

SCHAEFFLER



Corrotect Corrosion Protection Systems

Globally established and
sought-after coating concepts

Introduction

The thin surface protection of rolling bearings by coating, as developed by Schaeffler in the early 90s and applied for as a patent, has proven itself to this day as a globally unrivalled coating concept for long-lasting preservation of the component function.

The original zinc alloy coating with yellow or black chromate passivation (Corrotect C and Corrotect F) containing Cr(VI) was designed as a thin protective layer for bearing components that did not require adjustment of dimensional tolerances. This has since resulted in various variable Corrotect coating systems, which are all free from Cr(VI).

Test time 96 h in salt spray
(testing to ISO 9227)

Figure 1
Track roller without and
with Corrotect A* coating
after salt spray test



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Introduction

Functional impairment due to base metal corrosion

Base metal corrosion (red rust formation) is the most common type of corrosion on steel materials and is caused by the simultaneous presence of moisture and oxygen. In the metalworking industry, rust formation primarily impairs the component function and operating life.

As a general rule, minor corrosion to the exterior of a fitted bearing does not have an adverse effect. Rust formation in the interior of the bearing is, however, critical in many respects. Localised pitting corrosion on rolling surfaces generates stress peaks during over-rolling, which can lead to premature fatigue. As in the case of false brinelling, rust particles have an abrasive effect and lead to wear.

Lubricants and seals serve to protect the internal components of a bearing. The applied protective coatings act as surface protection in the outer area of a bearing and thus prevent damage to the rotary shaft seals.

Innovative coating variants as key technology

With its innovative coating variants, Schaeffler ensures that premature fatigue does not occur, thus enabling long-term function. By optimising process parameters and making further developments in plant technology, Schaeffler is providing an important and future-oriented key technology for the deposition of thin and uniformly distributed coatings. In the area of corrosion protection, the protective coatings produced in this way bring about an improvement in general component characteristics and play a key role in optimising components.

The outstanding characteristics of the original thin film coating (electroplated zinc alloy system) have been continuously improved by the further development of this system and the establishment of new coating systems, and correspond to (or significantly exceed) the current level of technology.

As a globally established system supplier of automotive and industrial components, Schaeffler equips its products with added value through state-of-the-art technologies based on high-performance surface treatments.

General advantages of thin film variants

A noteworthy advantage of these thin film variants lies in the technical feature that allows bearing components to be manufactured in a coated or uncoated variant from one and the same stock item, without consideration of the bearing tolerance.

Depending on the coating variant, relevant layer thicknesses of 0,5 μm to 3 μm or 2 μm to 6 μm and the use of modern zinc alloy processes play a decisive role here.

Components with this Corrotect coating require no additional treatment in the form of familiar corrosion protection media such as oils, waxes or greases. This reduces lasting environmental pollution.

Alleged rust-resistant alternative materials have only a relatively low corrosion resistance, which is essentially dependent on the specific treatment type (ground, polished or passivated).

Depending on the variant, initial signs of rust are already visible on individual alloy steels after 5 h in salt spray (testing in accordance with ISO 9227). For passivated surfaces, this may be extended to 48 h in some circumstances, however, the risk of surface corrosion is still present in this case.

Cr(VI)-free protection systems in accordance with REACH

Due to legal regulations in the automotive industry (End of Life Vehicles Directive) and numerous EU restrictions (REACH), the original protection systems Corrotect C and Corrotect F containing Cr(VI) are no longer widely used.

The Cr(VI)-free protection systems Corrotect A* and Corrotect N*, which were developed and successfully established in 2006, are available as replacements for the original systems. They are part of the Schaeffler modular coating tool box and, even in these variants, enable reliable corrosion in the same layer thickness range of 0,5 μm to 5 μm , taking account of current environmental aspects.

For special applications and increased protection requirements, systems with minimum layer thicknesses $> 5 \mu\text{m}$ in accordance with current DIN EN ISO standards are, however, also available in addition to these thin film variants.

Introduction

Modular coating tool box

In addition to a pure corrosion protection coating for bearing components, numerous Schaeffler innovations now require adapted surface protection.

As a result of this huge increase in varying requirements from the industrial and automotive sectors over the past decades, numerous new Corrotect corrosion protection systems have been added to the Schaeffler modular coating tool box. This offers an extensive range of individual advantages for the respective applications, *Figure 2*.

The focus of a Corrotect coating is to protect against corrosion. The secondary effects provided in isolated cases, such as sliding characteristics and influences of torsional or retaining forces, can be used as additional characteristics, but do not constitute the main characteristic of the coating.

In contrast to earlier variants, all coating systems available today are free from Cr(VI). Depending on the version (drum or rack variant) and the respective layer thickness, they offer different and thus individual corrosion protection performances. In addition to the electroplating methods, paint systems and zinc flake coatings have also been included for corrosion protection purposes. Depending on the requirements and functional suitability, these systems (Corrotect P, Corrotect ZF) are widely used.

The Schaeffler symbiosis between high-quality industrial and automotive components and decades of proven corrosion protection coatings offers our customers significant competitive advantages.



If you are interested in Durotect, Triondur, Insutect or Sensotect coating systems, please contact Schaeffler Surface Technologies.

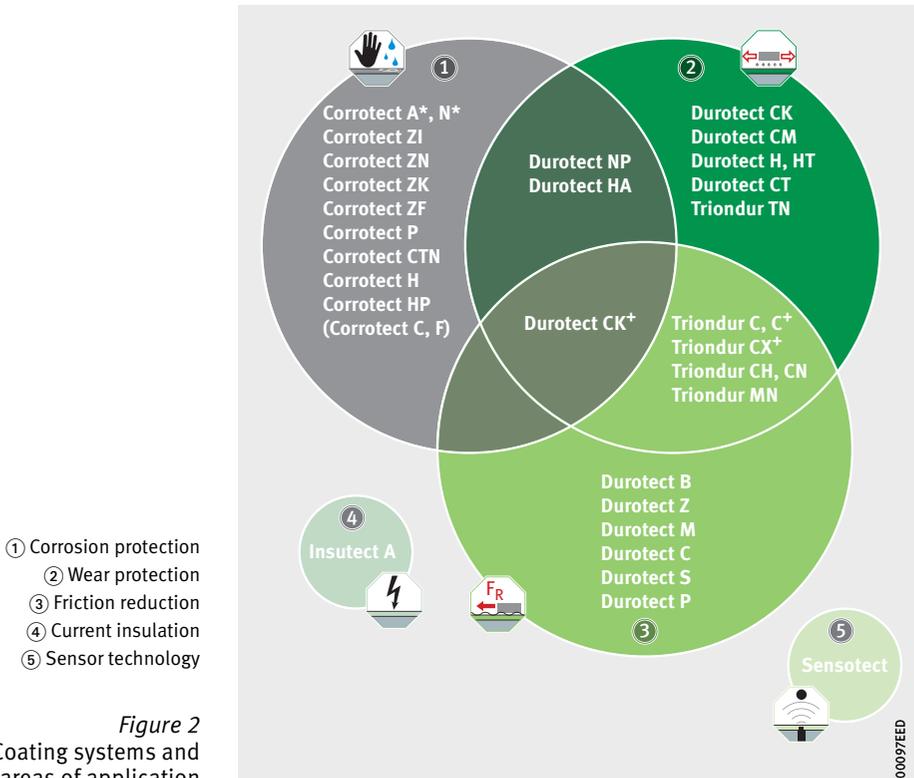


Figure 2
Coating systems and their areas of application

Further information

An overview of the coating systems is provided in:

- TPI 186, Higher Performance Capacity Through the Use of Coatings ► <https://www.schaeffler.de/std/1F39>.

**Corrotect coating systems
free from Cr(VI),
standard methods**

Coating system	Composition	Main area of application, special feature
Corrotect A*	Zinc-iron Thin film	Belt drives, selector shafts, bearings, bearing components
Corrotect N*	Zinc-iron Thin film	Belt drives, detent systems
Corrotect ZI	Zinc-iron	Belt drives, bearing components, screws with moderate corrosion protection requirements
Corrotect ZN	Zinc-nickel	Belt drives, bearing components, screws with high corrosion protection requirements
Corrotect ZK	Zinc	Simple corrosion protection applications, for combination coatings
Corrotect ZF	Zinc flakes	Chassis engineering, components, screws and safety components with high tensile strength

**Corrotect coating systems
free from Cr(VI),
special methods¹⁾**

Coating system	Composition	Main area of application, special feature
Corrotect F	Paint systems	Housings, flanges, slewing rings, connectors, main bearings
Corrotect CTN	Copper-tin-nickel combination	Corrosion protection in maritime applications
Corrotect H	Zinc or zinc-aluminium	Corrosion protection for inner and outer rings of large size bearings, slewing rings, main bearings, generator bearings
Corrotect HP	Zinc or zinc-aluminium with topcoat	Corrosion protection for inner and outer rings of large size bearings, slewing rings, main bearings, generator bearings

¹⁾ The special coating methods listed are used for individual surface treatments and after appropriate system modification. The specific material criteria for the given situation and the environmental conditions present are decisive in selecting a special variant.

Additional function	Brief description	Description Page
–	Zinc-iron coating (layer thickness < 5 µm) with thick film passivation A*	16
–	Zinc-iron coating (layer thickness < 5 µm) with nanoparticle-backed thick film passivation N*	16
–	Zinc-iron coating (layer thickness > 5 µm) with thick film passivation A* or nanoparticle-backed thick film passivation N*. Corrosion resistance, as a function of the layer thickness and passivation, between 120 h and 600 h against base metal corrosion	14
–	Zinc-nickel coating with thick film passivation A*. Corrosion resistance, as a function of the layer thickness and passivation, between 360 h and 720 h against base metal corrosion	18
–	Electroplated zinc coating with thick film passivation A* or thin film passivation A or B. Corrosion resistance, as a function of the layer thickness and passivation, between 24 h and 192 h against base metal corrosion	13
–	Zinc flake coating. Corrosion resistance, as a function of the layer thickness, of up to 1000 h against base metal corrosion	20

Additional function	Brief description	Description Page
■ Current-insulating according to coating variant	Polymer-based coating. Corrotect P includes various paint coating systems used for corrosion protection. Can be combined with coatings containing zinc (such as Corrotect ZF or Corrotect HP) for applications exposed to high levels of corrosion	22
■ Wear protection based on hardness of coating	High-performance protection through copper-bronze-nickel combination. Corrosion resistance, as a function of the layer thickness and design, \cong 1 000 h due to barrier effect against base metal corrosion. Excellent resistance to seawater	23
–	Thermally sprayed, metallic layers as corrosion protection with zinc or zinc-aluminium	25
–	Thermally sprayed, metallic layers as corrosion protection with zinc or zinc-aluminium, with topcoat	25

Corrotect coating systems

Corrotect coating systems

Rolling bearing components are normally manufactured from martensitic, bainitic or case hardened rolling bearing steels 100Cr6. If standard rolling bearing steels come into contact with water or humidity, however, they can undergo corrosion, which can cause a permanent impairment of the intended function. Corrosion-resistant rolling bearing steels provide a remedy here but are expensive. The most economical variant for optimising the characteristics under moderate corrosion conditions is therefore the combination of a standard rolling bearing steel with an appropriate coating; see tables, page 8. For particularly high corrosion loads, coatings resistant to seawater are available.

A wide selection of Corrotect coatings of differing performance capability ensures corrosion protection (for film and base metal corrosion) individually matched to the customer application, *Figure 1*. The anti-corrosion coatings from Schaeffler are explained in detail below and application examples are given.

Corrotect covers all coating systems that are used primarily to give protection against corrosion. The coating systems available for this purpose give protection in different ways. Depending on the coating system, the action is based on cathodic corrosion protection (as in the case of zinc alloys), anodic corrosion protection (as in the case of chemical nickel coatings) or a barrier effect (for example in paint systems).

Characteristics of coatings with primary corrosion protection function

Coating system	Principal function		
	Corrosion protection	Wear protection	Friction reduction
Corrotect ZK	+	--	--
Corrotect ZI	++	--	--
Corrotect ZN	+++	--	--
Corrotect ZF	+++	--	--
Corrotect P	++	--	--
Corrotect CTN	+++	++	--
Corrotect H	++	--	--
Corrotect HP	+++	--	--

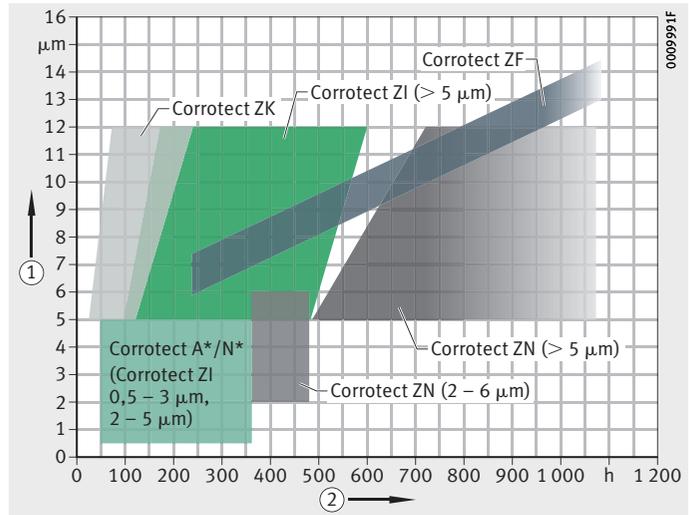
- +++ = high
- ++ = moderate
- + = low
- = short term (for example for transport with oiling)
- = not ensured

- ① Layer thickness
- ② Corrosion resistance to red rust in accordance with DIN EN ISO 9227

In the neutral salt spray test (NSS test) in accordance with DIN EN ISO 9227, the components are exposed to a defined sodium chloride climate, in order to compare the corrosion protection performance of the coating systems.

Figure 1

Comparison of Corrotect coating systems (cathodic corrosion protection) in the salt spray test



Added value by means of coatings

The variety of available protection systems always provides a suitable customer solution. They ensure a longer operating life and increase the value of an application. Protection systems offer numerous advantages, especially where technical limitations are not relevant.

After selection of the coating system, the overall layer thickness is the decisive criterion for achieving the best possible coating characteristics.

Advantages

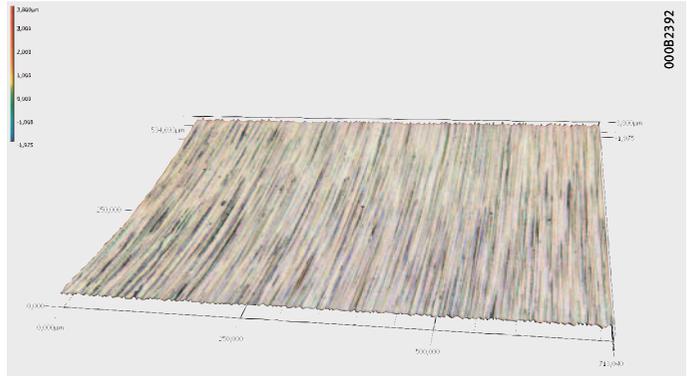
Advantages of Corrotect coatings:

- All-round or, occasionally, partial corrosion protection of functional and secondary surfaces.
- Penetration of rust in functional zones, such as seal raceways, is prevented in the long term with zinc-based coatings.
- Small bright spots or minor damage occurring during function are also protected against corrosion by the cathodic protection mechanism.
- The corrosion protection gives a verifiable and significant increase in operating life compared to uncoated parts.
- Seawater applications require special consideration and are to be treated with the Corrotect coating variants provided for this purpose.
- In the field of rolling bearings, bearings of the same dimensions can be interchanged without problems when using the Corrotect thin film variants.
- The replacement of stainless steel versions with Corrotect-coated versions offers financial incentives.
- Corrotect ZI only changes the surface topography slightly and is therefore highly suitable as additional corrosion protection for end-machined bearing components.

Corrotect coating systems

Technical limitations	<p>Technical limitations of Corrotect coatings:</p> <ul style="list-style-type: none">■ Thick film forming systems require consideration of the resulting dimensional changes and any limitations where applicable.■ Coated functional zones lose their original layer thickness during use, resulting in corresponding dimensional changes.■ Due to their chemical characteristics, zinc-based protection systems are not suitable for use in aggressive media. Media with $\text{pH} < 6$ and $\text{pH} > 8$ attack the coating chemically.■ In the event of contact with special chemicals (for example, cooling lubricants or anti-freeze agents), suitability and compatibility must be determined in a separate test.■ For food applications, or where there is direct contact with these, a zinc-based coating is not permitted.■ Zinc-based systems do not provide long-lasting resistance in contact with seawater.■ Certain Corrotect coating variants lose their protective performance at application temperatures $\vartheta > 120\text{ °C}$.
Protective mechanisms	<p>There are basically three different corrosion protection mechanisms available and in use in the respective variants.</p> <p>Barrier effect:</p> <ul style="list-style-type: none">■ Ingress of moisture and oxygen is prevented as long as the barrier is intact.■ Example: paint coatings, oil films, sealing, VCI paper. <p>Anodic corrosion protection:</p> <ul style="list-style-type: none">■ More noble metals with low affinity for corrosion protect the base material against chemical attack, as long as they are undamaged.■ Example: Corrotect CTN-coated spherical plain bearings. <p>Cathodic corrosion protection:</p> <ul style="list-style-type: none">■ Less noble metals protect the more noble base material against corrosion by dissolving under chemical attack (sacrificial effect).■ Example: zinc-coated brackets made from ferrous materials.
Running-in process	<p>Corrotect A*-coated surfaces provide, with optimum process control, an identical or slightly improved base roughness after coating, <i>Figure 2 to Figure 5</i>.</p> <p>The running noises occurring in initial practical applications are substantiated by the running in and shrinkage of the coating and disappear after a corresponding period of operation.</p>

Figure 2
Ground raceway surface



- ① Deviation
- ② Path x

Figure 3
Raceway roughness
for ground, uncoated surface

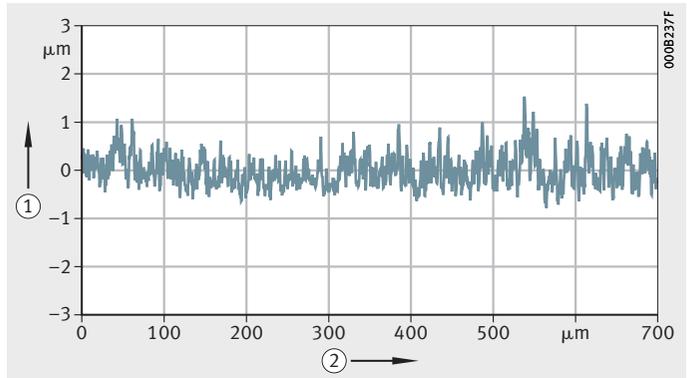
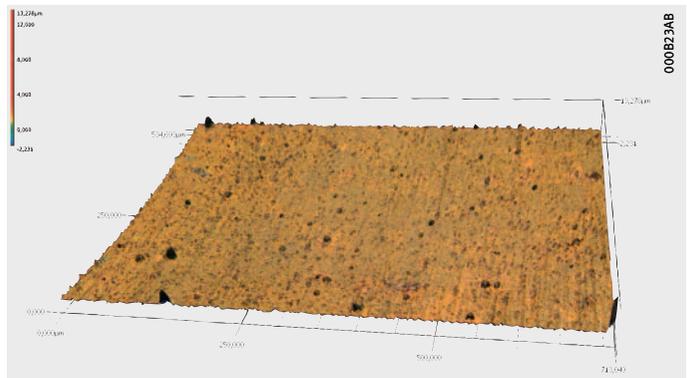
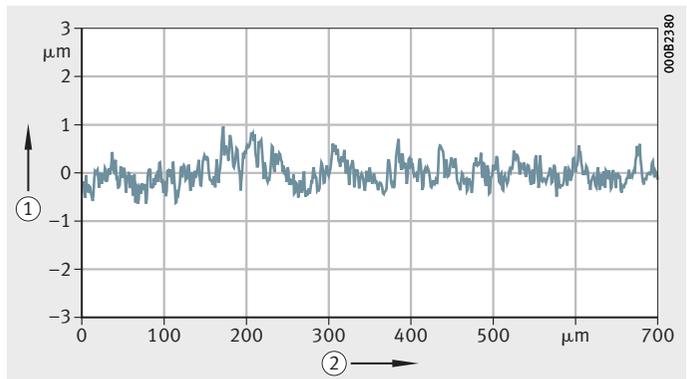


Figure 4
Ground raceway surface,
with Corrotect A* coating



- ① Deviation
- ② Path x

Figure 5
Raceway roughness
for ground surface,
with Corrotect A* coating



Corroctect coating systems

Coating capacities of Schaeffler

In addition to rolling bearing components, various automotive and industrial components are also suitable for the verified Corroctect coating, in order to give the end product good corrosion protection characteristics.

A network of internationally available coating facilities already covers the required capacities.



If a region does not have sufficient coating capacity, qualified specialists are available in the Schaeffler Surface Technologies function for market analysis, potential analysis and supplier development.



Figure 6
Internationally available
coating facilities

Corrotect ZK

Zinc coating with classic colourless/transparent passivation A or B (corresponds to An in accordance with DIN EN ISO 19598). Individual special applications are also designed with thick film passivation A*.

Pure zinc systems provide good corrosion protection. Depending on the layer thicknesses and passivation variants used, corrosion protection performances of up to 240 h are achieved against base metal corrosion (red rust).

In contrast to zinc alloy systems, pure zinc systems are used with relatively low protection performances. Due to this known characteristic, they are usually only used in simple industrial applications.

Common process variants are acid, alkaline and cyanide-free alkaline coating processes, which are used in accordance with the area of application, the required characteristics and as a function of the base material and, nowadays, are usually provided with post-treatments free from Cr(VI).

Acid zinc electrolytes, which are finally optimised by means of an additional zinc alloy system (Duplex Corrotect) are, for example, used in the coating of cast materials.

Characteristics

Feature	Coating		
Composition	Zinc		
Post-treatment	Thick film passivation	Thin film passivation	Thin film passivation
Corrosion resistance	Depending on the layer thickness and passivation, between 24 h and 240 h against base metal corrosion (salt spray test in accordance with DIN EN ISO 9227)		
Colour	Silver, iridescent	Colourless, silver	Silver-blue
Layer thickness	> 5 µm		
Coating resistance	Coating is amphoteric in character and therefore has reduced corrosion resistance for pH value < 6 and pH value > 8		

Corrotect ZK A- or Corrotect ZK B-coated components

Figure 7
Automotive components with small corrosion protection requirement



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Corrotect coating systems

Corrotect ZI

Zinc-iron coating (layer thickness $> 5 \mu\text{m}$) with thick film passivation A* or nanoparticle-backed thick film passivation N*.

In zinc alloy systems with a defined iron content (0,2% – 1,0% Fe), there is a reduced electrochemical potential (in contrast to pure zinc) in relation to base materials containing iron. This modified physical characteristic is, among other things, responsible for a reduced corrosion current, which manifests itself in a slower coating corrosion and thus improved resistance.

Zinc-iron alloy systems offer greatly improved corrosion resistance over pure zinc coatings with comparable layer thicknesses and passivations.

For decades, Corrotect ZI has been an important protective coating for automotive and industrial applications, providing Schaeffler components with the required corrosion protection.

If thick film passivations A* (standard) are doped with nanoparticles, additional protective layers form on the surface which bring about improved corrosion protection performances due to their chemical inertness.

Corrotect ZI as a variant with layer thicknesses $> 5 \mu\text{m}$ is also commonly used in numerous industrial and automotive applications. The coating complies with current DIN, EN or ISO standards in most specifications.

- ① Corrotect ZI A*-coated
- ② Uncoated

Figure 8
Ball bearing outer rings



Characteristics

Feature	Coating	
Composition	Zinc-iron	
Post-treatment	Thick film passivation	Nanoparticle-backed thick film passivation
Corrosion resistance	Depending on the layer thickness and passivation, between 120 h and 600 h against base metal corrosion (salt spray test in accordance with DIN EN ISO 9227)	
Colour	Silver, iridescent	Silver, slightly iridescent
Layer thickness	> 5 µm	
Coating resistance	Coating is amphoteric in character and therefore has reduced corrosion resistance for pH value < 6 and pH value > 8	

Example of overrunning alternator pulleys

In the automotive sector, Schaeffler overrunning alternator pulleys are provided in millions of cases with a Corrotect ZI N* coating. This protects the innovative alternator driving plate effectively against base metal corrosion.

In this version, the component which is most commonly located in the visual range of a motor vehicle engine combines outstanding functional characteristics and a long-lasting corrosion protection coating with optical requirements.



Corrotect ZI N*-coated

Figure 9
Overrunning alternator pulley

Corrotect coating systems

Corrotect A*, Corrotect N*

Zinc-iron coating (layer thickness $< 5 \mu\text{m}$) with thick film passivation A* or nanoparticle-backed thick film passivation N*.

For application by means of thin film technology ($0,5 \mu\text{m} - 3 \mu\text{m}$ or $2 \mu\text{m} - 5 \mu\text{m}$), rack and drum processes as well as numerous validated coating service providers are available.

Under load, this thin coating is compacted into the surface roughness profile and partially worn away. As expected, the protective layer in the functional area (raceway) has disappeared after running in and the bearing runs under its originally calculated conditions. Remaining areas are still protected effectively against corrosion and thus contribute significantly towards increasing the operating life.

Characteristics

Feature	Coating	
	Corrotect A*	Corrotect N*
Composition	Zinc-iron	
Post-treatment	Thick film passivation	Nanoparticle-backed thick film passivation
Corrosion resistance	Depending on the layer thickness and passivation, between 48 h and 360 h against base metal corrosion (salt spray test in accordance with DIN EN ISO 9227)	
Colour	Silver, iridescent	Silver, slightly iridescent
Layer thickness	$0,5 \mu\text{m} - 3 \mu\text{m}$ $2 \mu\text{m} - 5 \mu\text{m}$	
Coating resistance	Coating is amphoteric in character and therefore has reduced corrosion resistance for pH value < 6 and pH value > 8	

Examples Cylindrical roller bearings with thin film Corrotect A* ($2\ \mu\text{m} - 5\ \mu\text{m}$). Bearing components with corrosion protection requirements are each provided as a single part complete with Corrotect A* coating. The thin layer thickness of $2\ \mu\text{m}$ to $5\ \mu\text{m}$ generates a slight bearing preload after mounting. Due to the levelling of the raceways, this reduces after commissioning and the bearing component exhibits the calculated tolerances after a short running-in period. The bearing thus has the performance characteristics of a high precision bearing with simultaneous corrosion protection in the remaining secondary zones.

Rope sheave bearing SL04260

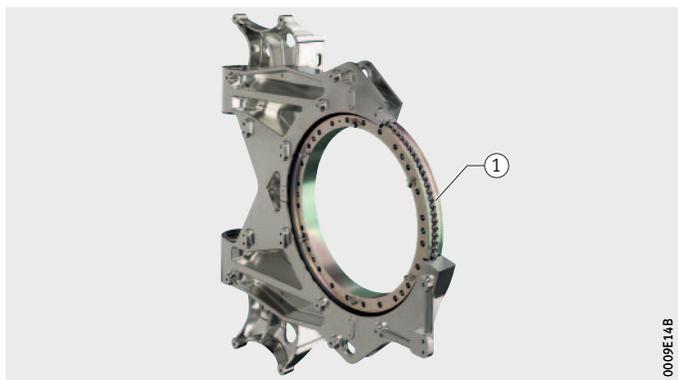
① Corrotect A*-coated bearing

Figure 10
Cylindrical roller bearing with corrosion protection and seals



① Four point contact bearing with Corrotect A*-coated inner ring

Figure 11
Application example Swivel system



Example of large size bearings

In industrial applications involving large size bearings, thin film Corrotect coatings continue to be used in areas where corrosion protection is the primary requirement.

Examples of industrial applications involving large size bearings:

- crane production
- guide rollers in fork lift trucks
- washing plant
- machine tools
- rolling mills.

Corrotect coating systems

Corrotect ZN Zinc-nickel coating for the highest corrosion protection requirements with thick film passivation A* (Cn in accordance with DIN EN ISO 19598). Possible corrosion protection of up to 720 h or more against base metal corrosion (red rust, suffix RR) depending on variant, design and layer thickness.

Zinc-nickel alloy systems currently count among the high-performance systems in terms of corrosion protection and are widely used in automotive and industrial applications.

Targeted control of the Ni mass fractions (standard is 10% – 15% Ni) still gives the surface a less noble potential (compared to iron), to ensure cathodic corrosion protection.

The potential differences between coating and base material present in this combination are largely approximated. The electrochemically driven coating resolution is thereby reduced and, as a result, the sacrificial effect of the zinc alloy coating is decelerated.

Highly corrosion-resistant coatings from drum or rack processes are possible in combination with high-performance thick film passivations.

Corrosion protection coatings based on ZnNi provide a level of corrosion protection which is at least 5 times higher than that of pure zinc (Corrotect ZK) with the same layer thickness and design.

In comparison with zinc-iron coatings (Corrotect ZI), the additional performance of ZnNi corrosion protection with identical layer thicknesses and identical design should be given as a factor of 3- to 4-fold.

For this purpose, thin film options are available in layer thicknesses of 2 µm to 6 µm from rack and drum production.

Characteristics

Feature	Coating
Composition	Zinc-nickel
Post-treatment	Thick film passivation
Corrosion resistance	Depending on the layer thickness and passivation, between 360 h and 720 h against base metal corrosion (salt spray test in accordance with DIN EN ISO 9227); in combination with a performance-enhancing post-treatment, corrosion protection of more than 720 h against red rust may be possible
Colour	Silver-blue, in some cases with coloured iridescence
Layer thickness	> 2 µm
Coating resistance	Coating is amphoteric in character and therefore has reduced corrosion resistance for pH value < 6 and pH value > 8

Examples Applications exposed to high levels of corrosion in the construction industry or in general machine building utilise the excellent corrosion protection performances of ZnNi.

In combination with functional topcoats (such as seals or paint), corrosion protection performances of > 2 000 h against base metal corrosion in accordance with ISO 9227 are possible. The resulting system performances must be determined by specific component.

Today, automotive components with ZnNi surface protection are state of the art and are used extensively in permissible chassis construction applications and in the engine compartment.

Corrotect ZN A* coating

Figure 12
Components from the automotive
and industrial sector



Corrotect coating systems

Corrotect ZF

Zinc flake protective coating with excellent corrosion protection performance. Protection performance ≥ 720 h against red rust is possible with adapted coating system and layer thicknesses.

Modern zinc flake systems are similar in structure to classic paint variants. Instead of colour pigmentation, a defined proportion of particles which provide protection against corrosion, such as zinc-aluminium flakes, is added. In terms of their mode of action, they behave like zinc coatings.

As a result of the less noble character in relation to iron, these corrosion protection particles act as sacrificial anode. Among other things, they protect the base material against corrosion by means of this effect (cathodic corrosion protection) and guarantee this even in the presence of slight coating damage.

As a positive secondary effect, the paint-like matrix contributes to the protective function and improves the overall corrosion performance by means of an additional barrier effect.

Depending on the design, size and weight of the component, the flakes are applied using dipping, centrifugal or spraying methods and are baked by means of subsequent hot drying at approximately 250 °C.

The use of systems that harden at room temperature has become increasingly established in cases where consideration of the structural state is required or in the coating of already mounted complete components. The protective performances of these systems are identical to classic zinc-flake systems, but require a separate equipment technology.

Characteristics

Feature	Coating
Composition	Zinc(-aluminium) flakes
Post-treatment	No passivation, topcoat in some cases
Corrosion resistance	Depending on the layer thickness, up to 1000 h against base metal corrosion (salt spray test in accordance with DIN EN ISO 9227)
Colour	Silver-grey (topcoat can optionally be coloured as required)
Layer thickness	$> 5 \mu\text{m}$

Corrotect ZF coating

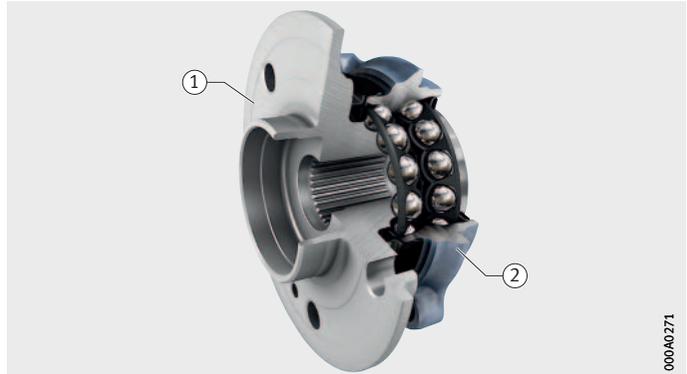
Figure 13
Various components



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- ① Rim seat with Corrotect ZF coating
- ② Outer ring with Corrotect ZN coating

Figure 14
Wheel flange



Standard applications

Zinc flake coatings are preferably used for high strength materials in which a potentially occurring hydrogen load could lead to functional disturbances. Pretreatments required for this purpose are implemented by means of degreasing and blasting processes. Sintered materials are often critical in terms of wet chemical surface treatment variants. Zinc flake coatings have established themselves as an adequate alternative here and offer excellent corrosion protection with attractive coating costs.

Other areas of application

Systems which harden at room temperature are now available for special applications, enabling completely new fields of application. An additional treatment with components which influence friction (rougher or smoother) or colouring of the zinc flake surfaces by means of special process solutions opens up further areas of application. This must, however, be clarified as necessary in consultation with the Schaeffler Surface Technologies function.

Corrotect coating systems

Corrotect P

The coating variants with a polymer base include various high-performance coating systems that are used for corrosion protection. These systems are mostly used for components that must fulfil primary corrosion protection and optical requirements in combination (for example, Black Series plummer block housings).

Due to the present barrier effect, the base materials are reliably protected against corrosion when the surface is intact.

Paint systems are particularly suitable for geometrically complex components that require adequate corrosion protection, but which cannot be optimised using other surface treatments due to their design, base material or assembly stage. The active principle of corrosion protection is based on separating the base material from the chemical corrosion process by means of a barrier. Damage to the coating can lead to corrosion at these points.

Corrotect P coatings are preferably applied to phosphated or blasted substrates to allow reliable layer adhesion.

Characteristics

Feature	Coating
Composition	Polymer-based
Post-treatment	No passivation
Corrosion resistance	Corrosion protection in accordance with DIN EN ISO 12944-2; corrosivity categories C1 to C5-M; depending on the layer thickness, up to 720 h against base metal corrosion (salt spray test in accordance with DIN EN ISO 9227)
Colour	Freely selectable
Layer thickness	15 µm – 500 µm

① Roll arm with Corrotect P coating

Figure 15
Active roll control component



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Corrotect CTN

High-performance corrosion protection through copper-bronze-nickel combination coating. Corrosion protection performance ≥ 1000 h against red rust. Furthermore, resistance to seawater in accordance with ASTM G48-C is ensured.

Offshore applications are exposed to extreme weather and environmental conditions. The requirements placed on the corrosion protection systems are very high and require special solutions adapted specifically to these conditions, in order to be able to offer functional protective performance.

In overall terms, seawater contact, wind and, where applicable, abrasive wear caused by contaminant particles are influences that should not be disregarded, bringing most coating variants to the limits of their performance and potentially causing premature failure.

Corrotect CTN rises to these aggressive challenges with a combination of three layers. In addition, it has considerable anti-wear characteristics.

The outstanding corrosion protection performance is demonstrated by an internationally recognised test specification:

- layer thickness $> 60 \mu\text{m}$
- temperature resistance up to $+600 \text{ }^\circ\text{C}$.

Characteristics

Feature	Coating
Composition	Copper-bronze-nickel combination
Post-treatment	None
Corrosion resistance	Corrosion protection due to barrier effect against base metal corrosion (red rust formation), depending on design and layer thickness: <ul style="list-style-type: none">■ ≥ 1000 h according to salt spray test in accordance with DIN EN ISO 9227■ ≥ 72 h seawater-resistant in accordance with ASTM G48-C
Colour	Silver, in some cases with yellow shimmer
Layer thickness	$> 60 \mu\text{m}$ (preferred)

Corrotect coating systems

Example Schaeffler offers bearing components with a Corrotect CTN coating in continuous seawater contact, thus increasing their functionality in offshore applications many times over.

① Inner ring with Corrotect CTN coating

Figure 16
Spherical plain bearing
with two-piece outer ring and
ELGOGLIDE-W11 sliding layer

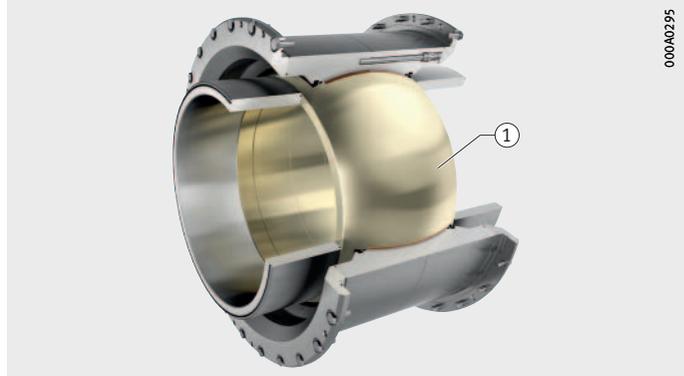


Figure 17
Offshore application
Shipping



Corrotect H, Corrotect HP

Thermally sprayed, metallic layers as corrosion protection with zinc or zinc-aluminium (optionally with topcoat).

Characteristics

Feature	Coating	
	Corrotect H	Corrotect HP
Composition	Zinc or zinc-aluminium coating	
Post-treatment	None	Polymer-based topcoat (paint)
Corrosion resistance	> 15 years possible, in accordance with DIN EN ISO 12944	
Colour	Metallic	Topcoat suitable for individual colouring
Layer thickness	50 µm – 400 µm	

Corrotect H coating on all outside surfaces

Figure 18
Tapered roller bearing system
for wind turbines



Corrotect H

Thermal zinc flame spraying to provide corrosion protection for large components.

Flame spraying methods are generally classified under the thermal coating methods. With this method, powder, wire, cord or rod-shaped additional materials are prepared for coating by means of thermal effects and sprayed under additional kinetic conditions (gas flow or compressed air combustion) on the required surfaces. Depending on the combustion gas used, flame temperatures of up to 3 200 °C can be achieved. As a result, a variety of coating materials, such as metals, ceramics and plastics, are available.

Corrotect H coatings are mostly applied at Schaeffler as zinc spray coatings. Layer thicknesses of 70 µm to 160 µm are applied for the purpose of corrosion protection, if the respective components do not experience direct contact with aggressive ambient media.

Corrotect coating systems

Other flame spraying methods are used with Durotect H. In this case, hard metals or plastics are applied and used to improve the wear resistance.

Examples:

- power plants
- aerospace industry
- automotive industry
- paper industry
- machine building industry.

Further information

Descriptions relating to Durotect H:

- TPI 186, Higher Performance Capacity Through the Use of Coatings ► <https://www.schaeffler.de/std/1F39>.

Corrotect HP

Thermal Zn flame spraying and additional cover painting for the purposes of providing corrosion protection for large components with high requirements.

The paint systems required for this duplex system are specified in accordance with DIN EN ISO 12944 and are classified and selected according to requirements.

Corrotect HP is intended for highly corrosive, aggressive ambient atmospheres, for example:

- offshore applications
- large bearings in wind energy applications.

Notes

Notes

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Issued: 2019, september

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TPI 67 GB-D