PRETEC

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Pc-Coat™

Duplex coating

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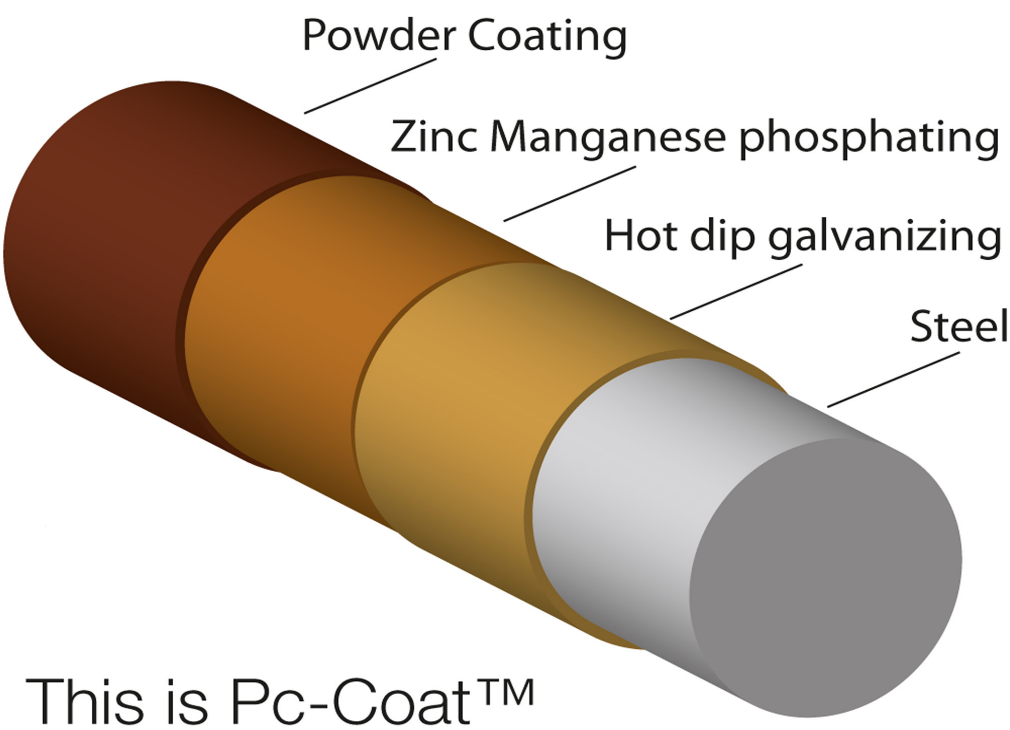
Zhejiang Pretec Metal Products Co. Ltd

Pc-Coat™

This is a surface coating that provides optimum corrosion protection for steel using three different processes in the following order:

- **Hot-dip galvanizing**
- **Zinc-manganese phosphating**
- **Powder coating in one or two layers**



The result is a very attractive surface, a coating with a long lifetime and insignificant future maintenance costs.

HOT-DIP GALVANIZING

In many environments, hot-dip galvanizing of steel provides adequate protection against corrosion and a long lifetime. The process is cost-effective and require little or no maintenance afterwards.
When steel is dipped into hot zinc, the temperature and the dip time produce a zinc coating in an alloy reaction with the steel. This provides very good adhesion between the zinc and the steel surface. Hot-dip galvanizing is performed following the standard EN ISO 1461.

Low temperature 450–460°C
High temperature 540–560°C

It is important to choose steel grades that are suitable for hot-dip galvanizing.
Steel with a silicon content + phosphorus of between 0.03% and 0.14% yields a thick, brittle and poor quality zinc layer. It has been shown that powder coat in this steel grade in addition have major problems with pitting of the coating.

Other flaws and defects that can occur during and after hot-dip galvanizing and that will negatively affect the powder coating include:

- White rust. Hot-dip galvanized products stored in humid conditions.

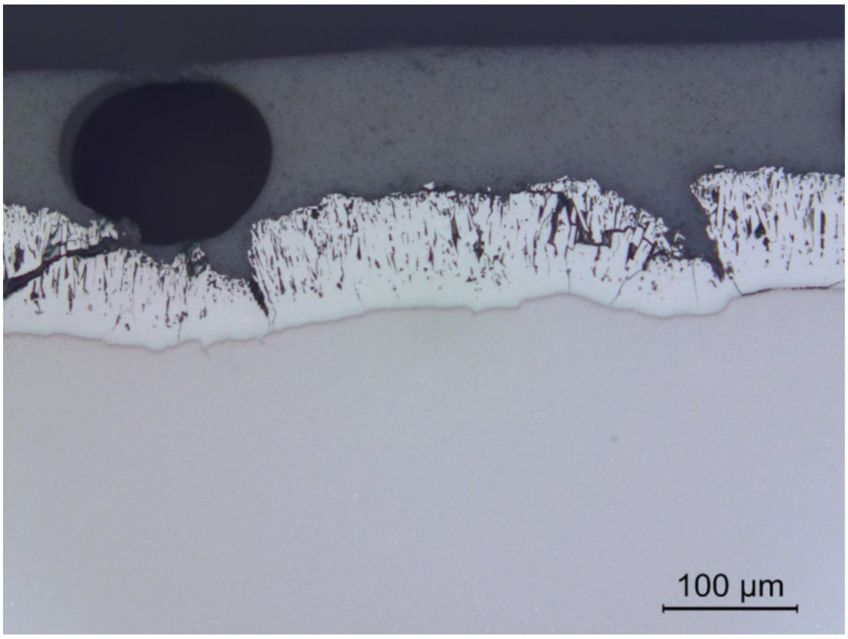
- Ash and flux residue on the surface. If the surface of the zinc bath is poorly cleaned, ash and flux residue may stick to the surface of the product when it is lifted out of the zinc bath.

The quality of the final product is therefore highly dependent on choosing the proper steel grade, that hot-dip galvanizing is performed properly and that the items being dipped are properly handled during the entire process.

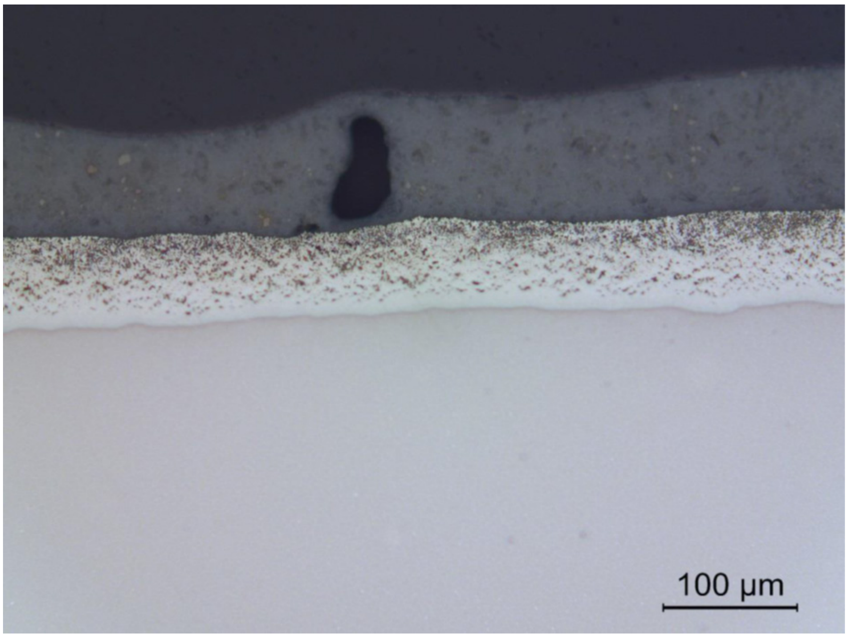
Please contact us for more information regarding which steel grades are suitable for hot-dip galvanizing.

To achieve an optimum alloying reaction between the steel and the hot zinc and a uniform coating thickness that will not crack, shot blasting may be necessary prior to galvanizing.

Picture 1 – Rebar not shot blasted



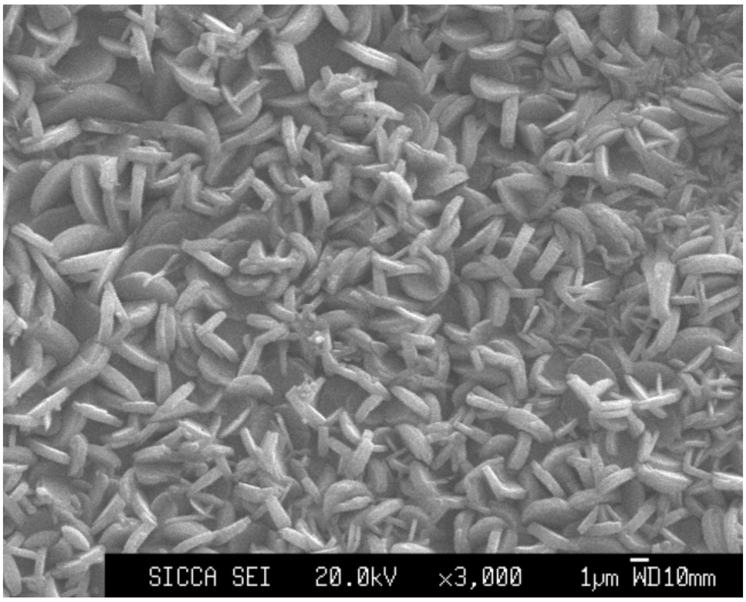
Picture 2 – Rebar that has been shot blasted



Zinc-manganese phosphating

After hot-dip galvanizing, the product undergoes a pre-treatment process in the powder coating plant. This process is performed in several steps, including degreasing, rinses, activation, phosphating, passivation and drying, leaving a dried and phosphated zinc layer. Then the product is automatically and immediately sent to powder coating.

Phosphating is essential to get good adhesion to the powder coating, and thus a coating with a long lifetime. With good monitoring and quality assurance of the baths, this process produces a layer that passivates the zinc and ensures good adhesion to the powder coating.
A phosphated zinc layer has a matt grey surface, so that it is easy to see if the desired quality has been achieved.



Powder coating

The powder paint protects the zinc layer and the zinc layer is a stable surface for the powder coating. This ensures that the hot-dip galvanizing and powder coating provide a long lifetime in corrosive environments. Corrosion-resistant powder coating is normally based on an epoxy or polyester bonding agent, or combinations of the two. The powder is electrostatically charged and sprayed onto the product in a closed environment before proceeding to the curing oven where it melts and flows together to form a film, hardening at 180 to 210°C. Powder coating is available in many colours and textures and is often specified using RAL or NCS colour codes. Powder coating is delivered in line with EN 13438.

Environment

From an environmental perspective, hot-dip galvanizing and powder coating are very good processes that do not have a negative impact on the environment. Both processes produce components with a long lifetime and are therefore also important for long-term environmental accounting. The chemical pre-treatment is water-based. The powder is free from harmful hardeners, with no solvents, and waste is properly treated by certified companies.

Corrosion protection

Zinc’s corrosion rate is dependent on the environment to which the object is exposed. This can be expressed in the following table, which is taken from ISO 12944-2

Corrosion rate of zinc in various environments.

	Unalloyed carbon steel	Unalloyed carbon steel	Zinc	Zinc	Environment	Environment
Corrosion class	Mass loss	Thickness reduction µm/year	Mass loss g/m^2/year	Thickness reduction µm/year	Outdoors (example)	Indoors (example)
C1 very low	=10	=1.3	=0.7	=0.1		Heated buildings with clean atmosphere.
C2 low	>10 to 200	>1.3 to 25	>0.7 to 5	>0.1 to 0.7	Atmosphere with little or no pollution. Country atmosphere.	Heated buildings. Condensation may occur. Larger sport halls.
C3 medium	>200 to 400	>25 to 50	>5 to 15	>0.7 to 2.1	City and industrial atmosphere, moderately polluted with sulphur. Coastal climate, low salinity.	Manufacturing facilities, high humidity. E.g food factories, laundries, breweries.
C4 high	>400 to 650	>50 to 80	>15 to 30	>2.1 to 4.2	Industrial and coastal areas with moderate salinity.	Chemical companies, swimming pools, shipyards, boat builders.
C5-I very high (industrial)	>650 to 1,500	>80 to 200	>30 to 60	>4.2 to 8.4	Industrial and coastal areas with high humidity and aggressive atmosphere.	Buildings with almost constant condensation and a high contaminated atmosphere.
C5-M very high (marine)	>650 to 1,500	>80 to 200	>30 to 60	>4.2 to 8.4	Coastal and ocean areas with high salinity.	Buildings with almost constant condensation and a high contaminated atmosphere.

The highest reduction in coating thickness happens during the first year. Then the corrosion rate usually goes down because the products of corrosion provide a certain degree of protection. Specifically, the corrosion rate is low for zinc that is exposed to a moderately corrosive atmosphere due to a film of protective zinc carbonate.

Lifetime

A large study[1] from the Netherlands has shown that lifetime can be calculated using the following formula, depending on the environment to which the object is exposed.

Formula $L_T = K (L_{Zn} + L_M)$
L_T = Duplex system's lifetime in years
L_{Zn} = Estimated lifetime of zinc coating in years in the current environment
L_M = Estimated lifetime of powder coating in years in the current environment, if applied directly to steel
K = environmental synergy factor, which can be set to:
1.5 when exposed to environmental class C5 or permanently submerged in seawater
1.6–2.0 when exposed to environmental class C3–C4, or when the time that it is wet is less than about 60%
2.1–2.3 when exposed to environmental class C2.

Example

The lifetime of the coating on a bolt with Pc-Coat with the following coating specification:

Hot-dip galvanized coating mean thickness min. 65 µm in accordance with ISO 1461.
Powder coated single layer epoxy mean coating thickness min. 60 µm in accordance with EN 13438.
The bolt is used in a corrosive C4 class environment, with a mean corrosion rate of 3 µm/year for zinc.
If we assume that the powder coating has a lifetime of 10 years for steel in the given environment, then the lifetime of Pc-Coat is calculated with the following formula:

LT = 1.6 (65/3 + 10) = 50 years

Such calculations are only an indication of expected lifetime and not a guaranteed lifetime. But it shows that hot-dip galvanized and powder coated products can have a very long life.

[1] Eijnsbergen: Duplex systems. Hot-dip galvanizing plus painting (Elsevier Science, 1994)

Why choose Pc-Coat corrosion protection:

- Experiences with hot-dip galvanized and powder coated products have shown the potential for an extremely long product life. Research projects at SINTEF[2] have shown the same.

- In addition to good corrosion protection, the coating gives the product a decorative appearance and an almost unlimited colour range.

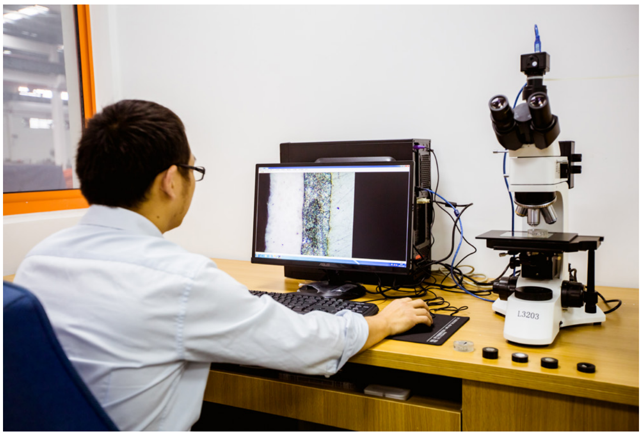
- This type of corrosion protection is often used were requirements stipulate high quality combined with a desire for long life and low maintenance costs. We are talking about lifetimes of more than 50 years, depending on climatic and environmental conditions, and quality of material and workmanship. Examples of this include coastal installations, underground constructions, infrastructure, climate with high humidity, combined with high temperatures.

- Powder coating is an environmentally friendly and economical process with little waste and no volatile solvents. This provides a good working environment and significant cost savings.

- We are committed to quality at all levels. The processes are automatically controlled in plants with repetitive operations. This, in combination with good quality assurance routines and skilled employees, ensures consistent and high quality.

[2] M. Bjordal, S.B. Axelsen, O.Ø. Knudsen, “Quality criteria of powder coated HDG steel in corrosive environment”, Progress in Organic Coatings 56, 1 (2006): pp. 68–75

The contents of this presentation have been verified and quality controlled by SINTEF AS.



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