IBC

IBC Rolling Bearings
With ATCoat Coating

TI-I-5011.2/E

IBC Rolling Bearings and Linear Guidance Systems With ATCoat Coating

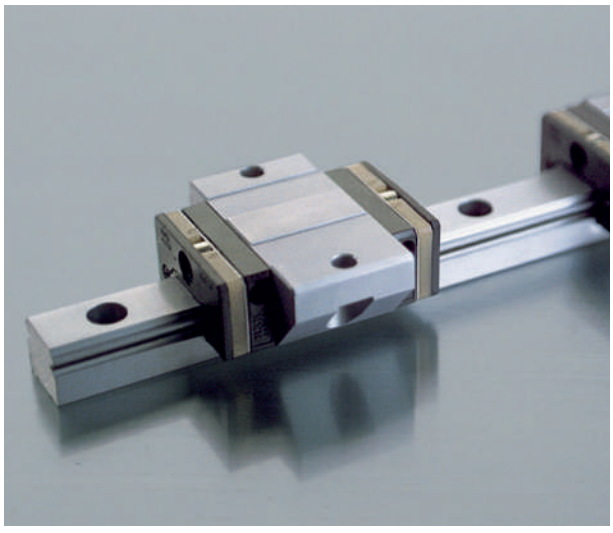
The solution to exceptional challenges

A variety of processes and new materials have been developed in recent years that are designed to meet the demanding and extremely varied technical and commercial needs of today. And the material surface of rolling bearings and linear components is becoming more and more important for the overall performance and reliability of machines, units and equipment. However, outside influences very often alter the surface quality of materials or corrode the surface material. A whole range of advantages can be achieved by coating the material surface of rolling bearings and linear components.

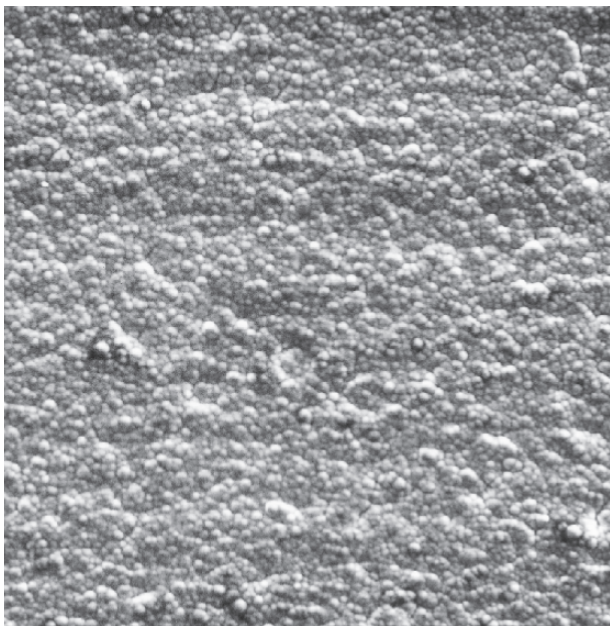
However, many coating processes are not suitable for situations in which rolling or compressive stress occurs. ATCoat thin dense chromium coating for rolling bearings is a process developed jointly by IBC Wälzlager GmbH and ATC Armoloy Technology Coatings GmbH & Co. KG. The coating is available in a range of specifications, depending on the basic material that is used and the intended application. Since this type of coating results in extremely good rolling capacity, especially if used on rolling bearings, it provides very good protection against wear and corrosion.

ATCoat protects the surface from outside environmental conditions and thereby increases the service life of rolling bearings and linear components and the life time of machines and units.

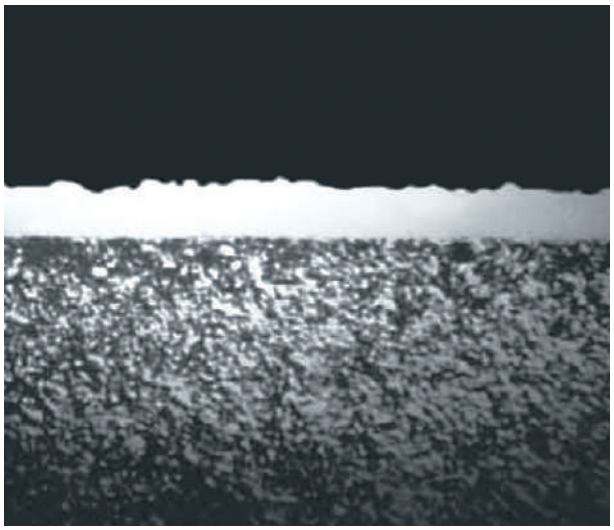
The considerable technical improvement involved in this process also leads to energy savings and an efficient use of material. Any steel suitable for rolling bearings may be used as the basic material to be coated, e.g. 100Cr6 (1.3505) steel. Coating is also very beneficial if you use AISI 440C (1.4125) corrosion resistant steel or AISIM50 (1.3551). The ATCoat process permits the combination of a tough basic material with a firmly adhering, very thin chromium coat. This is why, compared to bearings of the same size, those with an ATCoat coating offer higher resistance to wear and corrosion and therefore lead to a longer life time.



The ATCoat coating consists of 98% pure chrome. The chromium coating is extremely hard, cone-shaped, precise, very thin, elastic and highly pure. It can be deposited by a high-energy process for any steel that is suitable for coating. Because the process temperature is below 80 °C there is no structural change to the basic material, and the coated rolling bearings and linear components retain their dimensional stability. The ATCoat surface hardness is between 75 and 78 HRC (1300–1560 HV).



Surface of the ATCoat coating



Cross section of the ATCoat coating

Experience has shown that the expected service life is considerably longer if this coating is used. If the intended application allows for such processing, the raceways may be further processed with the Hyper Surf Finish technology developed by IBC. Especially if used with ceramic rolling elements made of Si_3N_4, the coating permits a significant increase in speed of up to 40%. Fretting corrosion that may form on floating bearings, a phenomenon that occurs due to the micro displacement of the rings of the bearing during thermal expansion or vibration, is also avoided. In many cases this leads to a significantly longer and trouble-free operating of units. The result is a long-lasting loose bearing fit as well as easier disassembly if the bearing needs to be replaced.

Because of the special surface topography, the emergency run properties of the bearings are substantially improved. Should the lubrication system fail for instance, the units are still able to run under part load for a certain period of time; they can also be shut down properly. This means that secondary damage can be limited or avoided altogether.

IBC rolling bearings with ATCoat coating are therefore often used in unfavourable lubrication conditions.

Such unfavourable conditions exist for example:

- if lubrication may only be effected with low-viscosity media that do not produce a separative lubrication film;
- if very low rotational speeds occur that do not allow an elasto-hydrodynamic lubrication film to develop;
- if oscillating movements, e.g. swivelling, without achieving a full revolution occur, and a separative lubrication film cannot be maintained at the reversal points;
- if sliding occurs in unloaded rolling bearings;
- if, during fast accelerations or decelerations, smearing occurs when bearing rolling elements slide due to the force of continuance that is caused by mass inertia in conjunction with an inadequate preload.

The two diagrams below demonstrate the benefits of the ATCoat coating, with high precision angular contact ball bearings taken as an example.

Less friction leads to a lower temperature and therefore a better rolling coefficient for high precision angular contact ball bearings with ATCoat coating (see Fig. 1). There are many different types of application: IBC rolling bearings and linear components with ATCoat coating have been used successfully in the aerospace industry, in plant engineering for the food, pharmaceutical and chemical industries, in high-performance unit engineering as well as in offshore technology. Areas of application include vacuum technology, liquid gas pumps, pumps with insufficient lubrication, and gas turbines. The ATCoat coating technology has also been used successfully in turbo-chargers, construction machines, shaker screens, machine tools and ballscrews.

These benefits are illustrated below, with high precision angular contact ball bearings used in machine tools as an example. The permissible rotational speed of high precision angular contact ball bearings is closely linked to other parameters like preload, friction, operating and ambient temperature, lubrication, materials, and installation conditions. These factors interact and are decisive in determining the life time of a bearing.

High precision angular contact ball bearings

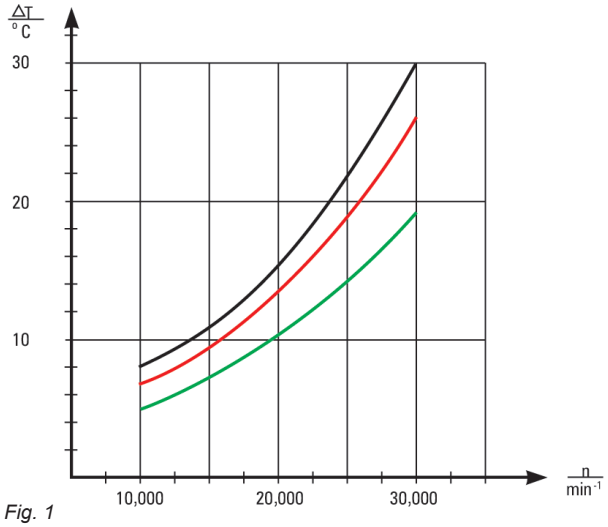


Fig. 1

standard type

coated inner and outer ring

coated inner and outer ring with ceramic rolling elements

Rotational speed for oil/air lubrication

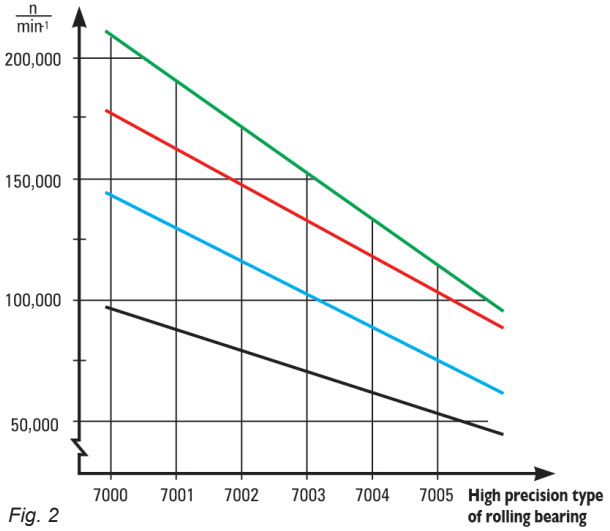


Fig. 2

standard type

increased rotational speed due to a larger number of smaller rolling elements

coated inner and outer ring

coated inner and outer ring with ceramic rolling elements

Fig. 2 depicts ways of successfully increasing rotational speed. The coating leads to significant technical improvement in this respect.

Resistance to corrosion

The ATCoat coating is especially suitable for protecting steel against corrosion. Rolling bearings and linear components coated with an ATCoat coating can be used as an alternative to bearings and components made of corrosion resistant steel. The ATCoat coating exhibits a corrosion behaviour that is similar to corrosion resistant steel, especially with regard to the functional surfaces. Rolling bearings and linear components that have an improved surface due to their ATCoat coating are protected against water, steam, caustic solutions and, to a limited extent, acids. Carrying out a salt spray test illustrates the very good results that the ATCoat coating achieves for corrosion protection. Within the space of only 24 hours, 95% of the surface of an uncoated standard bearing has succumbed to corrosion. In comparison, corrosion extends to approx. 25% of the surface of a bearing made of corrosion resistant steel, but an ATCoat coated bearing has a corroded surface area of only 1%. The test is carried out according to ASTM B 117 and largely conforms to DIN 50 021.

The roughness of the surfaces is a significant factor in protecting against corrosion. The most effective protection against corrosion can therefore be carried out on the raceway of the bearing rings.

How to increase rotational speeds

ATCoat coated high precision angular contact ball bearings lead to a **lower temperature because there is less friction;** they therefore have an improved rolling resistance.

Coating the raceway of a rolling bearing enables **higher rotational speeds** and a longer service life at lower operating temperatures. The use of ceramic rolling elements made of Si_3N_4 leads to further improvements because of the reduced rotating mass of such elements.

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Increased life time

Recent technical improvements in steel production and in rolling bearing manufacture have led to a reduction in the "traditional" causes of failure due to material fatigue. While wear to the surface increasingly occurs through metal parts coming into contact with each other, failure may also be caused by bearings whose rotating speed is too slow, because the lubricant film that separates the contact surfaces may be breached if the bearing does not maintain sufficient speed. Another cause of failure is an excessively high operating temperature. To avoid such failures, the surface should be improved with regard to as many factors as possible. The result should be a surface topography that has a cone-shaped surface structure. This improves the running surface of the bearings and leads to the best possible performance and an increased life time. Where insufficient lubrication exists or unfavourable operating conditions apply, only an improved surface will enable better emergency run properties to be achieved.

Tolerances, bearing clearance, dimensions and precision

The ideal coating for rolling bearings is between 2–4 µm thick, and the dimensional tolerance for surfaces and chamfers is approx. ± 1 µm for such a thin coating. This means that the ATCoat coating does not affect the dimensional accuracy. Therefore, rolling bearings of the highest precision grades may be coated. Rolling bearings with small dimensions should be checked for a possible change in fit.

Coated rolling bearings are manufactured by IBC in their factory within the upper half of the radial bearing clearance class, e.g.:

CN ⇛ CNH
C3 ⇛ C3H

It is not advisable to disassemble and coat a bearing once it has been manufactured.

Surface finish and coefficient of friction

Depending on the pre-existing roughness, there may be a slight increase in the mean roughness R_a. If R_a is between 0.02 µm and 0.05 µm, an increase to between 0.05 µm and 0.07 µm is possible. Such an increase can, however, be reduced again by employing the HSF (Hyper Surf Finish) process developed by IBC. This process only smooths the upper part of the cone-shaped structure, according to the various areas of application and purposes. The very good rolling characteristics of the ATCoat coating lead to an improvement in the friction coefficients. The friction coefficient that applies to friction between two ATC chromium coatings is up to 50% lower than the coefficient for two steel surfaces. The following values are applicable for lightly oiled fitting surfaces:

Friction partner	Static friction (dry) μ_0	Sliding friction (dry) µ
steel/steel	0.25	0.18
steel/ATCoat	0.17	0.15
ATCoat/ATCoat	0.14	0.12

Operating temperature

The hardness of the ATCoat coating ranges between 75 and 78 HRC (1300–1560 HV), and the coating is neutral in a temperature range between approx. –230 °C and + 800 °C, without any major changes occurring to adhesion or structure. The usable range of operating temperatures largely depends on the materials used for the rolling bearings, e.g. basic materials, cage materials, seal materials or lubricants.

Elasticity and contact pressure

The ATCoat coating has outstanding adhesive qualities due to its specific molecular bond. The coating has extremely high elasticity, due to the composition of its electrolytes. Even when heavy static loads or specific contact pressures are applied, the coating does not flake off.

Conformity and standards

ATCoat thin dense chromium complies with many standards and specifications. It has been tested and approved according to AMS 2438 A, AMS QQ-C-320, AMS 2406 G and MIL-ST D as well as according to many DSV company

specifications. Independent studies have shown that the ATCoat coating is neither toxic nor does it cause skin reactions. According to EU Regulation No. 1935/2004, the ATCoat coating may come into direct contact with food.

Operating efficiency

The ATCoat coating is the efficient solution to many problems. It protects surfaces from environmental influences and thereby increases the life time of rolling bearings and linear components as well as of machines and units. This is a significant technical advance and is an effective way of saving on materials and energy. The ATCoat coating leads to increased production reliability as well as to reductions in machine shutdown and, as a consequence, to lower maintenance costs.

Functions of the ATCoat coating

- reduction of friction
- better adhesive strength of the lubrication film
- separation of materials of the same type
- prevention or reduction of cold welding caused by adhesion
- reduction of the formation of fretting corrosion
- the sliding properties of a rolling bearing ring with regard to the shaft or the housing are ensured (important for floating bearings)
- outward corrosion protection and extensive chemical resistance to aggressive materials or tribooxidation
- wear protection due to increased hardness of the coating: 72–78 HRC (1300–1560 HV)

Prefix of ATCoat coated rolling bearings

AC- ATCoat rings
ACC- ATCoat rings + Si_3N_4 rolling elements

Suffix of ATCoat coated rolling bearings

A11 coated inner and outer ring
A15 coated inner and outer ring, corrosion resistant rolling elements and cage
A21 coated inner ring
A31 coated outer ring

Taylor Hobson PRECISION

Taylor Hobson
Talysurf plus

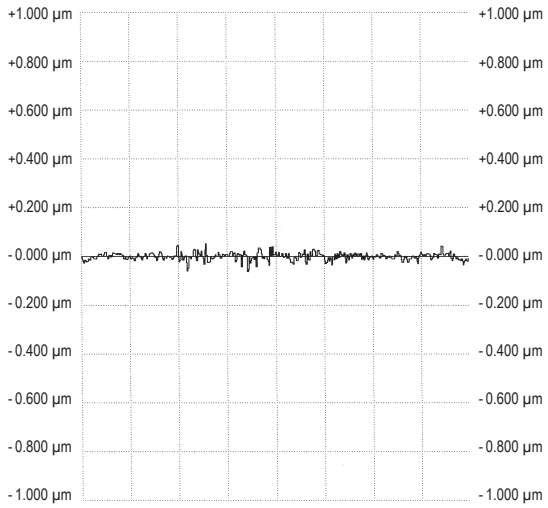
IBC Wälzlager GmbH

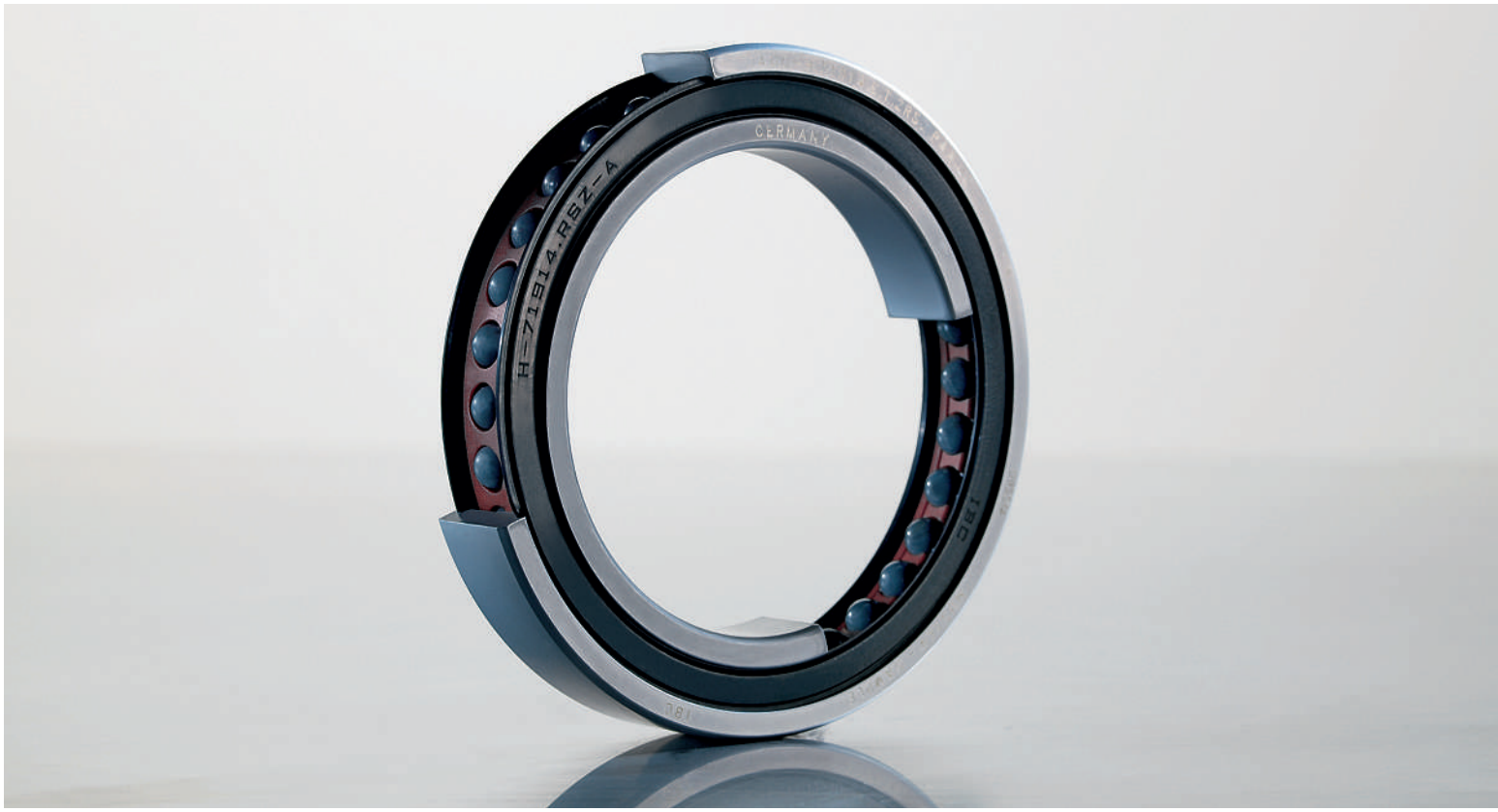
Test specimen:	**IR 71906**
Measuring point:	Raceway laterally – roughness
Inspector:	rom
Date:	20-05-2011

R_a	0.0120 µm
R_t	0.13 µm
R_{zDIN}	0.08 µm

Measurement:	R/10x0,08/G/32
Form type:	LS Radius
Length:	0.80 mm
Area of measurement:	1 mm

Horizontal scale:	50 µm per unit
Horizontal magnification:	200x
Vertical scale:	0.20 µm per unit
Vertical magnification:	50000x





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