Oxsilan® thin-film technology:
The next generation in metal protection.

Chemetall
expect more

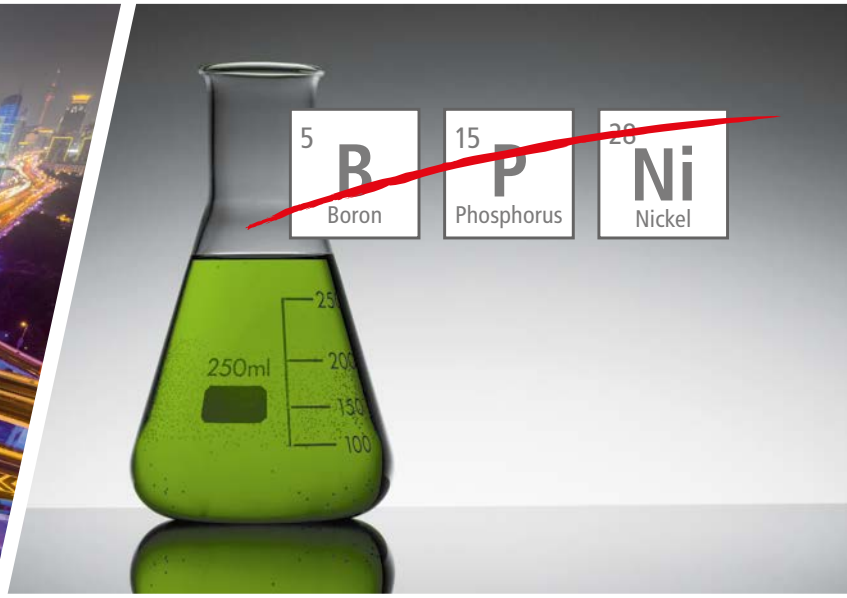
Innovation-driven and forward-looking
The evolution of surface treatment

Industry trends, customer specifications and legal regulations all impose new requirements on existing pretreatment technologies. The question is, can current processes be further adapted or are new technologies the answer to meet the demands of today and tomorrow?

Metal pretreatment plays a vital role in manufacturing processes. It provides long-term corrosion protection and ensures optimal paint adhesion. For many years, phosphating and chromating processes have been the technology of choice. They are robust processes and have proved their effectiveness over many years. Over time, the technologies have been developed or improved to meet ever increasing market demands. Factors such as being environmentally sustainable, rising energy costs, as well as the ever more varied metal combinations used in applications are now becoming considerably more relevant and present a challenge to traditional conversion coating processes.

Oxsilan® facilitates meeting legal requirements

Nickel, boron, phosphates – in recent years heightened attention has been paid to the protection of human health and the environment. This has lead to limits, sometimes even bans, being placed on the use of certain chemicals. In 2007, REACH came into force and the regulation on chemicals makes great demands on manufacturers, importers and users of chemicals. In addition to these regulations there are also further regional or local market restrictions in existence, such as the ban placed by some countries on the use of phosphate-containing processes because of the eutrophication of rivers and lakes. Oxsilan® is the answer for phosphate-free processes.



Oxsilan® is ahead of trends – lightweight design

It is expected that the use of lightweight materials for example in the automotive industry, will increase from 35 - 60% by 2020. Aluminium is already increasingly used and new substrates such as zinc-magnesium, high-strength steel and magnesium are finding their way into applications. Multi-metal capability is thus the buzz word for today's flexiblevpretreatment technologies.

Zero emission with Oxsilan®

Zero is at the core of the latest global megatrend, zero emissions (i.e. CO_2), zero defects and zero waste. Operating at lower temperatures with a lower energy requirement, producing little or no sludge, the Oxsilan® technology takes a big step towards realizing this megatrend.

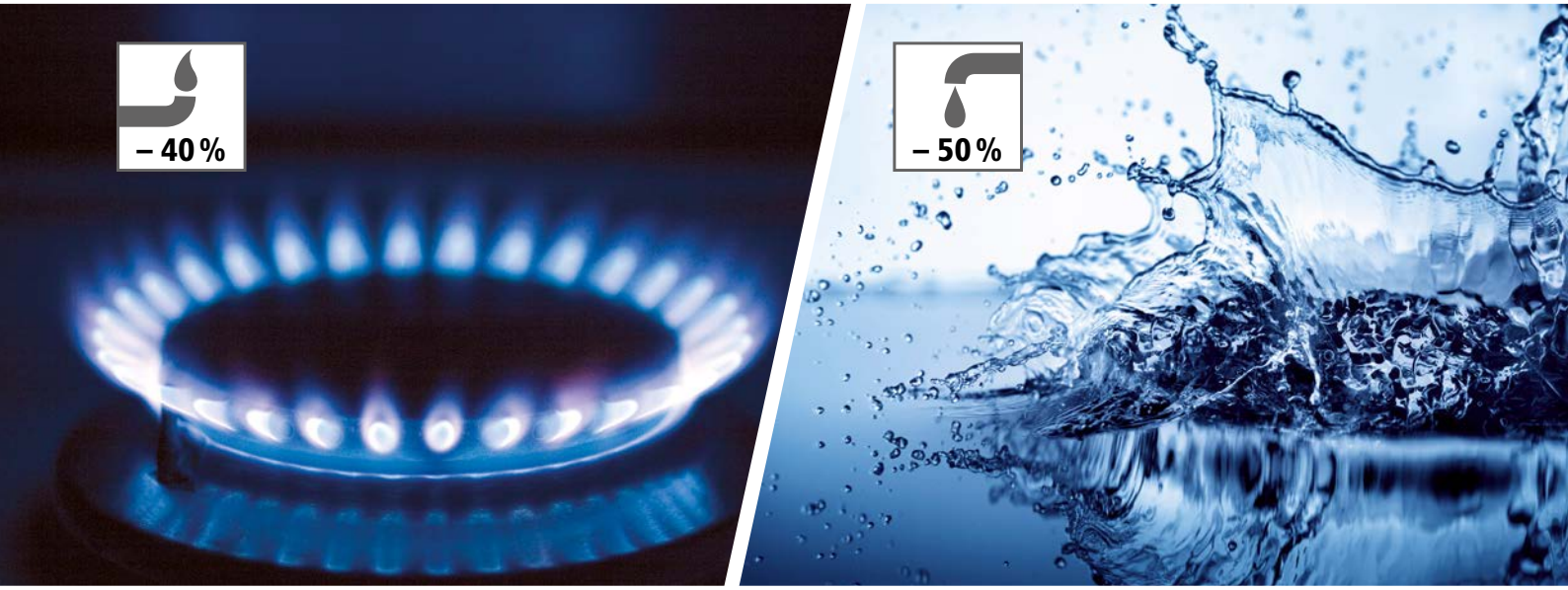
Oxsilan® is the future-proof technology of choice

Chemetall was the first company to introduce a multi-metal thin-film technology on the market – long before most of the current developments had taken place. Nowadays, Oxsilan® represents a mature alternative – comparable in terms of quality to zinc-phosphating or chromating processes. With a view to their technical and economic profile, the thin-film technologies clearly show advancements in terms of higher productivity and multi-metal capability, resulting in considerably lower process costs.

Easy changeover from conventional processes to Oxsilan®

Manufacturers who are considering an upgrade of their paint and pretreatment system should therefore consider taking a step towards the future. Many years' industrialized experience has shown that existing processes can be converted without significant investment.

The key benefits of Oxsilan®
Process-cost-efficient & environmentally compliant



Nowadays the adoption of eco-friendly production techniques is directly linked to cost savings. Major advantages of changing over to the Oxsilan® technology are its environmental profile, technical competitiveness and the commercial benefits through process cost reduction.

Comparison of relative figures*:

	Zinc-phosphating	Oxsilan® process
Heating costs	100	60
Electricity	100	70
Rinsing water	100	50
Waste disposal	100	20
Maintenance costs	100	60
CO_2 - Emission	100	60

* Average figures of inhouse calculations.

High energy savings achievable with Oxsilan®

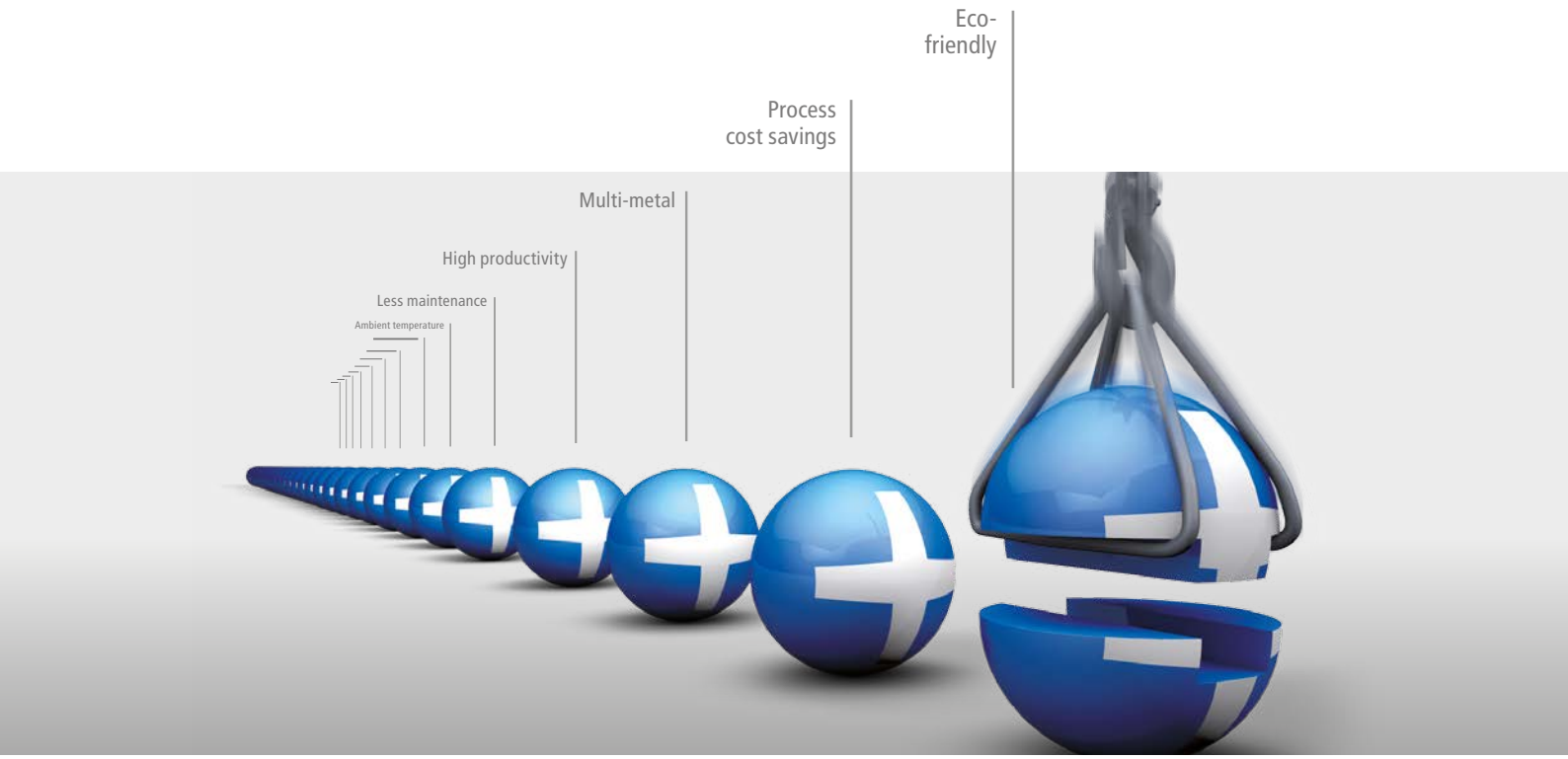
Oxsilan® is an ambient temperature process, meaning that bath heating is usually not required at process temperatures ranging between 25 and 30 °C. Consequently, a substantial reduction in energy usage can be attained resulting in considerable cost savings and reduced sensitivity to future price fluctuations in the energy markets.

Increased productivity enabled by fewer process steps

Compared to zinc-phosphating, the Oxsilan® process does not require activation and passivation. The fewer process stages result in less product consumption. Additionally, the shorter treatment times, for example in the conversion coating stage, enhance productivity.

Up to 50% reduction in water consumption

The Oxsilan® process normally requires fewer rinse stages than traditional phosphating processes. Smart rinse water management therefore allows savings of up to 50% in water usage. Reduced water consumption also has a positive effect on the costs of waste-water and effluent treatment.



No hazardous heavy metals, no phosphates

Oxsilan® has an excellent environmental and low toxicological profile. According to GHS it is rated as 'corrosive'. The process is free from hazardous heavy metals such as nickel and chromium. In combination with a phosphate-free cleaner, the entire Oxsilan® process becomes completely free of phosphates. As a result, expensive disposal of phosphate sludge is no longer required, and there is no danger in case of an accidental discharge of phosphates into inland and coastal waters.

Tri-cationic zinc-phosphating	Oxsilan®
Chromating (yellow / green)	

Significantly less sludge with Oxsilan®

Most manufacturing businesses are proud to show-off their production facilities. However, plant tours often by-pass the zinc-phosphate pretreatment process because it is considered too dirty to be viewed on the tour. Some process tanks contain large quantities of phosphate sludge and the plant is often encrusted with scale deposits. Ongoing and costly chemical or mechanical cleaning is required to keep the facility in full working order.

Since the Oxsilan® process takes place under more moderate conditions, the treated metals are hardly etched. Thus, the sludge formation is reduced to a maximum of 0.2 g/m² material throughput representing a 95% decrease. Scale formation in the pretreatment tunnel as well as clogged pipes and spray nozzles, which would need chemical or mechanical cleaning, is now a thing of the past. The cleanliness of this technology allows the pretreatment plant to become a visible part of the production process.

Shorter production line, smaller investment

Oxsilan® can reduce investment costs

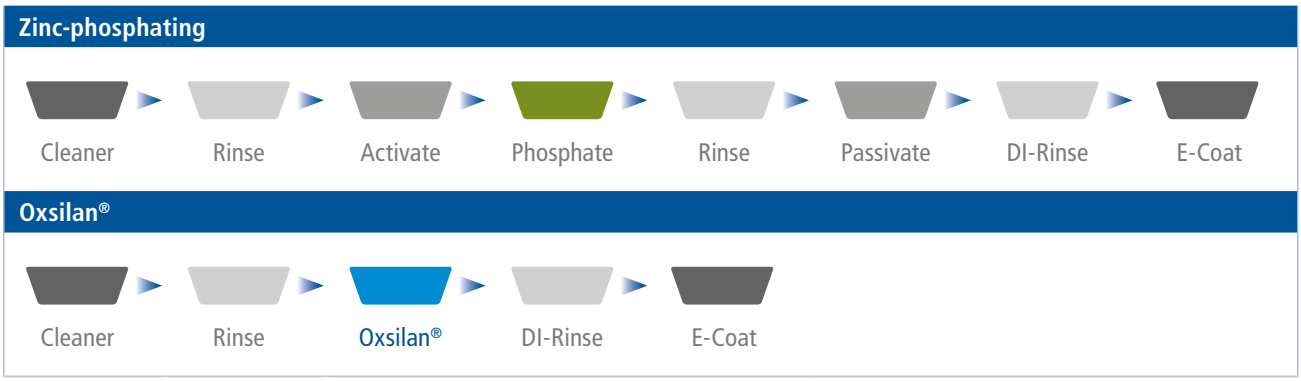
The thin-film technology offers high process cost savings in brownfield lines. The lower operating costs are achieved through shorter process steps compared to a traditional zinc-phosphating process, as well as significantly reduced water and energy consumption. However the savings achieved for greenfield lines are even greater. The fewer stages and installations required for the Oxsilan® pretreatment process can reduce the investment costs by around 20%.

With regard to the surface treatment of aluminium, there is no significant change in process sequences. The surfaces must be cleaned, etched and thoroughly rinsed before the conversion coating can be applied. This makes it easy to convert any chromating process to Oxsilan® without any significant line modifications. Oxsilan® is approved by GSB and Qualicoat and will exceed the requirements of AAMA.

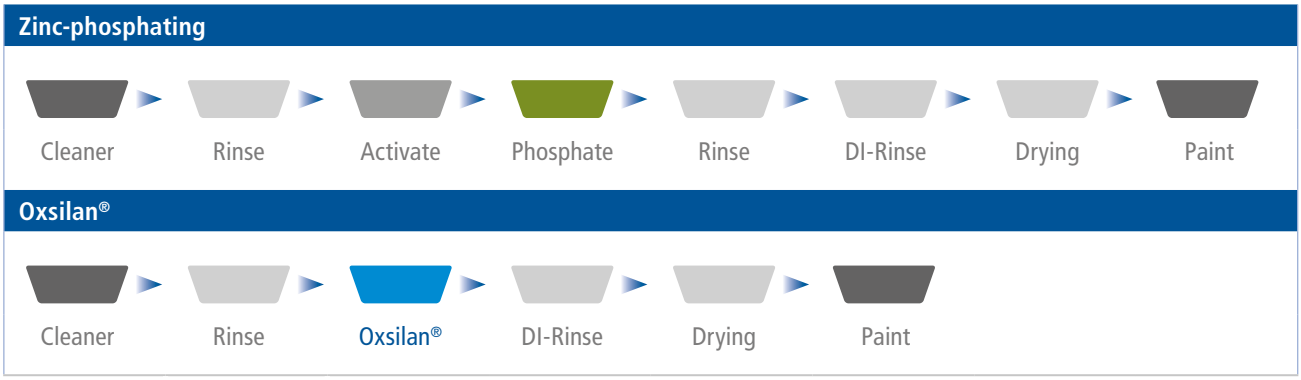
Oxsilan® benefits at a glance:

- significantly reduced process costs
- reduced water and energy consumption
- free of nickel and phosphates
- ambient temperature process without heating
- environmentally compliant
- practically sludge-free, reduced maintenance
- fewer process stages, higher productivity
- multi-metal capability

Zinc-phosphating vs. Oxsilan® pretreatment prior to e-coat



Zinc-phosphating vs. Oxsilan® pretreatment prior to powder / liquid paint



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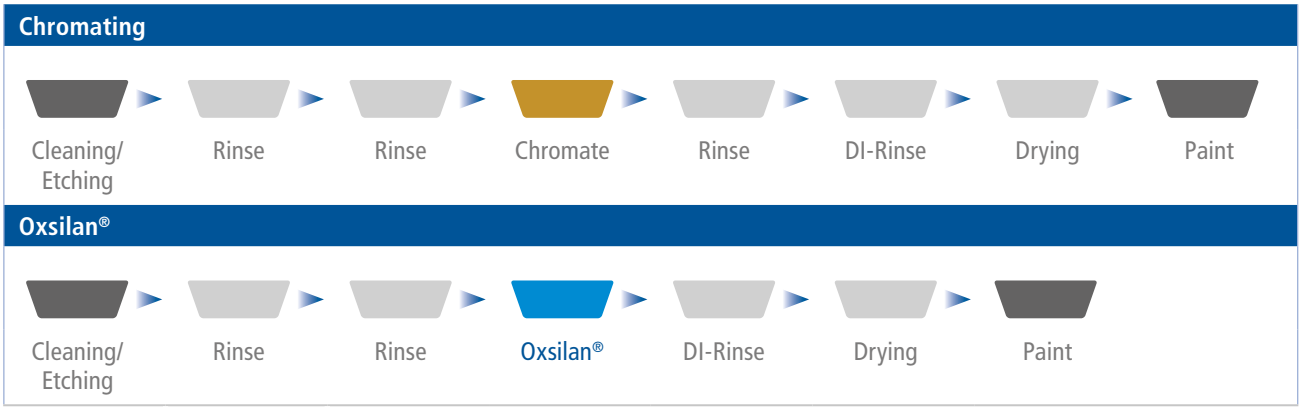
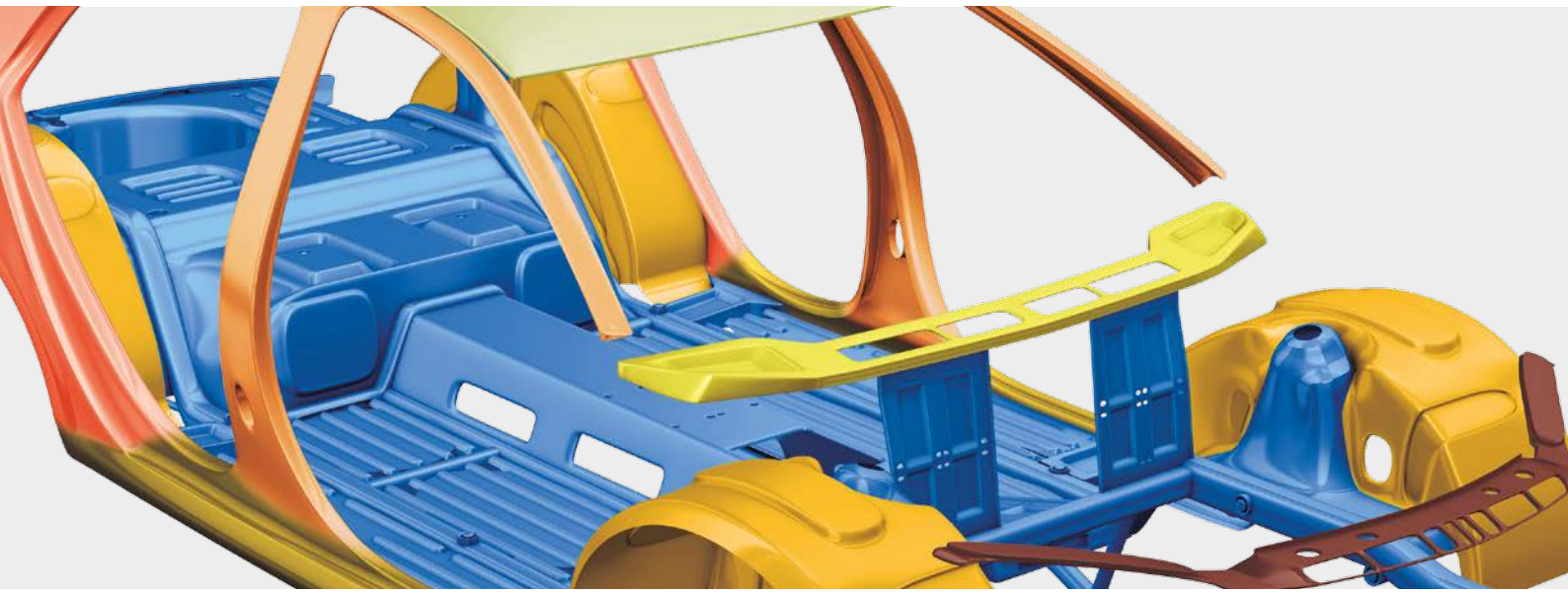


Multi-metal capable and simple analyses



Oxsilan® fosters multi-material construction

The performance requirements for vehicles and components, amongst others, are continuously growing: more functionality, higher speed, stylish design and increased safety are all being demanded by consumers. To meet those expectations at a technical, affordable and environmental level, new substrates are needed. However, single materials alone are not the answer to this ever increasing list of demands. The solution lies in combining materials. Thus, multi-material design is becoming more important and with it, the need for a corrosion protection functionality with multi-metal capability.

All common metals can be treated with Oxsilan®

The increasing mix of metal substrates in an application poses no challenge for Oxsilan®. Whereas traditional pretreatment technologies are not flexible enough or the set-up times are too long to treat the substrate-mix, the Oxsilan® technology is by its very nature a multi-metal process. All common metals and alloys in any combination can be treated with this thin-film technology.

Oxsilan® for lightweight and new substrates

Lightweight materials such as aluminium and high-strength steel can also be pretreated with the Oxsilan® process in the same way as steel and galvanized steel. Additionally, new substrates such as zinc-magnesium sheet metal have been successfully pretreated with it.

Oxsilan® layers have no influence on fatigue resistance and thus are the preferred pretreatment for magnesium wheels and other dynamic loaded components. The thin-film technology has low electrical resistance and high corrosion resistance and therefore provides a consistent conductivity across all contact points of the magnesium component.

Oxsilan® enables fast and simple analyses directly on site

The chemistry of the Oxsilan® technology is extremely robust, however, the baths still require regular checks. After all, the bath conditions are subject to constant change due to metal dissolution, carry-over and the actual substrate consumption. Unlike phosphating, this does not require time-consuming manual titration (free acid, total acid, zinc or Karl-Fischer).

Nearly all analyses can be performed directly on site using portable meters: measurement of the electrical conductivity, pH and fluoride content already gives a largely accurate picture. As with the phosphating technology, the ICP analysis (inductively coupled plasma) can provide an analysis of all metal ions.

The quickest method for checking the coating quality is by means of an x-ray fluorescence analysis (XRF) of the pretreated substrates. For a better process quality control, a non-destructive method, i.e. a mobile XRF meter, can be used to provide the results almost immediately allowing for any quality problems to be quickly identified and corrected.

Line monitoring at a glance:

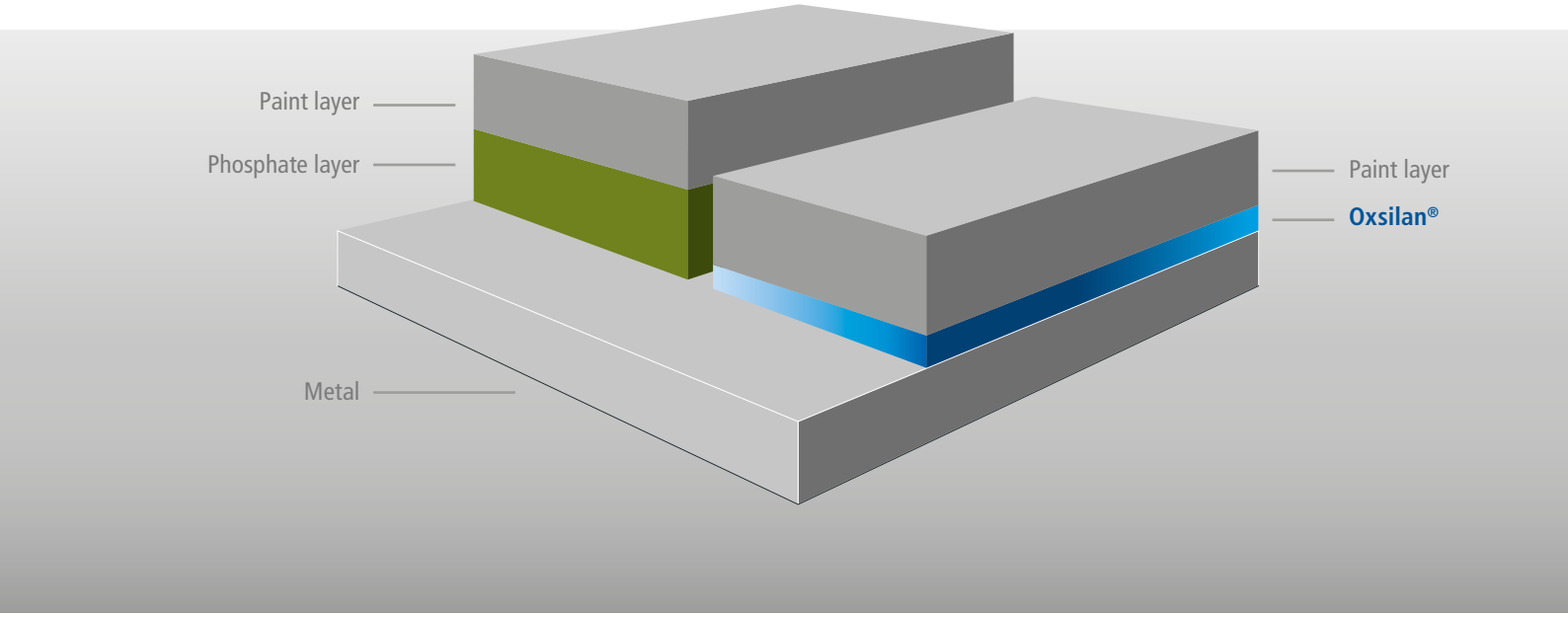
- Cleaner
  - Free acid (FA)
  - Total acid (TA)
  - pH-value
- Oxsilan®
  - pH-value
  - Free fluoride
  - Conductivity
  - In certain cases: zirconium (Zr), copper (Cu) and silicon (Si)

Chemical reaction
Thin-film technology based on silanes

With the Oxsilan® technology, Chemetall has developed a sustainable, efficient and economic pretreatment portfolio that exceeds today's customer demands and industry trends in a variety of ways. Based on silanes, this thin-film technology offers great potential for process cost savings and performance modifications.

The base materials for the Oxsilan® technology are silanes. During the manufacturing process the silanes are hydrolyzed and converted to polysiloxanes. During the coating process, the reactive silanol groups are chemically bonded to the metal surface as well as to the paint coating. Heat treatment, e.g. curing of a subsequent cathodic electro-painting (E-Coat) further cross-links the polysiloxanes creating a coating layer in the range of 100 nm.

This thin layer is sufficient to achieve the same degree of corrosion protection as a zinc-phosphate coating which is ten times thicker. This has been proven in combination with many paint systems. The numerous functional groups present in the polysiloxanes contribute to the excellent paint adhesion. Additionally, they offer considerable potential for product performance modification and optimization.



Comparison of Oxsilan® versus zinc-phosphate layer

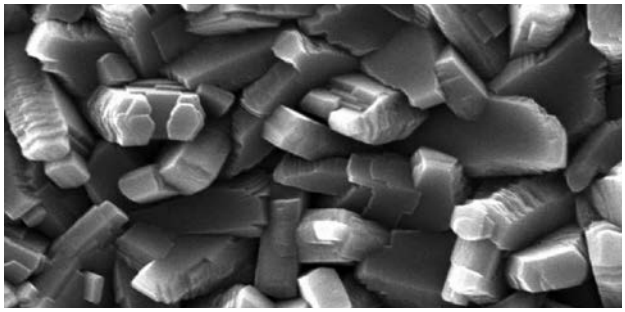
Limitations of zinc-phosphate technology

An optimized zinc-phosphate layer gives excellent corrosion protection and paint adhesion properties. The characteristics of a phosphate system have to be balanced, because a coating weight which is too high, with bigger phosphate crystals can lead to poor paint adhesion, but a coating weight which is too low can give insufficient corrosion protection. Acid etching, which is the first part of the phosphate process reaction can help to even the metal surface, however it also causes some hydrogen embrittlement which reduces the load-bearing capacity of components such as injectors or drive shafts.

With Oxsilan® less etching and higher component stability

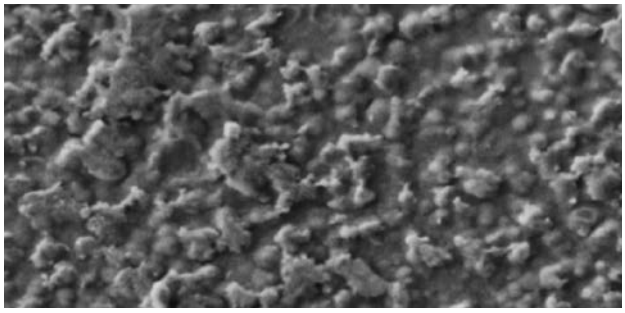
The approach of the Oxsilan® thin-film technology is quite different. Chemical reactions take place with both the metal surface and the paint layer, forming strong bonds. Depending on the specific functional groups in the diverse Oxsilan® systems, the pretreatment process can be adapted to different substrates and paint systems. The extremely low etching rate means embrittlement cannot occur and thus the pretreated components can withstand higher loads when in service. The Oxsilan® process also avoids one of the typical phosphating disadvantages for electronics: an increase in electrical resistance. Oxsilan® processed electronic control units receive not only bare metal corrosion protection, but are also given a remarkably lower electrical resistivity.

Traditional zinc-phosphate

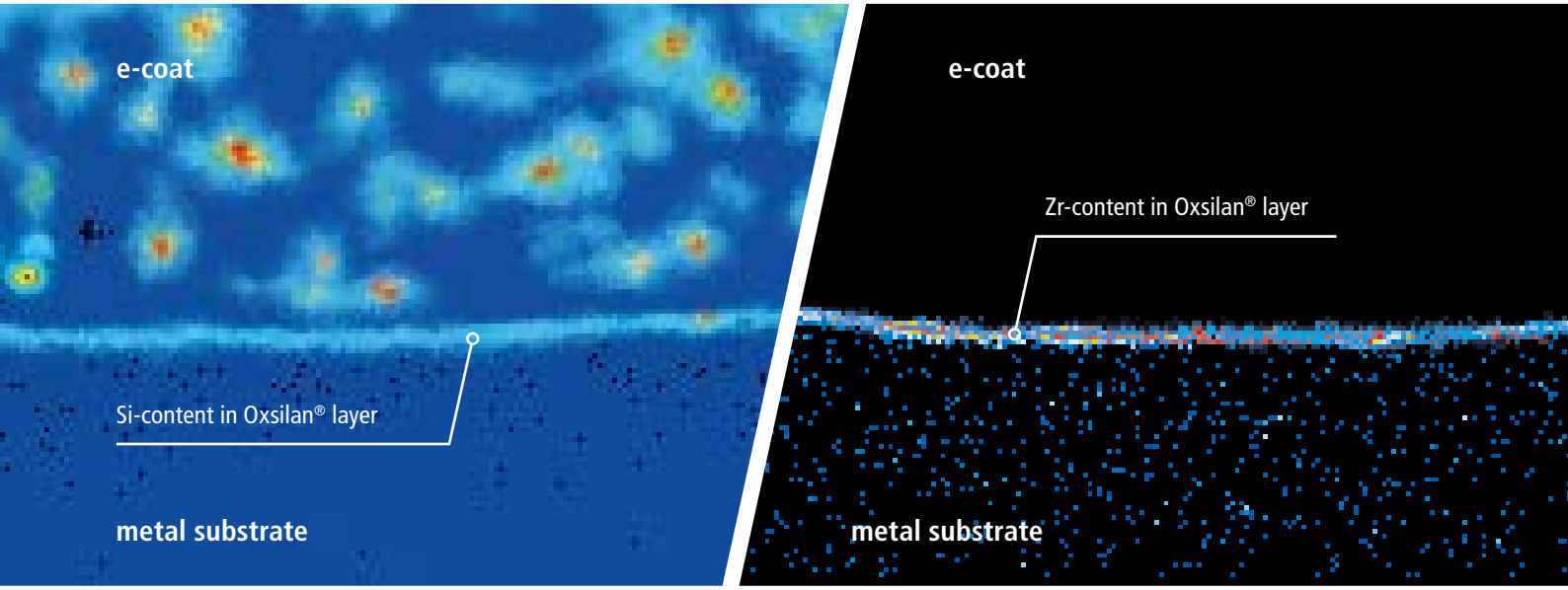


Crystalline layer

Oxsilan® thin-film technology



Amorphous layer



Element distribution by electron probe micro-analyzer conducted by Chemetall analytical laboratory.

Higher productivity with Oxsilan®

The use of thin-film technologies results in lower material consumption, shorter treatment times and, as a consequence, higher productivity. Field experiences demonstrate that material throughputs of the Oxsilan® plants outperform those of phosphating plants by 30 - 65%.

Despite the simple and stable chemistry of the Oxsilan® process, some key aspects require specialist know-how to meet the requirements for corrosion protection, paint adhesion and process robustness.

Milder conditions in Oxsilan® stage require attention to the cleaning step

Due to the aggressive process conditions in the zinc-phosphating process (high temperature of 55 °C and acidic pH 3), contamination or oil residues remaining on the surface are simply removed from the component. The milder conditions of the Oxsilan® bath (room temperature, pH 4-5) means there is limited capacity to overcome cleaning inefficiencies. Consequently, it is necessary to ensure there is an effective cleaning stage incorporated in this process. Chemetall has developed specific cleaning agents with selected additives to achieve excellent cleaning results.

Walk-in salt spray chamber at the Chemetall laboratory.

Oxsilan® tests confirm high metal protection

The performance of the thin-film technology has not only been tested extensively in-house, but also at numerous customers. Neutral salt spray (DIN EN ISO 9227 NSS) test results exceeding 480 hours and 1,008 hours demonstrate that Oxsilan® achieves the same corrosion protection level as traditional technologies. On test panels it even shows less creepage than phosphated ones.

A dedicated salt spray test for aluminium substrates, the so-called CASS test (DIN EN ISO 9227 CASS), also confirms the excellent corrosion resistance of Oxsilan® pretreated components. In a field test and with a full paint system, it is possible to achieve a creepage < 0.5 mm after 1,008 hours – corrosion damage well below the values required by the automotive industry, required by the automotive industry.

Oxsilan® demonstrates high performance on car bodies

Dynamic corrosion tests are always a challenge for automotive vehicles and components. With the latest developments in Oxsilan® technology, the tests performed on car bodies have shown continually improved results. Meanwhile, when checked and inspected, Oxsilan® pretreated cars which have already been on the road for several years show a better level of corrosion protection compared to those with zinc-phosphate.

New application opportunities on steel

Chromate and some chrome-free processes are not suitable for use on steel or give poor corrosion protection. In contrast, Oxsilan® technology – in combination with common paint systems – gives a corrosion protection of >1000 h neutral salt spray (DIN EN ISO 9227 NSS) testing on steel as well as on galvanized steel.

While some other competitive thin-film technologies contain phosphates to enhance flash rust resistance, the Oxsilan® process achieves this goal but is completely phosphate free.

Oxsilan® has been adopted by many industries
Sustainable thin-film technologies for progressive companies

Coil Aluminium Passivation
Oxsilan® shows very good bonding qualities, for example with epoxy adhesives, and facilitates an excellent weldability of aluminium sheets due to the low, homogeneous electrical resistance of the surface after treatment. This gives manufacturers the flexibility to create distinctive designs which define their brand. Metal-free Oxsilan® complies with the required adhesive specifications and holds appropriate approvals. This advanced no-rinse process can be applied by spray and squeeze roll or by rollcoater and is compatible with subsequent car body pretreatments based on a zinc-phosphate or silane-based processes.

Architectural & Building
With the expected sunset date for chromium(VI) substances in the EU by September 2017, manufacturers are intensively searching for alternatives. Chemetall's chrome-free Oxsilan® technology is already approved by GSB and Qualicoat and has over 100 licensed chrome-free third party certifications worldwide. Use of this thin-film technology ensures excellent corrosion protection and durability for aluminium profiles and flat-rolled sheets and gives excellent weather resistance for painted aluminium substrates.

Agricultural, Construction & Earthmoving (ACE)
In the ACE market, corrosion protection layers have to demonstrate what they are capable of. When harvesters plough through densely grown wheat fields or tractors till the fields rain or shine, stone chipping, wet conditions and sludge are acting aggressively on the vehicle bodies and implements. Nonetheless, the paints applied must exhibit highest brilliance and color fidelity. Diverse base materials made from cold-rolled, electro-galvanized or hot-dip galvanized steel and a multitude of standards conclude the list of high demands made by this industry. Under such conditions the flexibility and economic efficiency of Oxsilan® plays an ever greater role. This is why this thin-film technology is increasingly utlized by renowned manufacturers for the ACE market. Oxsilan® has proven its excellent level of performance in combination with different types of e-coats, powder and liquid paints.

Automotive Components

Leading Automotive OEMs have approved Oxsilan® for all kinds of components used in vehicle assembly such as drive shafts, shock absorbers, chassis parts, hydraulic cylinders, car seats, oil filter housings and many others. The technology is also used successfully in aluminium wheel lines for fully painted wheels. The performance of the coating is equal to existing non-chrome processes but has some major advantages over them. Heating is not required and the Oxsilan® tank can be automatically controlled and fed by the Gardo®matic system. OEM approvals for diamond turned aluminium wheels are expected to come soon.

Job Coaters

A job coater's daily work is shaped by an increasing variety of materials, which poses an ever-growing challenge for phosphating processes. The new Oxsilan® multi-metal process is capable of pretreating all common metals such as steel, stainless steel, aluminium or magnesium alloys and cast steel.

Automotive

Lightweight in design yet capable of handling extreme loads, the different materials used in automotive construction require a high-quality multi-metal pretreatment solution. With the Oxsilan® process, all common metals can be treated – with no limits on the substrate mix. The latest success is its use in combination with a primerless paint system. Today there are almost seven million cars on the road protected by Chemetall's silane-based thin-film technology. And the number of Oxsilan® pretreated car bodies is increasing steadily.

Appliance and HVAC

In both markets, increased production rates and cost optimization are key drivers. Oxsilan® can help to increase production efficiency by 20 - 30% due to reduced pretreatment process times. Thus, an overall cost reduction of over 20% can be achieved.

Chemetall at a glance

Chemetall is a leading global surface treatment supplier, headquartered in Frankfurt, Germany. With our 2,500 employees, 40 subsidiaries and 22 production sites, we are a financially strong and fast growing company with a long-term orientation. Our aim is to further strengthen our quality and innovation leadership. With our own sales offices, production facilities, service teams, laboratories and warehouses at locations all around the world, we are operating in close proximity to our customers.

The chemical treatment of metal surfaces is our core competence: Our products are developed for cleaning, giving corrosion protection, sealing, improving paint adhesion, and facilitating the forming and treatment of metals. Our globally established technologies are used in the most diverse industry sectors and have played a leading role in shaping metal treatment.

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