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Waterborne Silane Conversion Coating for Replacement of Phosphate/Chromate Pretreatments

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Abstract

Environmental and health issues surrounding the use of chromates have led to an intensive effort to find alternative materials for corrosion protection of metals. Silane-based pretreatments continue to be of considerable interest for the improvement of adhesion and corrosion resistance of reactive metal surfaces like aluminum, zinc and steel. A chromium-free metal pretreatment system based on an aqueous organofunctional silane and nanoparticle hybrid system has been developed. This conversion coating can provide excellent corrosion protection for both steel and aluminum. In this presentation a new proprietary technology is described and the details of corrosion tests are presented.

Introduction

For many decades, organic coatings, such as paints, have been used to protect metal against corrosion. When polymer coatings are applied to the metal substrate, corrosion of the base metal may cause a loss of adhesion between the polymer coating and the substrate. This coating de-lamination may lead to catastrophic corrosion of the metal. Metal pretreatments that improve the adhesion of a coating to a substrate are essential to ensure the long-term performance of painted metals such as steel, galvanized steel and aluminum alloys. It is well known in the industry that the use of zinc phosphate conversion coatings in conjunction with a chromate rinse improves paint adhesion and provides good corrosion protection. It is believed that the chromate rinse seals the pinholes between crystals of zinc phosphate, thereby improving the corrosion resistance and adhesion performance. However, hexavalent chromium is carcinogenic and highly toxic, it poses disposal issues, and its use is coming under increased regulatory pressure up to and including a ban in some products. It is highly desirable to eliminate the use of chromate pretreatment. Recently, various techniques for eliminating the use of chromate have been proposed. They include the use of silicates,⁽¹⁾ aluminates, titanates,⁽²⁾ mixtures of polymeric resins with silane coupling agents,⁽³⁾ and rare earth salts.⁽⁴⁾ Silane-based pretreatments have also been considered.⁽⁵⁾

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Introduction (continued)

However, many of the cited silanes are not water soluble, therefore requiring the use of hazardous organic co-solvents.⁽⁶⁾ In our investigation we also found that exceptionally water-soluble amino silanes (for example γ -aminopropyltrialkoxysilane), when applied on a metal surface, react with the organic paints and damage the paint integrity. As a result of such aminosilane reactivity, the paint loses its gloss and becomes more permeable to moisture, which leads to poor corrosion protection.

In this work, we describe the use of waterborne silane-based pretreatment for corrosion protection of multiple metals. This conversion coating is commercially available from Momentive Performance Materials under the CoatOSil* MP trade name. The corrosion resistance provided by CoatOSil MP pretreatment may be comparable to conventional zinc phosphate and chromate based treatments. Silane-based conversion coatings can provide a chemical bonding of the metal substrate to paint and improve the adhesion of paint.

Experimental

Materials

CoatOSil MP pretreatment. CoatOSil MP Y-15817 organofunctional alkoxy silane, available from Momentive Performance Materials. CoatOSil MP Y-15779 metal oxide sol, available from Momentive Performance Materials. CoatOSil MP pretreatment is prepared by mixing 3/1 by weight of CoatOSil MP Y-15817 organofunctional alkoxy silane/CoatOSil MP Y-15779 metal oxide sol with water to the desired silane concentration. During aqueous dilution alkoxy groups of the silane are converted to active SiOH groups for the subsequent condensation reactions.

In this work 0.5 to 12 wt.% silane solutions were prepared by adding CoatOSil MP Y-15779 metal oxide sol to the distilled water followed by the addition of the second component (CoatOSil MP Y-15817 organofunctional alkoxy silane). A small amount of organic surfactant (0.1 wt.% of TRITON™ X-100, manufactured by the Dow Chemical Company) was added to the CoatOSil MP formulation as a wetting. The pH of the CoatOSil MP pretreatment was 4.2. The solution was stirred for 10 minutes, and then aged in ambient conditions for at least 1 hour to complete the hydrolysis reaction. Alcohols such as ethanol, isopropanol, n-butanol, 1-methoxy-2-propanol, 2-methoxy-1,3-propanediol can be added to enhance the stability of the CoatOSil MP aqueous solution.

Substrate. Cold-Rolled Steel (CRS) panels were obtained from ACT Laboratories. Unpolished, cut only CRS (8"x4"x0.032" and 6"x4"x0.032") panels were degreased with a standard alkaline cleaner (65°C for 2 min.), rinsed with distilled water, and then dried with compressed nitrogen. The cleaned panel surfaces were completely "water-break-free" (i.e., thoroughly wettable by water). CRS panels (6"x4"x0.032") already pretreated with immersion zinc phosphate conversion coating (Henkel Bonderite® 958) and rinsed with Parcolene® 60 were obtained from ACT and used as a control.

Hot-Dip Galvanized (HDG) steel panels were obtained from ACT Laboratories. Unpolished, cut only HDG G70 (8"x4"x0.03" and 6"x4"x0.030") panels were degreased with a standard alkaline cleaner (65°C for 2 min.), rinsed with distilled water, and then dried with compressed nitrogen. The cleaned panel surfaces were completely "water-break-free" (i.e., thoroughly wettable by water). HDG G70 panels (12"x4"x0.030") already pretreated with spray zinc phosphate conversion coating (Henkel Bonderite 952) and rinsed with Parcolene 60 and HDG G70 panels (12"x4"x0.030") already pretreated with zinc phosphate conversion coating (by Henkel, Henkel Bonderite 1421) and rinsed with Parcolene 62 were obtained from ACT and used as controls.

Aluminum alloy panels were obtained from Q-Lab Corporation. Mill finish 3105 H24 aluminum alloy panels (12"x4"x0.025") were degreased with a standard alkaline cleaner (65°C for 2 min.), rinsed with distilled water, and then dried with compressed nitrogen. The cleaned panel surfaces were completely "water-break-free" (i.e., thoroughly wettable by water). Chromated aluminum panels (12"x4"x0.025", type AL made from alloy 3003 H14) were used as received from Q-Lab.

Paints. Primerless polyester-based paints, obtained from three suppliers: Polyester Paint I, Polyester Paint II, Polyester Paint III and Polyester Paint IV, were used to paint CRS and Al alloy substrates. All paints were applied by standard drawdown technique with the dry film thickness of approximately 1.2 mil. The baking conditions were 15 min. at 175°C for Polyester Paint I, 20 min. at 175°C for Polyester Paint II, 20 min at 138°C for Polyester Paint III and Peak Metal Temperature 205-215°C for Polyester Paint IV, as suggested by manufacturers.

CoatOSil MP Application

Drawdown Bar. An aqueous CoatOSil MP solution was applied directly onto the freshly cleaned metal surface by a very fine drawdown wire rod (size #3, Gardco). The metal panel was dried vertically allowing the excess of treatment solution to accumulate at the bottom edge. The excess pretreatment solution is eventually wiped off from the bottom edge. Alternatively, the panel was laid flat (this gives a more uniform film from top to bottom). Once dried at ambient temperature, the panels were cured at 70°C for 2 min.

Reverse Roll Coating. A laboratory-scale reverse-roll coater was manufactured by The Union Tool Corporation. Coating and doctor roll speeds were 20 ft/min., back up roll speed was 10 ft/min. The gap between coating and backup rolls was approximately 10 mils less than the thickness of the metal panel. For example, 32 mil CRS panels were coated with the gap between rolls set at 22 mils. Coated panels were dried at ambient temperature and cured at 70°C for 2 min.

CoatOSil* MP Application (continued)

Accelerated Corrosion Tests

Accelerated corrosion tests were carried out in Cyclic Q-Fog® chambers from Q-Lab. The procedure for the neutral salt spray test (NSST) was based on ASTM B117. In addition to NSST, aluminum panels were subjected to acidic salt spray test (ASST). ASST is based on ASTM G 85 (Annex A1) where 5% NaCl solution is atomized in a salt spray chamber at 35°C with the solution pH adjusted with acetic acid between 3.1 and 3.3.

The backside and the edges of a panel were taped with 3M® Polyurethane Protective Tape 8672 to protect the unpainted areas against undesired corrosion. A pair of defects were introduced into the painted panels by using a scribe tool to produce two 10 to 20 cm long scribe lines as an "X." The scribe completely penetrates the paint layer, exposing a continuous line of base metal. After certain exposure time, the panels were taken from the salt spray chamber, and all loose paint and corrosion products were removed by blowing compressed air along the entire scribe line (used 3 mm ID nozzle to provide 10 ft³/min air flow and 80 PSI back pressure). The panels were then evaluated by making measurements of the total width of the corrosion creep at different points equidistant from each other. The average and standard deviation of the creep were calculated for CRS panels. For aluminum, anti-corrosion performance was evaluated according to ASTM D 1654 test method.

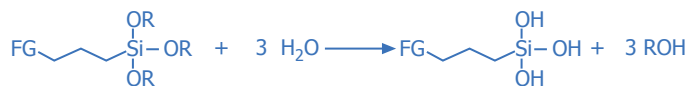
Scanning Electron Microscopy (SEM)

A Hitachi® S4500 Field Emission Scanning Electron Microscope was used to observe and measure the thickness of silane-based films on metal substrates. Samples were mounted in epoxy, mechanically polished, and coated with less than 100 Å platinum layer. Cross-section images were done at 5kV accelerating voltage. In situ EDX was also done to determine the elemental composition of the film.

Results and Discussion

Hydrolysis and Condensation of Organofunctional Silanes

Hydrolysis and condensation of organofunctional silanes are well documented.⁽⁷⁾ Upon exposure to water, an alkoxy silane is hydrolyzed with the formation of very active silanol species:



At pH range of 3.5 to 5.0, the hydrolysis is fastest and the condensation is slowest, *i.e.* by maintaining this pH range, aqueous CoatOSil MP solution typically stays in its most active form longer than in other pH ranges.

The silanol groups react with metal oxides and the hydroxides at metal surfaces via formation of hydrogen bonds.⁽⁸⁾ After drying or curing step, the silanol groups and the metal hydroxyl groups condense to form covalent siloxane bonds on the metal surface, releasing water as a byproduct:⁽⁹⁾



The silanol groups can also condense with other silanol groups to form a Si-O-Si bond, releasing water as a byproduct (also see Figure 1):

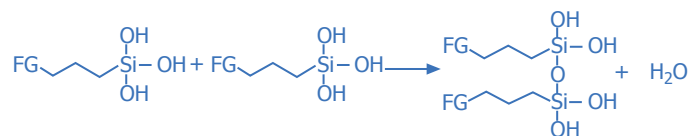
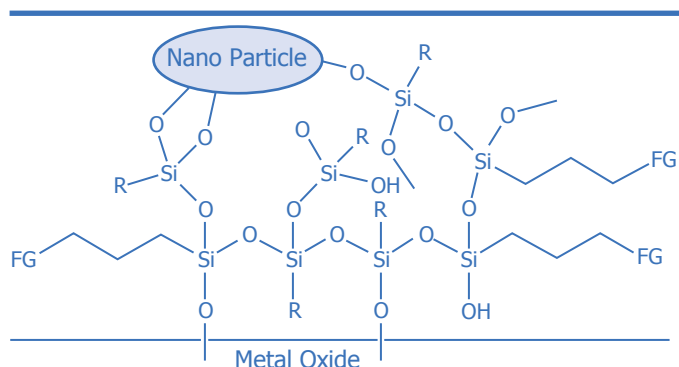


Figure 1. Simplified Schematic Diagram of CoatOSil MP Pretreatment Bonding Mechanism Between Silane Molecules, Nanoparticles and Metal Surface Hydroxide Layer after Condensation has Occurred.



In contrast to a conventional zinc phosphate or chromate treatment, a cross-linked hydrophobic CoatOSil MP pretreatment film only forms during a drying/curing process rather than an immersion process. Therefore, CoatOSil MP pretreatment coating weight depends on the silane concentration in the pretreatment and the wet pretreatment coating thickness. Though it is quite difficult to control wet thickness for the dip coating, the reverse-roll coater allows the variation of wet thickness in the range of approximately 0.1 - 0.2 mil. In this work, we set the reverse-roll coater at a targeted wet thickness of approximately 0.2 mil.

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Results and Discussion (continued)

Corrosion Protection and Paint Adhesion

Cold-Rolled Steel. Table 1a summarizes CRS substrate neutral salt spray test (NSST) results after 250 hrs. exposure. It can be seen that the CoatOSil* MP treated panels perform much better than the alkaline cleaned metal and even exceeded the corrosion resistance of conventional chromium rinsed zinc phosphate system. For the evaluation of CRS metal performance, we intentionally selected general industrial (GI) primerless paints because they contain no corrosion inhibitors and therefore are very sensitive to the quality of the conversion coating. For example, blank CRS panels coated with Polyester Paint II paint and exposed to NSST for 250 h. lose as much as 13 mm of paint. In contrast to this “no pretreatment” case, when a conventional zinc phosphate pretreatment is used, the paint adhesion loss is reduced to an average of 2.5 mm. In the case of CoatOSil MP pretreatment, with the optimized coating weight, 1.5 mm paint loss was observed (see Figure 2).

Table 1b summarizes the neutral salt spray test (NSST) results after 300 hrs. exposure for CRS substrate with a GI paint and a coil paint. It is evident that CoatOSil MP pretreatment greatly enhanced the adhesion of these two primerless polyester paints and improved the corrosion resistance.

Table 1a. CRS Substrate NSST (250 h) Results

Specimen	Paint	Average Creep, mm†
CoatOSil MP pretreatment, 4% silane, draw down	Polyester Paint I	1.5 (0.42)
CoatOSil MP pretreatment, 4% silane, roll coating	Polyester Paint I	1.5 (0.33)
CoatOSil MP pretreatment, 8% silane, roll coating	Polyester Paint I	1.2 (0.23)
CoatOSil MP pretreatment, 12% silane, roll coating	Polyester Paint I	1.3 (0.39)
CoatOSil MP Y-15817 organofunctional alkoxy silane, 4%, drawdown	Polyester Paint I	3
CoatOSil MP Y-15779 metal oxide sol, 1.33%, drawdown	Polyester Paint I	3
Chrome-rinsed zinc phosphate CRS	Polyester Paint I	2 (0.55)
CRS Clean Only	Polyester Paint I	6
CoatOSil MP pretreatment, 4% silane, drawdown	Polyester Paint II	1.5
CoatOSil MP pretreatment, 4% silane, roll coating	Polyester Paint II	2
CoatOSil MP pretreatment, 8% silane, roll coating	Polyester Paint II	1.4
Chrome-rinsed zinc phosphate CRS	Polyester Paint II	2.5
CoatOSil MP Y-15817 organofunctional alkoxy silane, 4%, drawdown	Polyester Paint II	9
CoatOSil MP Y-15779 metal oxide sol, 1.33%, drawdown	Polyester Paint II	12
CRS Clean Only	Polyester Paint II	13

† Standard deviation is shown in parentheses

Note: Test data. Actual results may vary.

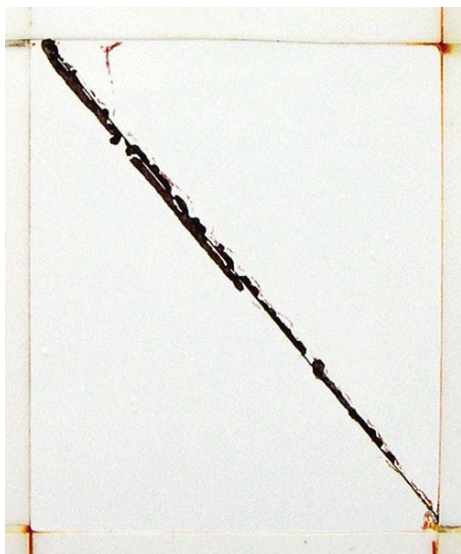
Table 1b. CRS Substrate NSST (300 h) Results, Polyester Paint III and IV

Specimen	Paint	Average Creep, mm
CoatOSil MP pretreatment, 2% silane, drawdown	GI, Polyester Paint III	3.8
Chrome-rinsed zinc phosphate CRS	GI, Polyester Paint III	9.8
Clean Only, CRS	GI, Polyester Paint III	26, no paint left
CoatOSil MP pretreatment, 2% silane, drawdown	Coil Polyester Paint IV	1.6
Chrome-rinsed zinc phosphate CRS	Coil Polyester Paint IV	5.2
Clean Only, CRS	Coil Polyester Paint IV	26, no paint left

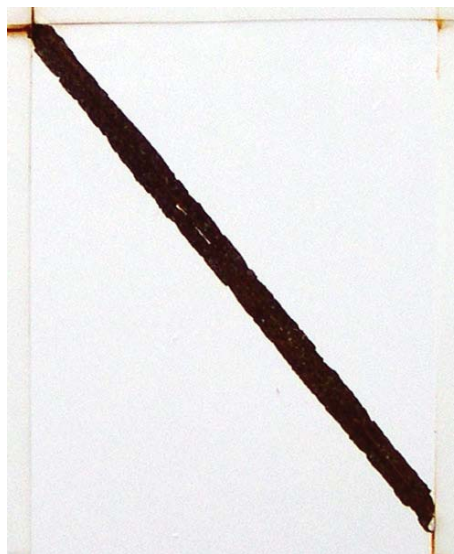
Note: Test data. Actual results may vary.

Results and Discussion (continued)

Figure 2. Digital Images of CRS Corrosion Panels after 250 Hours of Exposure (Polyester Paint II).



CoatOSil MP pretreatment, 4% silane, dip coating



Chrome rinsed zinc phosphate

Note: Test data. Actual results may vary.

It is important to highlight that the anti-corrosive properties of CoatOSil* MP pretreatment are due to a synergy between the silane (CoatOSil MP Y-15817 organofunctional alkoxy silane) and the nanoparticles (CoatOSil MP Y-15779 metal oxide sol). As can be seen in Table 1a, the performance of individual components of CoatOSil MP pretreatment was quite poor. In fact, 9 mm and 12 mm of paint loss was measured for CoatOSil MP Y-15817 organofunctional alkoxy silane and CoatOSil MP Y-15779 metal oxide sol, respectively, when the panels were painted with Polyester Paint II. It is also believed that chemical incorporation of nanoparticles into the silane-based matrix improves the mechanical properties of the resulting conversion coating. Conversion coatings with advanced mechanical properties are highly desirable for coil metal applications.

To understand the effect of CoatOSil MP pretreatment coating thickness on the anti-corrosion properties, the pretreatment thickness was determined by the cross-section SEM technique (see Figure 3). When 4% CoatOSil MP solution is applied via drawdown, the thickness of the fully cured silane-based layer is estimated at 0.35 μm (or 42mg/ft²). Panels treated with 8% CoatOSil MP solution via reverse-roll coater displayed corrosive creepage of 1.2 mm for Polyester Paint I and 1.4 mm for Polyester Paint II (see Figure 4).

Cure Temperature Study

To determine the effect of CoatOSil MP pretreatment cure conditions on anti-corrosion properties, the pretreatment was cured under several thermal profiles. Clean Cold-Rolled Steel was coated with 2% CoatOSil MP solution via #3 drawdown bar and followed by Polyester Paint II after curing the silane layer. As shown in Table 2, the anti-corrosion properties were not affected by the cure conditions studied.

Table 2. Effect of Pretreatment Cure Temperature on Performance: CRS Substrate, 2% Silane, drawdown bar #3, NSST (300 h)

Oven Temperature/Time	Paint	Average Creep, mm
Clean only CRS	Polyester Paint II	20
Ambient Temp/2 hours	Polyester Paint II	1.4
Ambient Temp/3 hours	Polyester Paint II	1.5
60 °C/2 minutes	Polyester Paint II	1.1
80 °C/2 minutes	Polyester Paint II	1.5
80 °C/5 minutes	Polyester Paint II	1.2
100 °C/2 minutes	Polyester Paint II	1.8 ⁽¹⁾
100 °C/5 minutes	Polyester Paint II	1.2
120 °C/1 minute	Polyester Paint II	1.1
150 °C/30 seconds	Polyester Paint II	1.0
150 °C/2 minutes	Polyester Paint II	1.5
150 °C/5 minutes	Polyester Paint II	1.4
200 °C/2 minutes	Polyester Paint II	1.3
200 °C/5 minutes	Polyester Paint II	1.4
Chrome-rinsed zinc phosphate CRS	Polyester Paint II	5.7

(1) another experiment gives 1.5 mm

Note: Test data. Actual results may vary.

Results and Discussion (continued)

Silane Concentration and Age of the Solution

The effects of CoatOSil* MP pretreatment concentration and the age of the solution on the anti-corrosion properties were studied with clean Cold-Rolled Steel and Polyester Paint II. As shown in Table 3, 0.5% CoatOSil MP pretreatment performed better than chrome-rinsed zinc phosphate CRS. Silane concentrations from 0.5% to 4% performed similarly. Panels treated with stabilized, one-year-old CoatOSil MP solutions displayed similar anti-corrosive properties to those treated with fresh samples (aged less than two hours).

Table 3. Effect of Pretreatment Concentration and Age on Anti-Corrosion Performance: CRS Substrate, drawdown bar #3, Polyester Paint II, NSST (300 h)

CoatOSil MP Concentration	Age of Aqueous Solution	Average Creep, mm
0.5% silane	< 2 hours	1.5
1.0% silane	< 2 hours	1.5
1.0% silane	2 days	1.5
2.0% silane	< 2 hours	1.4
2.0% silane	2 days	1.3
2.0% silane	1 year ⁽¹⁾	1.1
3.0% silane	< 2 hours	1.4
3.0% silane	2 days	1.0
4.0% silane	< 2 hours	1.5
4.0% silane	2 days	1.0
4.0% silane	1 year ⁽¹⁾	1.4
Clean Only	NA	15
Chrome-rinsed, zinc phosphate	NA	3.1
Non-Chrome rinsed, zinc phosphate	NA	4.2

(1) 1-butanol was used as stabilizer

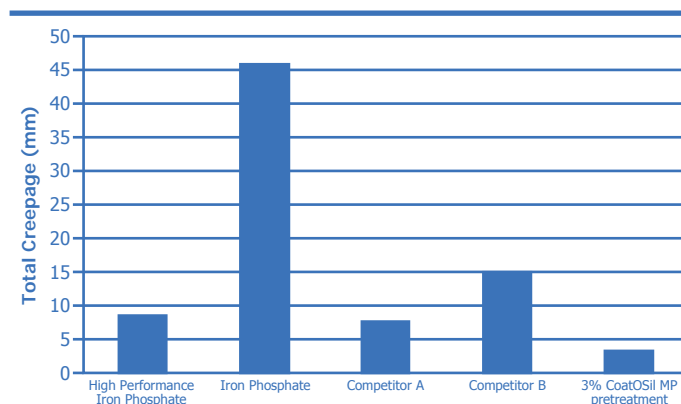
Note: Test data. Actual results may vary.

CoatOSil MP Versus Iron Phosphate Pretreatment

In another study, the performance of CoatOSil MP pretreatment was compared to a pair of iron phosphate-based pretreatments and two competitive, non-traditional conversion coatings. Aqueous solutions of CoatOSil MP pretreatment containing 3%, 1%, 0.5% CoatOSil MP Y-15817 organofunctional alkoxy silane and 1.0%, 0.3%, 0.1% CoatOSil MP Y-15779 metal oxide sol respectively were prepared. Clean panels were dipped into an agitated bath for 90 seconds followed by hanging in a 100°C oven for 2 minutes to dry off the water and cure the pretreatment. GI paint (Polyester Paint III) was applied via drawdown technique and cured at 138°C for 20 minutes as recommended by the manufacturer.

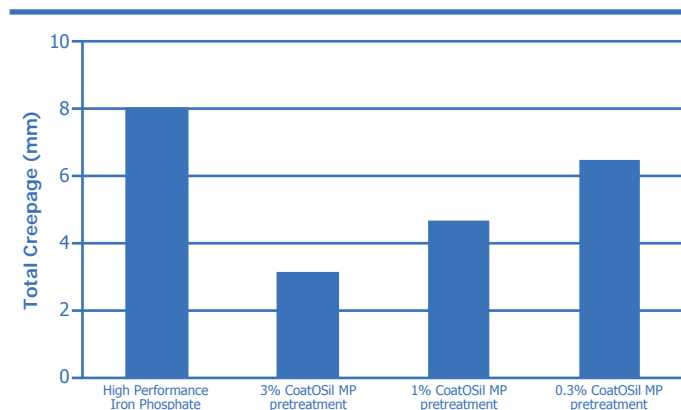
As shown in Figure 3, CoatOSil MP pretreatment outperformed iron phosphate (two types including a high-performance treatment) and both non-traditional conversion coatings (competitors A and B). Figure 4 indicates that panels pretreated with as little as 0.3% CoatOSil MP pretreatment displayed similar or better corrosion protection as panels with a high-performance iron-phosphate treatment.

Figure 3. Non-Traditional Conversion Coatings for Ferrous Metals. Comparison of CoatOSil MP Pretreatment with Iron Phosphates and Competitive Technologies. Polyester Paint III - Salt Spray Results (120 hours)



Note: Test data. Actual results may vary.

Figure 4. Performance of CoatOSil MP Pretreatment at Various Concentrations and High Performance Iron Phosphate



Note: Test data. Actual results may vary.

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Results and Discussion (continued)

Immersion Time

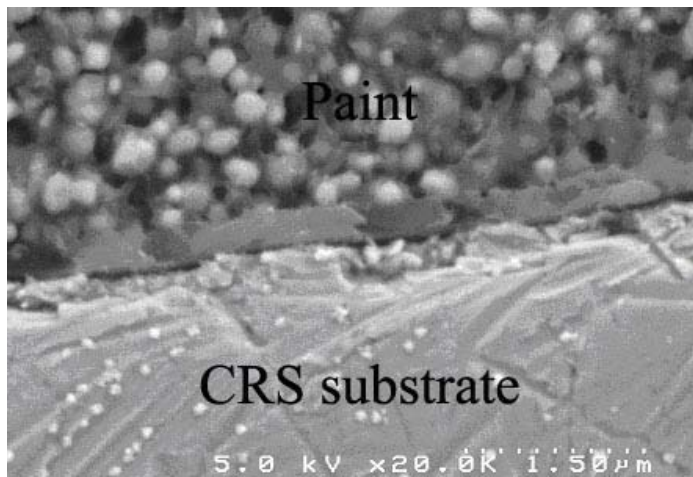
The effect of immersion time on the anti-corrosive properties was examined with 4% CoatOSil* MP solution and Polyester Paint II. The pretreatment was dried in an oven at 100°C for 5 minutes. As shown in Table 4, panels treated with 4% CoatOSil MP pretreatment with immersion times of 5-120 seconds performed similarly.

Table 4. Effect of Immersion Time on Anti-Corrosion Performance: CRS Substrate, 4% Silane, Polyester Paint II, NSST (300 h)

Immersion Time	Paint	Average Creep, mm
Clean only CRS	Polyester Paint II	16
5 seconds	Polyester Paint II	1.3
60 seconds	Polyester Paint II	1.2
120 seconds	Polyester Paint II	1.5
#3 drawdown bar	Polyester Paint II	1.4

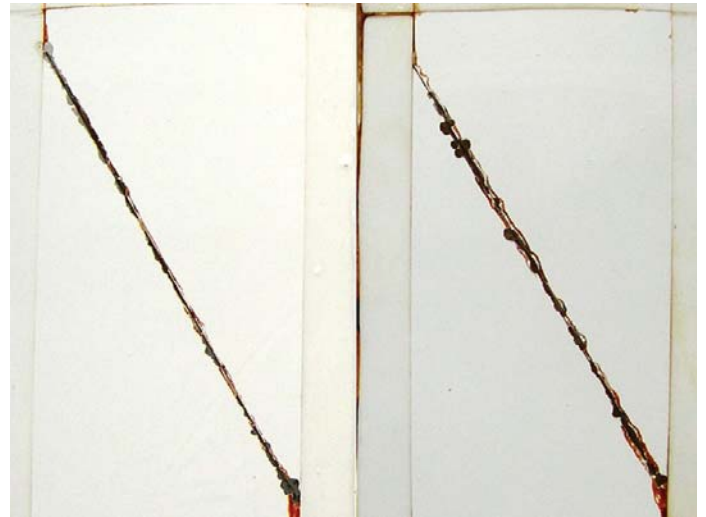
Note: Test data. Actual results may vary.

Figure 5. SEM Cross-Section Image of 4% CoatOSil MP Pretreatment Treated CRS Panel with ~0.35 µm Silane Layer



Note: Test data. Actual results may vary.

Figure 6. Digital Images of CRS Panels with the Optimized CoatOSil MP Pretreatment Coating Weight after 250 h of NSST (Polyester Paint I - Left Image, Polyester Paint II - Right Image)



Note: Test data. Actual results may vary.

Waterborne Silane Conversion Coating for Replacement of Phosphate/Chromate Pretreatments

Results and Discussion (continued)

Aluminum Alloy. Table 6 summarizes both neutral and acidic salt spray results after 1000 hrs. of exposure. The aluminum substrates were treated with a 4% CoatOSil* MP solution via reverse-roll coater. After 1000 hrs. of neutral salt spray testing, there was essentially no corrosion along the entire scribe. More aggressive acidic salt spray testing was needed to differentiate the

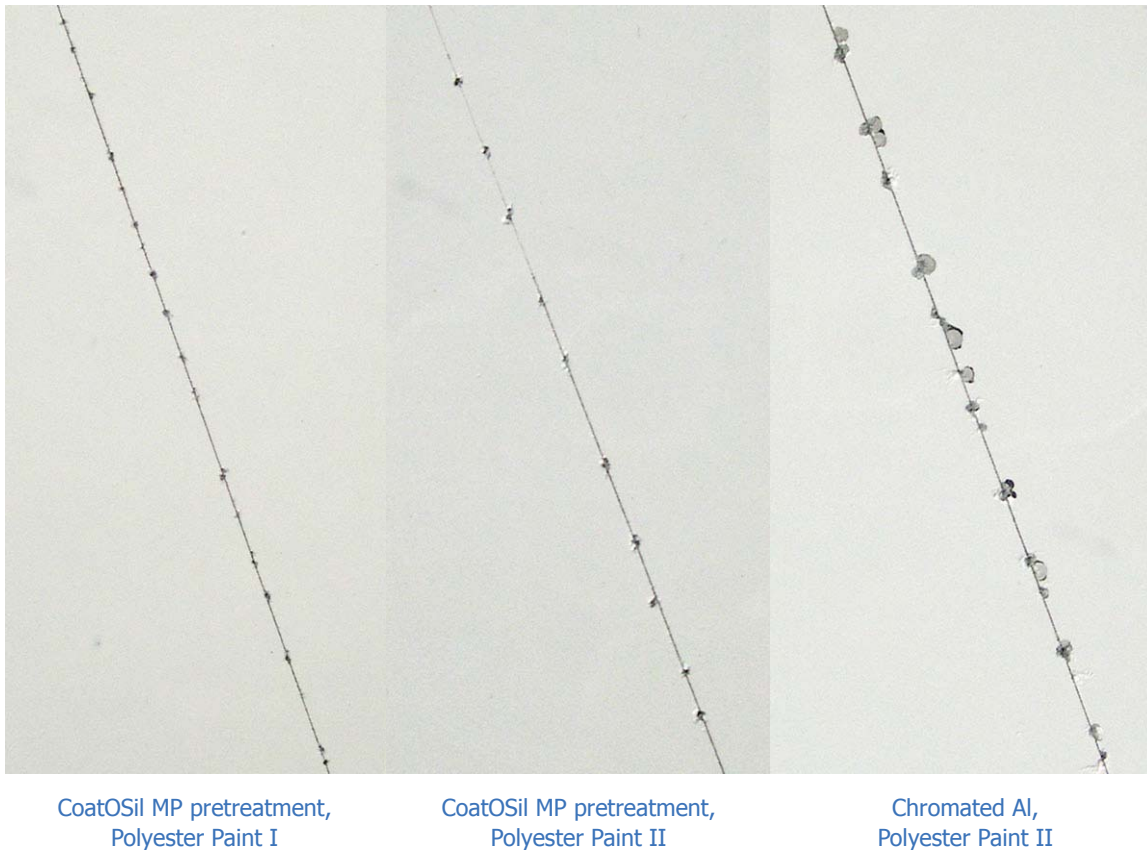
performance of CoatOSil MP pretreatment and the conventional chrome-based pretreatment. As depicted in Figure 7, CoatOSil MP treated aluminum panels showed anti-corrosion performance superior to the chrome-based pretreatment. It was estimated that only 5 mg/ft² of silane-based pretreatment is required to achieve excellent anti-corrosion properties.

Table 5. Aluminum Substrate NSST and ASST Test Results

Specimen	Paint	NSST, 1000 h		ASST, 1000 h	
		Maximum Creep, mm	ASTM D 1654 Score	Maximum Creep, mm	ASTM D 1654 Score
CoatOSil MP pretreatment Al 3105 H24	Polyester Paint I	0.25	9	0.5	9
CoatOSil MP pretreatment Al 3105 H24	Polyester Paint II	0.25	9	1	8
Chromated Al 3003 H14	Polyester Paint I	0.25	9	1	8
Chromated Al 3003 H14	Polyester Paint II	0.25	9	2	7
Blank Al 3105 H24	Polyester Paint I	4	5	16	1
Blank Al 3105 H24	Polyester Paint II	16	1	no paint left	0

Note: Test data. Actual results may vary.

Figure 7. Digital Images of Al Panels after 1000 h of ASST.



Note: Test data. Actual results may vary.

Waterborne Silane Conversion Coating for Replacement of Phosphate/Chromate Pretreatments

Results and Discussion (continued)

Bath Stability. The bath stability of aqueous solutions of CoatOSil* MP pretreatment was studied using 20% CoatOSil MP Y-15817 organofunctional alkoxy silane, 6.67% CoatOSil MP Y-15779 metal oxide sol and stabilizers varying in quantity and identity.

As shown in Table 6, the stability of the CoatOSil MP solution may be extended to greater than 12 months through the judicious choice of stabilizer.

Table 6. Bath Stability of 20% CoatOSil MP Solution

Stabilizer	Amount, %	Time Stable at 40°C
None	0	12 days
1-Methoxy-2-propanol	5	1 month
2-Methyl-1,3-propanediol	5	1.5 months
Glycerol	5	1.5 months
Propylene glycol	5	1.5 months
2-Propanol	5	4 months
1-Butanol	5	4 months
2-Propanol	20	5 months
Glycerol	20	7 months
2-Methyl-1,3- propanediol	20	> 12 months
Trimethylolpropane	20	> 12 months

Note: Test data. Actual results may vary.

Conclusion

The results presented above demonstrate that CoatOSil MP pretreatment multi-metal conversion coating can achieve performance equal to or better than currently used chromate and zinc phosphate based systems. A "dry-in-place" coating method may offer a simplified pretreatment process and reduced water use. Silane-based coatings can provide chemical bonding to a wide variety of polymers and paints. The coating weight of CoatOSil MP pretreatment may be easily controlled by adjusting the concentration of the silane. Depending on application needs, aqueous bath stability of CoatOSil MP pretreatment may be extended from one week to greater than one year.

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Patent Status

Technical subject matter in this publication is described and protected by one or more pending US patent applications and foreign counterparts.

Product Safety, Handling and Storage

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