

CEROBEAR AEROSPACE BEARINGS

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OUR COMPANY

CEROBEAR applies CERamic ROLLing BEARing solutions to mechanical operating condition extremes (in temperature, load, speed, lubrication, and more) to maximize reliability, life, and performance with an aim to significantly reduce total operating costs for its customers and their customers.

CEROBEAR GmbH was established in 1989 and operates a 43,000 square foot facility with state-of-the-art production, metrology, clean-room assembly, and testing equipment in Herzogenrath, Germany. Its staff of more than 100 highly skilled technical employees custom design, develop, and manufacture all ceramic and hybrid ceramic rolling bearings. The value added by CEROBEAR to every bearing is from in-house mastered production technologies such as precision hard turning (for metal), diamond grinding (for ceramic rings and rollers), and five-axis milling (for bearing races and cages).

In 2013, CEROBEAR became a member of the Minebea Group headquartered in Japan and comprised of 43 subsidiaries in 13 countries. CEROBEAR is a member of the NHBB/myonic New Business Unit based in the USA.

MANAGEMENT SYSTEM

CEROBEAR's commitment to the highest quality standards is reflected by our integrated management system. We are certified to the following international quality standards:

- 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





OUR PRODUCTS

CEROBEAR manufactures a very wide range of custom engineered, advanced technology ball and roller bearings of every type in 3 main categories:

- All-Ceramic Bearings
- Hybrid Ceramic Bearings
- All-Steel Bearings

ALL-CERAMIC BEARINGS: Made entirely from silicon nitride (Si_3N_4) or zirconia (ZrO_2) ceramic, CEROBEAR's all-ceramic bearings are used for the most extreme corrosion and temperature conditions. Our all-ceramic bearings are non-magnetic, corrosion resistant, extremely hard, and much lighter than steel (>60% less). They also maintain their strength in extreme temperatures (up to 1038°C , 1900°F) and can operate in dry conditions or with media lubrication (e.g. water).



HYBRID CERAMIC BEARINGS: CEROBEAR makes a wide range of hybrid ceramic ball and roller bearings. In hybrid bearings, races are made of metal and rolling elements from Si_3N_4 ceramic. We are the only bearing company in the world that is able to make hybrid roller bearings with a very wide range of roller sizes, shapes, and crown profiles due to our unique roller manufacturing process. Compared to conventional steel bearings, hybrid bearings are lighter, operate at higher speeds, generate lower friction, and require less lubrication. Since the Si_3N_4 ceramic rolling elements are totally inert due to their covalently bonded crystalline structure, there is absolutely no possibility of seizure, fretting, cold welding, or adhesive wear between the rolling elements and metal raceways even in "oil-off" situations.

ALL-STEEL BEARINGS: In order to service a customer's entire system, CEROBEAR draws upon its considerable materials experience to design and manufacture all steel and roller bearings in a wide range of configurations and sizes.

THE AEROSPACE MARKET – THE CEROBEAR DIFFERENCE

CEROBEAR is highly focused on developing and growing its aerospace business because its advanced ceramic bearing technology perfectly addresses key industry trends to affordably provide:

- significant weight reduction
- increased capabilities to operate at higher temperatures and increased speeds
- improved bearing life even under increasingly challenging operating conditions including poor lubrication or „oil off“ conditions

CEROBEAR is actively serving a range of aerospace segments including: helicopters, gearboxes, transmissions, aero-engines, hot air valves, actuation systems, surveillance systems, space mechanisms, rockets, and more.



CEROBEAR AEROSPACE BEARINGS

THE CEROBEAR DIFFERENCE

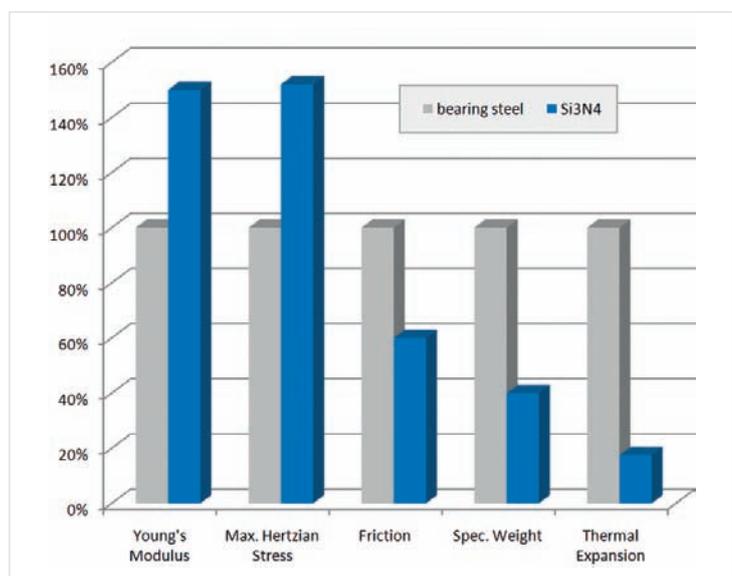
For each aerospace application, CEROBEAR applies its unique business model to custom engineer a bearing solution combining the following key elements:

- **ADVANCED MATERIALS:** We select the right materials to maximize life, reliability, and performance from an expansive portfolio for every part of the bearing.
- **ADVANCED COMPONENTS:** We are able to make nearly any ball or roller bearing design required with extremely precise internal geometry to minimize contact stress and thus maximize life and reliability.
- **SIMULTANEOUS ENGINEERING:** We work very closely with our customers to co-engineer bearing solutions from a white sheet of paper design, and/or utilize customer drawings and specifications.
- **SYSTEM INTEGRATION/SPECIAL FEATURES:** We are able to custom engineer and manufacture special bearing features to simplify integration into mechanical systems.
- **SERVICE WITH SPEED:** Due to our flexible, fully computerized production technology we are able to make both small quantities for testing and production volumes very quickly. Our typical delivery time is 10-18 weeks from finalized design for a first order.

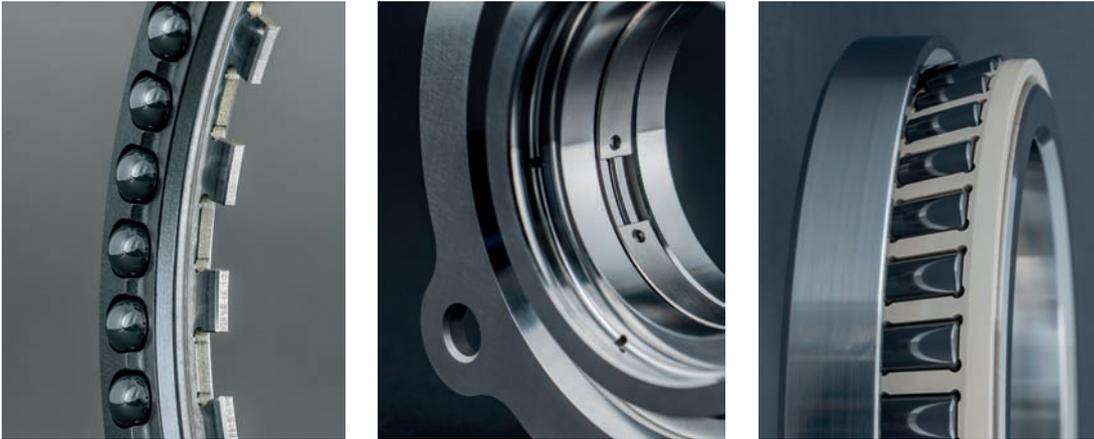


ADVANCED MATERIALS

CEROBEAR's philosophy is deeply rooted in proper material selection as the primary focus of bearing design. If the material of any bearing component is deficient, then the entire bearing is deficient. After thoroughly understanding the operating conditions for an application, we then select the most optimal materials from our extensive portfolio for rings/races, rolling elements, cages, coatings, shields/seals, and lubricants. Unlike any other bearing company in the world, CEROBEAR does not limit itself in material selection. We develop and adapt new materials on a routine basis as required.



Si₃N₄ vs. Steel for Rolling Elements: Extreme Hardness, Total Inertness, Lighter Weight, Lower Friction translates into superior bearing life, reliability, and performance



BEARING STEELS

While SAE52100 chrome steel and AISI 440C stainless steel are suitable for many applications, extreme operating conditions in aerospace applications may require the use of more advanced alloys such as BG42[®], M50, M50 NiL[®] and high nitrogen steels like Cronidur[®] 30. These materials offer superb performance and over-rolling fatigue at high speeds, extreme temperatures, under heavy loads and in corrosive environments.

CERAMIC ROLLING ELEMENTS - THE Si3N4 ADVANTAGE

Compared to bearing steel, Si3N4 provides superior operating benefits and is the cornerstone of why hybrid bearings are superior compared to conventional steel bearings. The combination of Si3N4's very high hardness, much lower mass, total inertness, smooth running, and enhanced stiffness leads to much longer life, higher reliability, and superior performance characteristics for hybrid bearings. The inert behavior of the Si3N4 rolling element prevents cold welding and adhesive wear in the contact area with steel bearing rings. This inertness along with smooth running lowers friction and reduces internal bearing temperature which extends lubricant life.

CAGE MATERIALS

CEROBEAR offers a wide range of cage materials. The portfolio extends from commonly used silver coated steel cages to brass, or PEEK cages and other high-tech plastic materials. PEEK is an excellent candidate for cages due to its low friction, high flexibility, wide temperature range (up to 200°C, 392°F), and manufacturability into complex designs.

ADVANCED COMPONENTS

CEROBEAR has developed the capability to produce highly complex bearing components to high precision tolerances from a wide range of materials including metals, ceramics, and plastics.

HARD TURNING: CEROBEAR is the world leader in precision hard turning technology for production of hardened steel bearing components up to HRC 72. We are able to substitute grinding and honing operations of races while maintaining the highest precision and surface integrity. In addition, our hard turning creates significant benefits in quality, cost, and delivery speed.

Si3N4 ROLLER FABRICATION: Our computerized ceramic grinding technology for high precision rollers has been proven in numerous bearing applications most notably the US Space Shuttle main engine liquid hydrogen pumps. CEROBEAR's ability to make a very wide range of roller sizes, shapes, and crown profiles allows for a complete design consideration for any application in which we can apply hybrid ball or roller bearings. No other bearing company in the world has this flexibility.

CAGE FABRICATION: CEROBEAR maintains a complete internal capability for cage fabrication using five-axis milling or other production methods applicable to a wide range of advanced materials and cage designs.

CEROBEAR AEROSPACE BEARINGS

SIMULTANEOUS ENGINEERING

CEROBEAR works very closely with its customers with speed and responsiveness to simultaneously engineer each bearing through every stage of the process from initial design all the way through to post-delivery follow-up including post-usage analysis for further optimization. We believe strongly that optimization of our product and success in the application comes from true partnership with our customers.

SYSTEM ENGINEERING/SPECIAL FEATURES

To fully support customer needs, CEROBEAR engages in bearing customization to integrate our bearing solution into the complete mechanical system. We find a way to uniquely integrate a bearing solution for simplicity, performance, reliability, and affordability. Our engineers optimize the internal geometry and design of every bearing to minimize contact stress and maximize performance. In addition, we routinely incorporate a variety of special features such as anti-rotation devices, flanges, integrated threads and much more.

AEROSPACE MARKET SEGMENTS SERVED

CEROBEAR serves a wide range of aerospace applications to maximize life, reliability, and performance which results in lower total operating cost for equipment users.

AERO-ENGINES, GEARBOXES/TRANSMISSIONS

CEROBEAR hybrid bearings are a perfect solution for gearbox, engine, and transmission bearings in helicopters and other aircraft.

The use of ceramic rolling elements offers a considerable amount of weight saving in engines and drive train. This weight savings can be increased further by using PEEK cages where application conditions allow.

CEROBEAR also exactly adapts inner bearing geometry to the application requirements to minimize contact stress. CEROBEAR's production technology allows complex bearing designs which allows a higher degree of integration of the bearings into the system reducing part count and increasing simplicity.

The use of Si₃N₄ ceramic rolling elements offers extraordinary bearing performance under oil-off conditions in gearbox and engine.

In grease lubricated transmission bearings, the life time of the grease can be prolonged resulting in a longer service life for the bearings which increases the time between re-greasing intervals and can even allow "for-life" lubrication.





HOT AIR VALVES & AIR MANAGEMENT

In hot air valves, bearings currently operate at high temperatures (up to 450°C, 842°F) and for the next generation of valves, the temperatures are expected to be even higher (up to 600°C, 1112°F). To operate under such extreme temperatures as well as typically high loads with shaft bending, CEROBear hybrid bearings are designed with BG42®, CSS-42L®, or other high temperature metal rings plus Si3N4 rolling elements, and high temperature cages (if required). We apply either ball or roller hybrid bearing designs depending on what is required. Our bearings run dry. In the future as temperatures rise, we expect new innovative materials such as PM-steel or ceramic rings to be incorporated.

SPACE MECHANISMS

CEROBear bearings for space applications are customized and perfectly adapted to a long service life with highest accuracy and low friction. For low speed bearings, which are typically used in space mechanisms, space qualified materials and coatings are available. For very special requirements, new materials like enhanced bearing steel and ceramic are also applied. In all cases, we work closely with system designers to meet all requirements for performance and life.



SURVEILLANCE SYSTEMS

High precision, light loads, and limited space are typical requirements for surveillance systems. CEROBear's constant section bearings serve these needs. A customized solution with integrated flanges minimizes the number of parts, simplifies the assembly and provides excellent bearing performance in terms of stiffness, runout, and friction.

ROCKETS

CEROBear's aerospace heritage began in early 2000 with the first flight of ceramic cylindrical rollers in the bearings of the USA Space Shuttle's main engine liquid hydrogen pumps. Performing flawlessly for nearly 40 missions, the ceramic rollers operated at 36,200 rpm in temperatures of -423°F (-253°C) while being lubricated by only liquid hydrogen. CEROBear's solution improved the time between overhaul for the engines by a factor of 12 (increasing life), while increasing payload by 9% (increasing performance and reducing cost), and reducing maintenance hours between missions from 1000 hours to <50 hours (reducing costs).





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:

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