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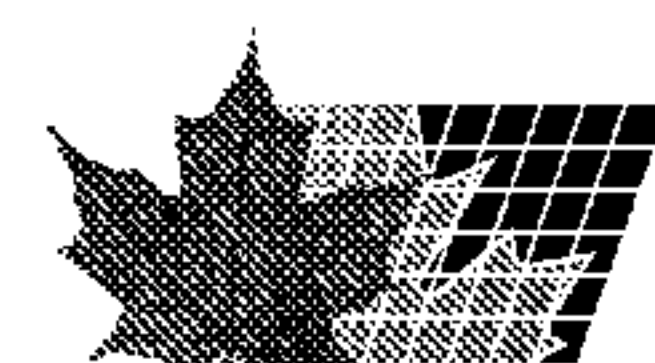
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(54) Title: COMPOSITION AND METHOD FOR TREATMENT OF PHOSPHATED METAL SURFACES

(57) **Abrégé/Abstract:**

A rinse solution for the treatment of conversion-coated metal substrates for improving the adhesion and corrosion resistance of siccative coatings, comprising an aqueous solution of a Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof, and a phenol polymer, with the pH of the total solution about 3.5 to 5.1. A method for treating such materials by applying the rinse solution to the substrate.



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(21) International Application Number: PCT/GB97/00493 (22) International Filing Date: 21 February 1997 (21.02.97) (30) Priority Data: 08/605,959 23 February 1996 (23.02.96) US (71) Applicant (for all designated States except US): BRENT INTERNATIONAL PLC [GB/GB]; Ridgeway, Iver, Bucks SL0 9JJ (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): AFFINITO, John, C. [US/US]; 1720 North Ryan Street, McHenry, IL 60050 (US). (74) Agent: GILL JENNINGS & EVERY; Broadgate House, 7 Eldon Street, London EC2M 7LH (GB).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report.
(54) Title: COMPOSITION AND METHOD FOR TREATMENT OF PHOSPHATED METAL SURFACES (57) Abstract A rinse solution for the treatment of conversion-coated metal substrates for improving the adhesion and corrosion resistance of siccative coatings, comprising an aqueous solution of a Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof, and a phenol polymer, with the pH of the total solution about 3.5 to 5.1. A method for treating such materials by applying the rinse solution to the substrate.		

COMPOSITION AND METHOD FOR TREATMENT OF PHOSPHATED METAL SURFACES

BACKGROUND OF THE INVENTION

5 This invention relates to the treatment of metal surfaces prior to a finishing operation, such as the application of a siccative organic coating (also known as an "organic coating", "organic finish", or simply, "paint"). Specifically, this invention relates to the treatment of conversion-coated metal with an aqueous solution comprising a phenolic resin and a Group IVA metal ion, namely zirconium, titanium, hafnium, and mixtures thereof. Treatment of conversion-coated metal with such a solution improves paint adhesion and corrosion resistance.

10 The primary purposes of applying siccative coatings to metal substrates (e.g., steel, aluminium, zinc and their alloys) are protection of the metal surface from corrosion and for aesthetic reasons. It is well-known, however, that many organic coatings adhere poorly to metals in their normal state. As a result, corrosion-resistance characteristics of the siccative coating are substantially diminished. It is therefore a typical procedure in the metal finishing industry to subject metals to a pretreatment process whereby a conversion coating is formed on the metal surface. This conversion coating acts as a protective layer, slowing the onset of the degradation of the base metal, owing to the conversion coating being less soluble in a corrosive environment than is the base metal. The conversion coating is also effective by serving as a recipient for a subsequent siccative coating. The conversion coating has a greater surface area than does the base metal and thus provides for a greater number of adhesion sites for the interaction between the conversion coating and the organic finish. Typical examples of such conversion coatings include, but are not limited to, iron phosphate coatings, zinc phosphate coatings, and chromate conversion coatings. These conversion coatings and others

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are well-known in the art and will not be described in any further detail.

Normally, the application of an organic finish to a conversion-coated metal surface is not sufficient to provide the highest levels of paint adhesion and corrosion resistance. Painted metal surfaces are able to reach maximum performance levels when the conversion-coated metal surface is treated with a "final rinse", also referred to in the art as a "post-rinse" or a "seal rinse", prior to the painting operation. Final rinses are typically aqueous solutions containing organic or inorganic entities designed to improve paint adhesion and corrosion resistance. The purpose of any final rinse, regardless of its composition, is to form a system with the conversion coating in order to maximize paint adhesion and corrosion resistance. This may be accomplished by altering the electrochemical state of the conversion-coated substrate by rendering it more passive or it may be accomplished by forming a barrier film which prevents a corrosive medium from reaching the metal surface. The most effective final rinses in general use today are aqueous solutions containing chromic acid, partially reduced to render a solution comprising a combination of hexavalent and trivalent chromium. Final rinses of this type have long been known to provide the highest levels of paint adhesion and corrosion resistance. Chromium-containing final rinses, however, have a serious drawback due to their inherent toxicity and their hazardous nature. These concerns make chromium-containing final rinses less desirable from a practical standpoint, when one considers such issues as safe handling of chemicals and the environmental problems associated with the discharge of such solutions into municipal water streams. Thus, it has been a goal of the industry to find chromium-free alternatives which are less toxic and more environmentally benign than chromium containing final rinses. It has also been desirous to develop chromium-free final rinses which are as effective as chromium-containing final rinses in

terms of paint adhesion and corrosion resistance properties.

Much work has already been done in the area of chromium-free final rinses. Some of these have utilized either Group IVA chemistry or phenolic polymers. US-A- 3,695,942 describes a method of treating conversion-coated metal with an aqueous solution containing soluble zirconium compounds. US-A-4,650,526 describes a method of treating phosphated metal surfaces with an aqueous mixture of an aluminum zirconium complex, an organofunctional ligand and a zirconium oxyhalide. The treated metal could be optionally rinsed with deionized water prior to painting. US-A-4,457,790 describes a treatment composition utilizing titanium, zirconium and hafnium in aqueous solutions containing polymers with chain length from 1 to 5 carbon atoms. US-A-4,656,097 describes a method for treating phosphated metal surfaces with organic titanium chelates. The treated metal surface can optionally be rinsed with water prior to the application of a siccative organic coating. US-A-4,497,666 details a process for treating phosphated metal surfaces with solutions containing trivalent titanium and having a pH of 2 to 7. US-A-4,457,790 and US-A-4,517,028 describe a final rinse composition comprising a polyalkylphenol (made by polymerising vinylphenol derivatives) and Group IVA metal ion. In US-A-3,912,548 phosphated or phosphate-chromated metal surfaces are treated with an aqueous solution containing a zirconium compound and a polymer which is preferably a polyacrylic acid. The pH of the solution is preferably 6-8. In US-A-5,246,507 metal surfaces are treated with aqueous solution of a metal compound and a polymer. The metal compound may be of titanium, zirconium or hafnium and the polymer may be a derivatised novolac resin.

In the above examples, it is claimed that the treatment method described improves paint adhesion and corrosion resistance.

In US-A-3,697,331 phosphate metal surfaces are treated with an aqueous solution of an alkali metal salt of a novolac phenol formaldehyde resin. In US-A-3,749,611 phosphated metal surface are treated with a non-aqueous solution of a novolac phenol-formaldehyde resin which may contain calcium hydroxide to assist stabilisation of the solution. In US-A-3,684,587 sulfur novolac resins in non-aqueous solution are used to treat phosphated surfaces. In US-A-3,961,992 alkaline-catalysed polymer of formaldehyde and phenol is used in aqueous solution to treat phosphated metal surfaces.

The levels of paint adhesion and corrosion resistance afforded by the treatment solutions in the above examples do not reach the levels desired by the metal finishing industry, namely the performance characteristics of chromium-containing final rinses. I have found that aqueous solutions containing a phenolic resin and Group IVA metal ions, namely, zirconium, titanium, hafnium, and mixtures thereof, provide paint adhesion and corrosion resistance characteristics comparable to those attained with chromium-containing final rinses. In many cases, the performance of conversion-coated metal surfaces treated with phenolic resin-Group IVA metal ion solutions in accelerated corrosion tests exceeds that of conversion-coated metal treated with chromium-containing solutions.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method and composition of an aqueous rinse which will impart an improved level of paint adhesion and corrosion resistance on painted, conversion-coated metal.

There is provided in the present invention a new rinse solution for the treatment of conversion-coated metal substrates for improving the adhesion and corrosion resistance of siccative coatings, which comprises an aqueous solution of a Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof, and a

resole phenolic resin, with the solution having a pH of about 3.5 to 5.1.

In one aspect of the invention, there is provided a rinse solution comprising an aqueous solution of a Group IVA metal ion, selected from the group consisting of zirconium, titanium, hafnium and mixtures thereof, and a phenolic resin characterized in that the resin is a resole phenolic and is present in a concentration in the range of about 0.01 to about 0.40% w/w, the Group IVA metal ion is present in a concentration in the range of about 0.00035 to about 0.0050% w/w, and the pH is in the range of about 3.5 to 5.1.

The invention also includes a method for treating such materials by applying the rinse solution to the substrate. The composition comprises an aqueous solution containing a phenolic resin and a Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof, and provides levels of paint adhesion and corrosion resistance comparable to or exceeding those provided by chromium-containing final rinses.

In the present invention, references to a phenolic resin is a resole phenolic.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The rinse solution of the invention is an aqueous solution containing a phenolic resin and Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof. It is intended that the rinse solution be applied to conversion-coated metal. The formation of conversion coatings on metal substrates is well-known within the metal finishing industry. In general, this process is usually described as a process requiring several pretreatment stages. The actual number of stages is typically dependent on the final use of the painted metal article. The number of pretreatment steps normally varies anywhere from two to nine stages. A representative example of a pretreatment process involves a five-stage operation where the metal

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which will ultimately be painted goes through a cleaning stage, a water rinse, a conversion coating stage, a water rinse and a final rinse stage. Modifications to the pretreatment process can be made according to specific needs. As an example, surfactants can be incorporated into some conversion coating baths so that cleaning and the formation of the conversion coating can be achieved simultaneously. In other cases it may be necessary to increase the number of pretreatment stages so as to accommodate more pretreatment steps. Examples of the types of conversion coatings that can be formed on metal substrates are iron phosphates and zinc phosphates. Iron phosphating is usually accomplished in no more than five

pretreatment stages, while zinc phosphating usually requires a minimum of six pretreatment stages. The number of rinse stages between the actual pretreatment steps can be adjusted to ensure that rinsing is complete and effective and so that the chemical pretreatment from one stage is not carried on the metal surface to subsequent stages, thereby possibly contaminating them. It is typical to increase the number of rinse stages when the metal parts to be treated have unusual geometries or areas that are difficult for the rinse water to contact. The method of application of the pretreatment operation can be either an immersion or a spray operation. In immersion operations, the metal articles are submersed in the various pretreatment baths for defined intervals before moving on to the next pretreatment stage. A spray operation is one where the pretreatment solutions and rinses are circulated by means of a pump through risers fashioned with spray nozzles. The metal articles to be treated normally proceed through the pretreatment operation by means of a continuous conveyor. Virtually all pretreatment processes can be modified to run in spray mode or immersion mode, and the choice is usually made based on the final requirements of the painted metal article. It is to be understood that the invention described here can be applied to any conversion-coated metal surface and can be applied either as a spray process or an immersion process.

The rinse solution of the invention comprises an aqueous solution of a phenolic resin and Group IVA metal ion. Specifically, the rinse solution is an aqueous solution containing zirconium, titanium, or hafnium ions, and mixtures thereof, whose source can be hexafluorozirconic acid, hexafluorotitanic acid, hafnium oxide, titanium oxysulfate, titanium tetrafluoride, zirconium sulfate and mixtures thereof; and a resole phenolic resin which is a polymer of a phenolic compound and an aldehyde, usually with formaldehyde. The phenolic resin is a water soluble base catalyzed condensation

product preferably of the reaction between phenol and a stoichiometric excess of formaldehyde. A present source for such resin is Schenectady International, Inc. SP-6877. The resin typically comprises a mixture of substituted phenol compounds, namely: 2-hydroxybenzyl alcohol, 4-hydroxybenzyl alcohol, 2,6-dimethylol phenol, 2,4-dimethylol phenol and 2,4,6-trimethylol phenol. The molecular weight of suitable resins is usually in the range 100-1000, for instance the weight average molecular weight may be in the range 125 to 500, preferably about 160-175, and the number average molecular weight may be in the range 100 to 300, preferably about 120-130.

The rinse solution is prepared by making an aqueous solution using deionized water. The solution contains: a Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof, such that the metal ion concentration is about 0.00035% w/w to about 0.005% w/w and that of the phenol polymer is about 0.01% w/w to about 0.4% w/w. The aqueous solution also contains a water-soluble solvent such as tripropylene glycol monomethyl ether to make the solution homogeneous. The pH of the resulting solution is adjusted to about 3.5 to 5.1 using sodium hydroxide.

A preferred version of the invention is an aqueous solution containing 0.00035 to 0.0016% w/w titanium ion and 0.01 to 0.40% w/w of phenol polymer. The resulting solution can be effectively operated at pH 3.5 to 5.1.

Another preferred version of the invention is an aqueous solution containing 0.00065 to 0.0050% w/w zirconium ion and 0.01 to 0.40% w/w of phenol polymer. The resulting solution can be effectively operated at pH 3.5 to 5.1.

Another preferred version of the invention is an aqueous solution containing 0.00035 to 0.0050% w/w hafnium ion and 0.01 to 0.40% w/w of phenol polymer. The resulting solution can be effectively operated at pH 3.5 to 5.1.

An especially preferred version of the invention is an aqueous solution containing 0.00035 to 0.0010% w/w titanium

ion and 0.01 to 0.077% w/w of phenol polymer. The resulting solution can be effectively operated at pH 4.0 to 5.1.

Another especially preferred version of the invention is an aqueous solution containing 0.00065 to 0.001 1% w/w zirconium ion and 0.01 to 0.077% w/w of phenol polymer. The resulting solution can be effectively operated at pH 4.0 to 5.1.

Another especially preferred version of the invention is an aqueous solution containing 0.0008 to 0.0010% w/w hafnium ion and 0.01 to 0.077% w/w of phenol polymer. The resulting solution can be effectively operated at pH 4.0 to 5.1.

The rinse solution of the invention can be applied by various means, so long as contact between the rinse solution and the conversion-coated substrate is effected. The preferred methods of application of the rinse solution of the invention are by immersion or by spray. In an immersion operation, the conversion-coated metal article is submersed in the rinse solution of the invention for a time interval from about 5 sec to 5 min, preferably 45 sec to 1 min. In a spray operation, the conversion-coated metal article comes in contact with the rinse solution of the invention by means of pumping the rinse solution through risers fashioned with spray nozzles. The application interval for the spray operation is about 5 sec to 5 min, preferably 45 sec to 1 min. The rinse solution of the invention can be applied at temperatures from about 20 to 65°C (70°F to 150°F), preferably 20 to 30°C (70°F to 90°F). Following treatment in the rinse solution, the treated metal article can be optionally post-rinsed with deionized water. The use of such a post-rinse is common in many industrial electrocoating operations. The conversion-coated metal article treated with the rinse solution of the invention can be dried by various means, preferably at a raised temperature, for instance by oven drying at about 175°C (350°F) for about 5 min. The

conversion-coated metal article, now treated with the rinse solution of the invention, is ready for application of the siccative coating.

EXAMPLES

5 The following examples demonstrate the utility of
the rinse solution of the invention. Examples 4, 16 and
17 are comparative examples. Further, comparative
examples include conversion-coated metal substrates
treated with a chromium containing rinse and
10 conversion-coated metal substrates treated with a final
rinse solution as described in U.S. Pat. No. 4,517,028,
which is a final rinse composition comprising a
polyalkylphenol and Group IVA metal ion. Another
15 comparative example was to treat conversion-coated
metal substrates with a deionized-water final rinse.
Throughout the examples, specific parameters for the
pretreatment process, for the rinse solution of the
invention, for the comparative rinses and the nature of
20 the substrate and the type of siccative coating are
described.

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Some of the panels described in the various examples were painted with three different electrocoatings, all applied anodically. These were: VectrocoatTM 300 Gray and Vectrocoat 300 Red, both acrylics, and both manufactured by the Valspar Corporation, Garland, Texas. The third electrocoat was UmchemTM E-2000, manufactured by Universal Chemicals & Coatings, Elgin Illinois. Two other organic coatings that were applied to some of the panels were a melamine modified polyester and a water-based coating, both manufactured by the Sheboygan Paint Company, Sheboygan, Wisconsin.

All treated and painted metal samples were subjected to accelerated corrosion testing. In general, the testing was performed according to the guidelines specified in ASTM B-117-90. Specifically, three identical specimens were prepared for each pretreatment system. The painted metal samples received a single, diagonal scribe which broke through the organic finish and penetrated to bare metal. All unpainted edges were covered with electrical tape. The specimens remained in the salt spray cabinet for an

interval that was commensurate with the type of siccative coating that was being tested. Once removed from the salt spray cabinet, the metal samples were rinsed with tap water, dried by blotting with paper towels and evaluated.

5 The evaluation was performed by scraping away the loose paint and corrosion products from the scribe area with the flat end of a spatula. The scraping was performed in such a manner so as only to remove loose paint and leave adhering paint intact. In the case of some organic

10 finishes, removal of the loose paint and corrosion products from the scribe was accomplished by means of a tape pull as specified in ASTM B-1 17-90. Once the loose paint was removed, the scribe areas on the specimens were then measured to determine the amount of paint lost due to

15 corrosion creepage. Each scribe line was measured at eight intervals, approximately 1 mm apart, measured across the entire width of the scribe area. The eight values were averaged for each specimen and the averages of the three identical specimens were averaged to arrive at the final

20 result. The creepage values reported in the following tables reflect these final results.

EXAMPLE 1

Cold-rolled steel test panels from Advanced Coating Technologies, Hillsdale, Michigan were processed through a

25 five-stage pretreatment operation. The panels were cleaned with Brent America, Inc Chem CleanTM 1303, a commercially available alkaline cleaning compound. Once rendered water-break-free, the test panels were rinsed in tap water and phosphated with Brent America, Inc. Chem CoteTM 3011, a

30 commercially available iron phosphate. The phosphating bath was operated at about 6.2 points, 60°C (140°F), 3 min contact time, pH 4.8. After phosphating, the panels were rinsed in tap water and treated with various final rinse solutions for 1 min. The panels were given a

35 deionized-water post-rinse prior to dry-off. The comparative chromium-containing rinse was Brent America, Inc. Chem SealTM 3603, a commercially available product.

This bath was run at 0.25% w/w. In accordance with normal practice in the metal finishing industry, panels treated with the chromium-containing final rinse (1) were rinsed with deionized water prior to dry-off. Panels treated with the comparative chromium-free final rinse (2) were obtained from Advanced Coating Technologies, Hillsdale, Michigan, identified by Code APR20809. All panels treated in the laboratory were then dried in an oven at 175°C (350°F) for 5 min. The panels were painted with Vectrocoat 300 Gray, Vectrocoat 300 Red, Unichem E-2000, the water-based coating, and the melamine-modified polyester. The various rinses studied are summarized as follows.

1. Chem Seal 3603, chromium-containing final rinse.
2. Comparative chromium-free final rinse.
3. Phenol polymer, 0.01% w/w, pH 4.00, Ti concentration, 0.00035% w/w.
4. Phenol polymer, 0.50% w/w, pH 4.00, Ti concentration, 0.00035% w/w.
5. Phenol polymer, 0.30% w/w, pH 4.00, Ti concentration, 0.00035% w/w.
6. Phenol polymer, 0.40% w/w, pH 4.00, Ti concentration, 0.00035% w/w.

The salt spray results are described in Tables I and II and III. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

EXAMPLE 2

Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The conversion-coated test panels were painted with Vectrocoat 300 Gray, Vectrocoat 300 Red, and the water-based coating. The various final rinses are summarized as follows.

1. Chem Seal 3603, chromium-containing final rinse.
2. Comparative chromium-free final rinse.
7. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w.

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8. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00060% w/w.
9. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00085% w/w.
- 5 10. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00110% w/w.
11. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00135% w/w.
- 10 12. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00160% w/w.
13. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00185% w/w.

The salt spray results are described in Table IV. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

EXAMPLE 3

Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The conversion-coated test panels were painted with Vectrocoat 300 Gray, Vectrocoat 300 Red, Unichem E-2000, and the melamine-modified polyester. The various final rinses are summarized as follows.

1. Chem Seal 3603, chromium-containing final rinse.
- 25 2. Comparative chromium-free final rinse.
14. Phenol polymer, 0.077% w/w, pH 3.50, Ti concentration, 0.00035% w/w.
15. Phenol polymer, 0.077% w/w, pH 5.10, Ti concentration, 0.00035% w/w.
- 30 16. Phenol polymer, 0.077% w/w, pH 3.00, Ti concentration, 0.00035% w/w.
17. Phenol polymer, 0.077% w/w, pH 5.40, Ti concentration, 0.00035% w/w.

The salt spray results are described in Tables V and VI. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

EXAMPLE 4

Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The final rinse was applied by an immersion technique on some conversion-coated panels and was applied by means of a recirculating spray on others. The conversion-coated test panels were painted with Vectrocoat 300 Gray, Vectrocoat 300 Red, Unichem E-2000, and the melamine-modified polyester. The various final rinses are summarized as follows.

7. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, spray application.
18. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, immersion application.

The salt spray results are described in Table VII. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

EXAMPLE 5

Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The conversion-coated test panels were painted with Vectrocoat 300 Red and the water-based coating. The various final rinses are summarized as follows.

1. Chem Seal 3603, chromium-containing final rinse.
19. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, Zr concentration, 0.00066% w/w.
20. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, Hf concentration, 0.00035% w/w.
21. Phenol polymer, 0.077% w/w, pH 4.00, Zr concentration, 0.00066% w/w, Hf concentration, 0.00035% w/w.

22. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, Zr concentration, 0.00066% w/w, Hf concentration, 0.00035% w/w.

The salt spray results are described in Table VIII.

- 5 The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

EXAMPLE 6

- 10 Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The conversion-coated test panels were painted with Vectrocoat 300 Red, Vectrocoat Gray, Unichem E-2000, the melamine-modified polyester and the water-based coating. The various final rinses are summarized as follows.

- 15 1. Chem Seal 3603, chromium-containing final rinse.
23. Phenol polymer, 0.077% w/w, pH 4.00, Zr concentration, 0.00065% w/w.
24. Phenol polymer, 0.077% w/w, pH 4.00, Zr concentration, 0.0050% w/w.
- 20 25. Phenol polymer, 0.077% w/w, pH 4.00, Zr concentration, 0.0011% w/w.
26. Phenol polymer, 0.077% w/w, pH 4.00, Hf concentration, 0.0010% w/w.
27. Phenol polymer, 0.077% w/w, pH 4.00, Hf concentration, 0.0008% w/w.
- 25 28. Phenol polymer, 0.077% w/w, pH 4.00, Hf concentration, 0.0050% w/w.

- The salt spray results are described in Tables IX, X, XI and XII. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.
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EXAMPLE 7

- 35 Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The conversion-coated test panels were painted with Vectrocoat

300 Red and Vectrocoat 300 Gray. The various final rinses are summarized as follows.

1. Chem Seal 3603, chromium-containing final rinse.
29. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w.
30. Phenol polymer, 0.077% w/w, pH 4.00, Zr concentration, 0.00065% w/w.

The salt spray results are described in Table XIII. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

EXAMPLE 8

Another set of cold-rolled steel test panels was prepared using the parameters described in Example 1. The conversion-coated test panels were painted with the melamine-modified polyester. The various final rinses are summarized as follows.

1. Chem Seal 3603, chromium-containing final rinse.
31. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, followed by a deionized water post-rinse.
32. Phenol polymer, 0.077% w/w, pH 4.00, Ti concentration, 0.00035% w/w, without a deionized water post-rinse.

The salt spray results are described in Table XIV. The values represent total creepage about the scribe area in mm. The numbers in parentheses represent the exposure interval for that particular organic finish.

The results from accelerated corrosion testing demonstrated in Examples 1 to 8 show that rinse solutions containing a phenolic resin and a Group IVA metal ion provided substantially better performance than the comparative chromium-free rinse, Rinse No. 2. The results demonstrated in Examples 1 to 8 also show that rinse solutions containing a phenolic resin and Group IVA metal ion, namely zirconium, titanium, hafnium and mixtures thereof, provided, in many cases, corrosion resistance

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comparable to that of a chromium-containing rinse, such as Final Rinse No. 1. In several instances, rinse solutions containing a phenolic resin and Group IVA metal ion, namely, zirconium, titanium, hafnium, and mixtures thereof, provided significantly higher levels of corrosion resistance than that achieved with a chromium-containing rinse.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described, or portions thereof, but it is recognised that various modifications are possible within the scope of the invention claimed.

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TABLE I

Final Rinse No.	300 Gray(120 hr)	300 Red (96 hr)	Unichem (504 hr)	Melamine (144 hr)
1	7.8	9	7.3	8.3
2	10.5	14.7	4.2	8.8
3	7.9	9.4	4.3	14.8

TABLE II

Final Rinse No.	300 Gray(120 hr)	300 Red (96 hr)	Unichem (504 hr)	Melamine (144 hr)
1	15.5	11.2	14.3	8.1
4	16.8	21.9	14.9	32.7

TABLE III

Final Rinse No.	300 Gray(120 hr)	300 Red (120 hr)	Water-based (168 hr)
1	14.7	16	7
5	19.1	17	6.3
6	10.4	10.2	6.1

TABLE IV

Final Rinse No.	300 Gray(120 hr)	300 Red (120 hr)	Water-based (168 hr)
1	12.1	11.5	5.7
7	8.4	12.4	2.2
8	3.5	6.7	2
9	5.5	6.4	1.9
10	5.8	7.5	2.4
11	6.6	9.9	3
12	9.2	11	3.3
13	9.5	12.9	22.9

TABLE V

Final Rinse No.	300 Gray(120 hr)	300 Red (96 hr)	Unichem (504 hr)	Melamine (144 hr)
1	7.8	9	7.3	8.3
2	10.5	14.7	4.2	8.8
14	8.8	9.5	5.1	10.3
15	6.2	5.8	8.5	3.9

TABLE VI

Final Rinse No.	300 Gray(120 hr)	300 Red (96 hr)	Unichem (504 hr)	Melamine (144 hr)
1	15.5	11.2	14.3	6.1
16	23.2	13.8	10.6	16.4
17	18.1	29.4	18.1	41.8

TABLE VII

Final Rinse No.	300 Gray(120 hr)	300 Red (96 hr)	Unichem (504 hr)	Melamine (144 hr)
7	4.3	4.7	4.7	4.5
18	7.1	3.3	9.4	3.5

TABLE VIII

Final Rinse No.	Water-based (216 hr)	300 Red (120 hr)
1	4.1	7.2
19	3.5	6.2
20	2.7	6.3
21	2.6	3.9
22	3.6	6.6

TABLE IX

Final Rinse No.	300 Gray (120 hr)	300 Red (96 hr)	Unichem (504 hr)	Melamine (144 hr)
1	7.8	9	7.3	8.3
23	5.5	4.7	5.9	4

TABLE X

Final Rinse No.	300 Red (96 hr)	300 Gray (120 hr)	Unichem (336 hr)	Melamine (144 hr)
1	15.9	24	20.4	28.9
25	7.3	10.9	2.6	38.6
26	5.3	6.5	1.6	5.5

TABLE XI

Final Rinse No.	300 Gray (120 hr)	300 Red (96 hr)	Melamine (144 hr)
1	56.7	17.2	30.5
27	11.7	5.8	1.9

TABLE XII

Final Rinse No.	300 Gray (120 hr)	300 Red (96 hr)	Water-based (120 hr)
1	24.7	20.8	24.5
24	22.1	19.8	10.8
28	9.3	12.9	10.7

TABLE XIII

Final Rinse No.	300 Gray (96 hr)	300 Red (96 hr)
1	.9	8.8
29	5.1	8.3
30	9.2	N/A

TABLE XIV

Final Rinse No.	Melamine (168 hr)
1	8.8
31	6.1
32	2.4

The rinses numbers 3 through 32 provided results at least as good as the results for the conventional chromium rinse number 1, and are considered acceptable examples of the present invention. Rinses with compositions outside the ranges of rinses 3-32 were also tested but provided unacceptable results.

CLAIMS:

1. A rinse solution comprising an aqueous solution of a Group IVA metal ion, selected from the Group consisting of zirconium, titanium, hafnium and mixtures thereof, and a phenolic resin characterized in that the resin is a resole phenolic and is present in a concentration in the range of about 0.01 to about 0.40% w/w, the Group IVA metal ion is present in a concentration in the range of about 0.00035 to about 0.0050% w/w, and the pH is in the range of about 3.5 to 5.1.
2. A rinse solution as defined in claim 1 wherein the Group IVA metal ion concentration in the rinse solution is in the range 0.00035 to 0.00016% w/w.
3. A rinse solution as defined in claim 1 or claim 2 wherein the Group IVA metal ion concentration is in the range 0.00035 to 0.0010% w/w, the phenolic resin concentration is in the range 0.01 to 0.077% w/w, and the pH is in the range 4.0 to 5.1.
4. A rinse solution as defined in any one of claims 1 to 3 in which the Group IVA metal ion comprises titanium.
5. A rinse solution as defined in any one of claims 1 to 4 in which the Group IVA metal ion comprises zirconium.
6. A rinse solution as defined in any one of claims 1 to 5 in which the Group IVA metal ion comprises hafnium.

7. A rinse solution as defined in claim 6 wherein the hafnium ion concentration in the rinse solution is in the range 0.0008 to 0.0010% w/w, the phenolic resin concentration is in the range 0.01 to 0.077% w/w and the pH is in the range 4.0 to 5.1.

8. A rinse solution as defined in any one of claims 1 to 3 which comprises at least two Groups IVA metal ions, the first of which is present at a concentration in the range 0.00035 to 0.0016% w/w and the second of which is present at a concentration in the range 0.00065 to 0.0011% by weight.

9. A rinse solution according to claim 8 in which the resin is present at a concentration in the range 0.01 to 0.077% w/w.

10. A solution according to claim 8 or claim 9 which has a pH in the range 4.0 to 5.1.

11. A rinse solution as defined in any one of claims 1 to 10 wherein the Group IVA metal ion is from a Group IVA metal ion source selected from the Group consisting of hexafluorozirconic acid, hexafluorotitanic acid, hafnium oxide, titanium oxysulfate, titanium tetrafluoride, zirconium sulfate and mixtures thereof.

12. A method of treating a metal surface by contacting it with a rinse solution according to any one of claims 1 to 11.

13. A method according to claim 12 in which the solution is contacted with the surface by spraying.

14. A method according to claim 12 in which the solution is contacted with the surface by dipping the surface in a bath of the solution.

15. A method according to any one of claims 12 to 14 in which the solution is at a temperature in the range 20 to 70°C.

16. A method according to any one of claims 12 to 15 in which the coated surface is dried at a raised temperature.

17. A method according to any one of claims 12 to 16 which involves a pretreatment step in which the metal surface is conversion coated and the conversion coated surface is contacted with the rinse solution.

18. A method according to any one of claims 12 to 17 in which the treated surface is subsequently coated with a siccative coating.

19. A rinse solution as defined in claim 2 wherein the Group IVA metal ion concentration in the rinse solution is in the range 0.00065 to 0.0050% w/w.

20. A method according to claim 17 wherein the metal surface is phosphate conversion coated.