CEROBEAR®
ceramic bearing technology

Cerobear Aerospace Bearings

CEROBEAR AEROSPACE BEARINGS

In Aviation and Space applications rolling bearings are operating in extremely demanding environments. Although highest speeds, intense loads, extreme temperatures and compromised lubrication characterize the operating conditions, the bearings have to perform perfectly reliable.

CEROBEAR has accepted the challenge to serve these demanding markets a decade ago and is since then strengthening its efforts to become and maintain a reliable partner to the industry.

View into CEROBEAR production

Management System

Our commitment to highest quality standards, not only for our products, but also for our organizational processes, is reflected by our integrated management system. Our strategy and quality management system promote continuous quality improvement, while metrics quantify measurable results.

To maintain continuous achievements we have adopted international quality standards and have earned the following certifications:

- Aerospace quality management system to EN 9100
- Quality management system to DIN EN ISO 9001
- Environmental management system to DIN EN ISO 14001
- Occupational health and safety management system to BS OHSAS 18001

The US Space Shuttle main engines operate with silicon nitride rollers produced by CEROBEAR.

Products

CEROBEAR offers a wide range of rolling bearings, differentiated into the product lines **ceramic bearings**, **hybrid bearings** and **steel bearings**. While in ceramic bearings ceramic rolling elements are combined with ceramic races in hybrid bearings the races are made from metal. CEROBEAR's product range comprises bearings with bore diameter d > 5 mm and outer diameter D < 420 mm (ceramic bearings D < 320 mm).

Beside common bearing types like deep groove ball bearings or angular contact ball bearings, CEROBEAR also offers specialties like hybrid four-point contact bearings, on request with integrated design elements like flanges, threads or splines, hybrid spherical roller bearings with integrated spur gears on the outer ring, hybrid constant section bearings, flanged or without flange, hybrid tapered roller bearings and hybrid spherical ball joints.

All bearing types are manufactured according to ISO dimensions and tolerances or can be produced as tailor-made designs in accordance with applicable standards and individual customer specifications.

CEROBEAR hybrid bearings are available in different steel grades depending on the application requirements.

Materials

Rolling bearing components for space and aviation applications are made of advanced materials, providing highest reliability and load carrying capability. CEROBEAR is highly experienced in machining a variety of bearing steel as well as different ceramic and thermoplastic materials.

Hybrid bearing races are made of conventional bearing steel AISI 52100, higher grades like ASI 440 C and AISI M50 or advanced high nitrogen steels like Cronidur 30 and X.D 15 N. Other materials like nickel-based alloys or powder metallurgical steels are also in production. The heat treatment is carried out in accordance with the specific application requirements, in order to provide thermal stability at high temperatures or maximum corrosion resistance.

Beside extreme hardness, ceramic provides a very stable chemical structure. As a consequence no seizure, no fretting and no cold welding between the rolling partners can occur, even at compromised lubrication conditions. For this reason lower requirements to lubricant specification and less lubricant consumption are possible in ceramic but also hybrid bearings.

The preferred materials for ceramic bearing races and rolling elements are silicon nitride (Si_3N_4) and zirconia (ZrO_2). While silicon nitride is mainly used in applications where Hertzian stress resistance is the key requirement, zirconia is the choice when steel-like mechanical and thermal properties are needed, e.g. to maintain a constant bearing preload over a wide range of temperature. CEROBEAR utilizes for its Si_3N_4 ceramic races and rollers only high strength HIP material and has developed a unique production technology for ceramic, which results in an extreme smooth, mirror-gloss like, surface finish combined with a high level of residual compressive stress in the surface. A visual inspection of all ceramic components guarantees a perfect surface integrity.

Bearing cages are made from a variety of materials. For the standard temperature range or cryo applications thermoplastic materials like PEEK, PI or PTFE are used. Under compromised lubrication or at dry running, filled specifications like e.g. PEEK FC30 or PGM-HT help to reduce friction between cage and rolling elements. Phenolic cages, available even with low evaporation rates, are suited in a multitude of applications. For high temperature applications metallic materials like steel, bronze or aluminum are available.

Friction reducing coatings like silver, MoS_2 or diamond-like-carbon (DLC) for cages, steel rolling elements or bearing races are available according to aerospace standards.

The usage of customized bearing designs with integrated functions enables a reduction of the installation size and weight and the number of additional components.

CEROBEAR hybrid constant section bearings are available in standard dimensions as well as in customized designs.

Applications

In cooperation with customers from space and aviation industry CEROBEAR develops and manufactures bearings for applications such as

- solar array drive mechanisms in satellites (SADM)
- antenna pointing mechanisms in satellites (APM)
- turbo pumps
- media lubricated turbines for auxiliary power units
- gearboxes for servo actuator units (SAU)
- helicopter transmission bearings
- control bearings

CEROBEAR Hybrid Double Row Angular Contact Ball Bearings can be preloaded to control the engagement in helical gearings.

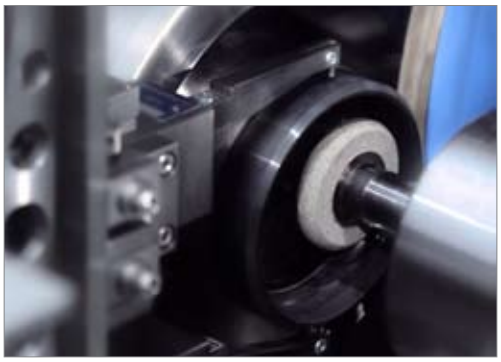
In satellite applications bearings have to operate under extreme and varying conditions. During the start phase of a spacecraft, the bearings are exposed to very high acceleration. To avoid brinelling in the races, caused by static overload from the g-forces, bearing pairs have to be precisely matched and preloaded. Once the satellite has reached its final destination, the bearings which e.g. have to unfold a solar array or position an antenna, have to perform in the vacuum environment at changing operating temperatures under compromised lubrication or at dry running but on a low and constant friction level. For applications like this CEROBEAR has developed angular contact ball bearings, consisting of races made of corrosion resistant bearing steel AISI 440 C and cages made of pure or reinforced PTFE (PGM-HT).

On customer request the bearing races can also be manufactured from high-nitrogen steels. For minimized friction under vacuum environment the races are coated with MoS_2. To achieve a constant but low preload level at different temperatures the balls are either made from AISI 440 C or zirconia. Zirconia possesses a coefficient of thermal expansion very similar to that of bearing steel. Therefore the contact angle and hence the preload of a hybrid bearing using zirconia balls, is not subjected to temperature changes. To guarantee optimum operating performance, friction measurement and run-in under nitrogen atmosphere can be added to the manufacturing flow.

For stiff and accurate bearings in accessory gearboxes CEROBEAR has developed different types of hybrid bearing systems. These bearings typically consist of high-nitrogen steel races (Cronidur 30, X.D 15 N.W), Si_3N_4 rolling elements and a PEEK cage. Upon customer request the races can also be manufactured from AISI M50 or AMS 6444. Fixed bearings are available as four point contact bearings or double row angular contact ball bearings. They are designed to take thrust load in both directions.

The bearing stiffness is adjustable by the internal bearing geometry and the applied preload. Floating bearings are build as hybrid roller bearings. By adapting the roller dimensions diameter and length to the specific load situation these bearings can be designed to very light weight at superior load capacity. With integrated flanges, threads or splines, hybrid bearings can be connected to housings and shafts very easily.

The usage of customized bearing designs with integrated functions enables a reduction of the installation size and weight and the number of additional components.



Simultanous inner and outer diameter grinding of a silicon nitride bearing race.

CEROBEAR ceramic deep groove ball bearing with rings made from zirconia.

CEROBEAR hybrid bearings for the use in accesory gearboxes .

Hybrid bearings are suited to operate under compromised lubrication conditions. This ability derives from the absolute stable chemical structure of the ceramic rolling elements.

Even at high loads seizure or cold welding between the steel races and the ceramic rolling elements does not occur. Short termed oil-off conditions or media lubrication, even by liquid hydrogen at cryo-temperatures with an extreme low viscosity, like in the turbo pump of the USS space shuttle main engine, do not harm the bearing. Under certain operating conditions hybrid and ceramic bearings are able to run without any lubrication ("dry running").

The usage of customized bearing designs with integrated functions enables a reduction of the installation size and weight.

Ceramic bearings are commonly considered to be totally non magnetic and are therefore used in magnetic resonance tomographs or magnetometers during space missions. But in fact even silicon nitride ceramic can provide a magnetic field.

Silicon nitride is never used in its pure form, but is always doped with additives, to influence its mechanical or electrical properties. These additives may affect the magnetic behavior. It therefore depends on the choice of the proper ceramic raw material to achieve a non magnetic bearing. CEROBEAR has developed silicon nitride and zirconia ceramic bearings with extremely low magnetic signature to guarantee minimized influence on experimental data.

CEROBEAR hybrid spherical ball joints provide increased wear resistance at reduced weight.

CEROBEAR bearings provide perfect reliability.

CEROBEAR®
ceramic bearing technology

We welcome your enquiries from around the world and look forward to hearing from you.

For more information on CEROBEAR and our unique technology and products, please contact us:

CEROBEAR GmbH
Kaiserstrasse 100
52134 Herzogenrath
GERMANY

Phone: +49 - 2407 - 9556 - 0
Fax: +49 - 2407 - 96224
Email: cb-sales@cerobear.de
www.cerobear.com

CEROBEAR North American Sales:

Tony Taglialavore
North American Sales Manager
Phone: +1-719-237-6859
Email: Tony.Taglialavore@cerobear.com

in Australia & New Zealand:

Roger Oliver
Phone: +64-9-438-0555
Fax: +64-9-438-0555
Email: rogeroliver@xtra.co.nz

in Israel:

Frank Agencies
Moshe Frank
Phone: +972-3-5441-941
Fax: +972-3-5441-438
Email: frank_ag@frank.co.il

in France:

CTI S.A.R.L
Olivier Brussaux
Phone: + 33-1-552107-04
Fax: +33-1-552107-01
Email: obrussaux@cti.fr

in Italy:

GD Consultants s.r.l
Raffaello Garbarino
Phone: +39-0141-538679
Fax: +39-0141-356329
Email: gd@atlink.it