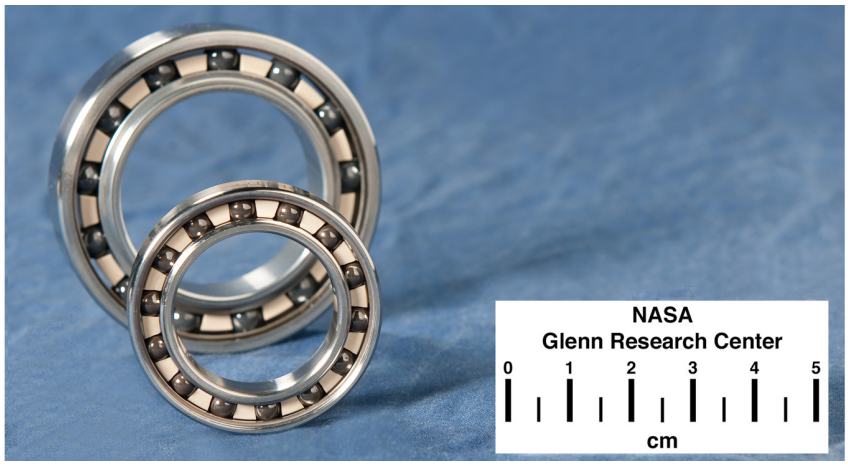
technology solution

THE TECHNOLOGY

60NiTi, which contains 60% nickel and 40% titanium, is a superelastic intermetallic material for use in bearings, gears, and other mechanical systems. When properly processed, 60NiTi is hard, lightweight, electrically conductive, highly corrosion resistant, readily machined prior to final heat treatment, non-galling, and non-magnetic.

60NiTi was previously considered difficult to machine, partly because of issues with residual stresses and quench cracking. Modern ceramic processing methods, co-developed by NASA Glenn, now enable 60NiTi bearings to be easily manufactured. In addition, a method is available for pre-stressing the materials to increase their durability.

Bearing-grade 60NiTi is manufactured via a patented, high-temperature powder metallurgy (PM) process. Pre-alloyed 60NiTi powder is hot isostatic pressed (HIPed) into various shapes and sizes depending upon the desired end product. To make 60NiTi balls, the powder is HIPed into rough, spherical ball blanks that are then ground, polished, and lapped. Because the PM process yields ball blanks that have isotropic mechanical properties, high-quality (Grade 5) ball bearings can be readily produced. The finished 60NiTi balls are bright and shiny in appearance and resemble conventional polished steel balls. The manufacture of 60NiTi balls is a fully commercialized process, and many standard ball sizes are available. The material can also be shaped into other metallic components, such as gears, sliding bearings, actuators, and drives.



Bearings with NiTiNOL 60 balls and races

APPLICATIONS

This material is best suited for oil-lubricated rolling and sliding contact applications, including:

- Aerospace bearings, gears, drives, actuators, and other mechanical systems
- Rotorcraft engine bearings, rotor mechanisms, and drive systems
- Flight and water vehicles exposed to corrosive marine environments
- Wear-resistant, corrosion-proof knives and cutters
- Structural and dynamic components of electric machines
- High-performance fasteners
- Valve components

PUBLICATIONS

U.S. Patent 8,709,176

More Information

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