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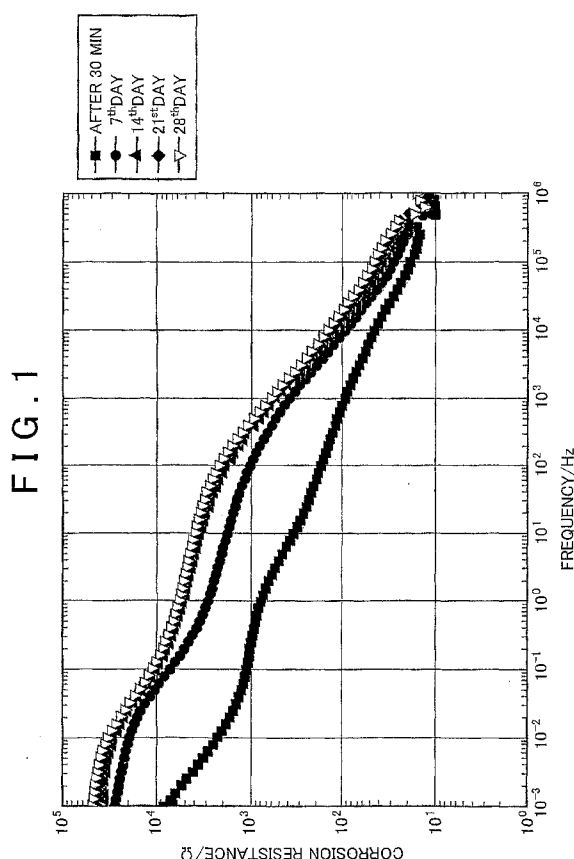
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[Continued on next page]

(54) Title: POLYANILINE, METHOD FOR MANUFACTURING SAME, AND POLYANILINE-CONTAINING SOLUTION AND COATING MATERIAL



(57) Abstract: A method for manufacturing a polyaniline by preparing an aniline mixed solution in which an antirust additive and at least one of aniline and aniline derivatives are mixed and polymerizing at least one of the aniline and the aniline derivatives by adding a polymerization initiator to the aniline mixed solution, polyaniline obtained by the method, a polyaniline-containing solution, and a coating material containing the polyaniline.



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POLYANILINE, METHOD FOR MANUFACTURING SAME, AND
POLYANILINE-CONTAINING SOLUTION AND COATING MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to polyaniline, a method for manufacturing same, and a polyaniline-containing solution and coating material.

2. Description of the Related Art

[0002] An antirust treatment is performed on a metal surface for corrosion prevention. Polyanilines have been studied as an antirust agent. Where a polyaniline solution or coating material containing a polyaniline is coated on a metal, the metal surface is passivated. Therefore, metal corrosion may be inhibited.

[0003] A variety of antirust additives may be added to coating materials containing a polyaniline in order to improve further the antirust ability of the coating materials. Examples of antirust additives include chromium-free antirust pigments (zinc oxide, zinc phosphate, aluminum zinc phosphate) and inorganic oxides (silica, alumina, and the like). Dispersing and dissolving an elemental metal or a metal salt and then admixing to a coating material composition has been reported as a process aimed at the improvement of antirust ability of a nonconductive polyaniline (see, for example, PCT application publication No. WO01/088047).

[0004] A polyaniline contained in a coating film formed by a polyaniline solution or polyaniline-containing coating material is gradually degraded by H^+ , OH^- produced by corrosion reactions (anodic reaction, cathodic reaction) occurring on the metal surface, and the function of forming a passivation layer on the metal surface is lost. Even when an antirust additive is added to the polyaniline-containing coating material, the degradation of polyaniline is difficult to inhibit completely. Therefore, as polyaniline degrades, the passivation layer is destroyed, and metal corrosion proceeds.

[0005] The following factors may be thought to advance corrosion of a metal surface having a coating film formed by a polyaniline-containing coating material including an antirust additive. When a typical polyaniline-containing coating material is prepared, the polyaniline and an antirust additive are prepared separately and then mixed. As a result, the polyaniline and antirust additive are randomly present in the coating film formed by the polyaniline-containing coating material. As a result, a local corrosion reaction easily occurs in zones where the antirust additive is not present, and metal corrosion may be supposed to advance from these zones.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a method for manufacturing a polyaniline that has excellent antirust ability by using a metal phosphate as an antirust additive, a polyaniline obtained by such manufacturing method, a polyaniline-containing solution, and a coating material containing the polyaniline and having excellent antirust ability.

[0007] A method for manufacturing a polyaniline according to the first aspect of the present invention includes preparing an aniline mixed solution in which an antirust additive and at least one of aniline and aniline derivatives are mixed and polymerizing at least one of the aniline and the aniline derivatives by adding a polymerization initiator to the aniline mixed solution.

[0008] In the method for manufacturing a polyaniline of the above-described aspect, the aniline mixed solution may be prepared by adding the antirust additive and at least one of the aniline and aniline derivatives to an organic solvent immiscible with water.

[0009] In the method for manufacturing a polyaniline of the above-described aspect, the aniline mixed solution may be prepared by adding a surfactant, water, and a water-soluble protonic acid to the organic solvent immiscible with water.

[0010] In the method for manufacturing a polyaniline of the above-described aspect, the antirust additive is one of a metal phosphate, powdered red earth, a cyanamide powder, zinc white, and zinc chromate.

[0011] A method for manufacturing a polyaniline doped with a metal phosphate according to the second aspect of the present invention includes preparing an aniline mixed solution by adding a surfactant, water, a water-soluble protonic acid, a metal phosphate, and at least one of aniline and aniline derivatives to an organic solvent immiscible with water, and polymerizing at least one of the aniline and the aniline derivatives by adding a polymerization initiator to the aniline mixed solution.

[0012] In the method for manufacturing a polyaniline of the above-described aspect, the water-soluble protonic acid may be one of phosphoric acid, hydrochloric acid, sulfuric acid, and nitric acid.

[0013] In the method for manufacturing a polyaniline of the above-described aspect, the water-soluble protonic acid may be phosphoric acid.

[0014] In the method for manufacturing a polyaniline of the above-described aspect, the metal phosphate may be one of zinc phosphate, iron phosphate, and manganese phosphate.

[0015] In the method for manufacturing a polyaniline of the above-described aspect, the metal phosphate may be zinc phosphate.

[0016] In the method for manufacturing a polyaniline of the above-described aspect, the polymerization initiator may be one of ammonium persulfate, hydrogen peroxide, and ferric chloride.

[0017] In the method for manufacturing a polyaniline of the above-described aspect, the polymerization initiator may be ammonium persulfate.

[0018] In the method for manufacturing a polyaniline of the above-described aspect, the surfactant may be one of an anionic surfactant, a cationic surfactant, and a nonionic surfactant.

[0019] In the method for manufacturing a polyaniline of the above-described aspect, the organic solvent immiscible with water may have a solubility parameter of about 7 to 12.

[0020] In the method for manufacturing a polyaniline of the above-described aspect, the organic solvent immiscible with water may be one of benzene, toluene, chloroform,

xylene, and ethyl acetate.

[0021] A polyaniline according to the third aspect of the present invention is manufactured by the method for manufacturing a polyaniline according to the above-described aspect.

[0022] A polyaniline-containing solution according to the fourth aspect of the present invention is manufactured by the method for manufacturing a polyaniline according to the above-described aspect.

[0023] A coating material according to the fifth aspect of the present invention contains the polyaniline according to the above-described aspect.

[0024] The coating material according to the fifth aspect may further contain a matrix resin, wherein the polyaniline is contained at 1 to 4 wt.% based on the matrix resin.

[0025] The coating material according to the fifth aspect may further contain a matrix resin, wherein the polyaniline is contained at 2 to 3 wt.% based on the matrix resin.

[0026] In the coating material according to the fifth aspect, the matrix resin may be one of an acrylic resin, an epoxy resin, and a polyester resin.

[0027] The present invention provides a method for manufacturing a polyaniline having excellent antirust ability, a polyaniline obtained by the manufacturing method, a polyaniline-containing solution, and a coating material containing the polyaniline and having excellent antirust ability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The foregoing and/or further objects, features and advantages of the invention will become apparent from the following description of preferred embodiments with reference to the accompanying drawings, in which like numerals are used to represent like elements and wherein:

FIG. 1 shows measurement results relating to an alternating current impedance of Evaluation Sample 1;

FIG. 2 shows measurement results relating to an alternating current impedance of Evaluation Sample 2;

FIG. 3A shows observation results relating to an external appearance of the coating film of Evaluation Sample 1; these results represent the external appearance of the coating film that was allowed to stay for 30 minutes;

FIG. 3B shows observation results relating to an external appearance of the coating film of Evaluation Sample 1; these results represent the external appearance of the coating film that was allowed to stay for 7 days;

FIG. 3C shows observation results relating to an external appearance of the coating film of Evaluation Sample 1; these results represent the external appearance of the coating film that was allowed to stay for 14 days;

FIG. 3D shows observation results relating to an external appearance of the coating film of Evaluation Sample 1; these results represent the external appearance of the coating film that was allowed to stay for 21 days;

FIG. 3E shows observation results relating to an external appearance of the coating film of Evaluation Sample 1; these results represent the external appearance of the coating film that was allowed to stay for 28 days;

FIG. 4A shows observation results relating to an external appearance of the coating film of Evaluation Sample 2; these results represent the external appearance of the coating film that was allowed to stay for 30 minutes;

FIG. 4B shows observation results relating to an external appearance of the coating film of Evaluation Sample 2; these results represent the external appearance of the coating film that was allowed to stay for 7 days;

FIG. 4C shows observation results relating to an external appearance of the coating film of Evaluation Sample 2; these results represent the external appearance of the coating film that was allowed to stay for 14 days;

FIG. 4D shows observation results relating to an external appearance of the coating film of Evaluation Sample 2; these results represent the external appearance of the coating film that was allowed to stay for 21 days;

FIG. 4E shows observation results relating to an external appearance of the coating film of Evaluation Sample 2; these results represent the external appearance of the coating film that was allowed to stay for 28 days;

FIG. 5A shows evaluation results on adhesivity of Evaluation Sample 9;

FIG. 5B shows evaluation results on adhesivity of Evaluation Sample 3;

FIG. 5C shows evaluation results on adhesivity of Evaluation Sample 4;

FIG. 5D shows evaluation results on adhesivity of Evaluation Sample 5;

FIG. 5E shows evaluation results on adhesivity of Evaluation Sample 6;

FIG. 5F shows evaluation results on adhesivity of Evaluation Sample 7; and

FIG. 6 shows measurement results relating to polarization resistance values of Evaluation Sample 3 to Evaluation Sample 9.

DETAILED DESCRIPTION OF EMBODIMENTS

[0029] A polyaniline doped with an antirust additive (in particular, a metal phosphate), a method for manufacturing same, a polyaniline-containing solvent, and a coating material in accordance with embodiments of the present invention will be described hereinbelow in greater detail.

[0030] A method for manufacturing a polyaniline doped with a metal phosphate as an antirust additive in accordance with an embodiment of the present invention (which may be referred to hereinbelow simply as "polyaniline") includes a process of preparing an aniline mixed solution by mixing a surfactant, water, a water-soluble protonic acid, a metal phosphate, and at least one of aniline and aniline derivatives with an organic solvent immiscible with water (which may be referred to hereinbelow as "mixing process") and a process of adding a polymerization initiator to the aniline mixed solution and polymerizing at least one of the aniline and the aniline derivatives (which may be referred to hereinbelow as "polymerization process"). A polyaniline and polyaniline-containing solution are obtained by the method for manufacturing a polyaniline in accordance with the embodiment.

[0031] Each process relating to the method for manufacturing a polyaniline in

accordance with the embodiment and materials used in each process will be described below.

[0032] In the mixing process in accordance with the embodiment, at least one of the aniline and the aniline derivatives and also a surfactant, water, water-soluble protonic acid, and a metal phosphate are added to an organic solvent immiscible with water to prepare an aniline mixed solution. In the aniline mixed solution, the aniline salt is formed by the metal phosphate and at least one of the aniline and the aniline derivatives.

[0033] Specific examples of the organic solvent immiscible with water that is used in the mixing process in accordance with the embodiment include benzene, toluene, chloroform, xylene, and ethyl acetate. Among them, toluene and xylene are especially preferred. The "organic solvent immiscible with water" may be an organic solvent with a solubility parameter (an SP value) of about 7 to 12.

[0034] The surfactant that is used in the mixing process in accordance with the embodiment is not particularly limited, and an anionic surfactant, a cationic surfactant, and a nonionic surfactant may be used. Examples of the cationic surfactant include long-chain alkyl ammonium salts and quaternary ammonium salts. Cetyltrimethyl ammonium bromide is a specific example. Examples of the anionic surfactant include long-chain alkyl sulfates, carboxylic acid salts, sulfuric acid esters and salts, and specific examples include sodium dodecylsulfate and esters and salts of alkylsulfuric acids. Examples of the nonionic surfactant include nonionic surfactants based on fatty acids and higher alcohols, specific examples including glycerin fatty acid esters and polyoxyethylene alkyl ethers.

[0035] Among them the anionic surfactant is preferred because the surfactant forms a salt with an aniline and then polymerization is performed under micelle formation.

[0036] Specific examples of the water-soluble protonic acid that is used in the mixing process in accordance with the embodiment include phosphoric acid, hydrochloric acid, sulfuric acid, and nitric acid, but phosphoric acid is preferred from the standpoint of imparting a function of a buffer solution to the polyaniline-containing solution due to coexistence of metal phosphate.

[0037] Specific examples of the metal phosphate that is used in the mixing process in accordance with the embodiment include zinc phosphate, iron phosphate, and manganese phosphate. Among them, zinc phosphate is preferably used because it has excellent antirust ability.

[0038] Specific examples of at least one of the aniline and the aniline derivatives that is used in the mixing process in accordance with the embodiment include aniline and anisidine. Aniline is preferably used because it is easy to acquire. In accordance with the embodiment, the aniline and derivatives thereof may be also used in combinations of two or more thereof.

[0039] In the mixing process in accordance with the embodiment, the sequence of adding the surfactant, water, water-soluble protonic acid, metal phosphate, and at least one of the aniline and the aniline derivatives to the organic solvent immiscible with water is not particularly limited.

[0040] In the polymerization process in accordance with the embodiment, a polymerization initiator is added to the aniline mixed solution prepared in the mixing process and at least one of the aniline and the aniline derivatives is polymerized. A polyaniline is synthesized by the polymerization reaction.

[0041] The polymerization initiator used in the polymerization process in accordance with the embodiment is not particularly limited, provided that it may induce polymerization of at least one of the aniline and the aniline derivatives. For example, ammonium persulfate, hydrogen peroxide, and ferric chloride may be used as the polymerization initiator. The polymerization initiators may be used individually or in combinations of two or more thereof. Among them, ammonium persulfate is preferred as the polymerization initiator.

[0042] The polymerization temperature and polymerization time in the polymerization process are appropriately adjusted based on the type and amount of at least one of the aniline and the aniline derivatives and the polymerization initiator.

[0043] With the method for manufacturing a polyaniline in accordance with the embodiment, a polyaniline and a polyaniline-containing solution having excellent antirust

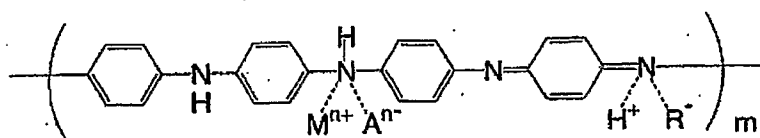
ability may be obtained. The following reason may be suggested therefore. Because at least one of the aniline and the aniline derivatives is polymerized in the presence of a metal phosphate, which is an antirust additive demonstrating a pH buffer ability and sacrificial anticorrosive action, the polyaniline and metal phosphate form a salt and the metal phosphate is caused to be present in the vicinity of the polyaniline. Further, because the metal phosphate present in the vicinity of the polyaniline inhibits the corrosion reaction at the metal surface, degradation of polyaniline caused by the corrosion reaction may be inhibited.

[0044] A typical coating material including a polyaniline and an antirust additive requires a process of preparing the polyaniline and the antirust additive separately and a subsequent process of obtaining a coating material. Accordingly, the coating material is manufactured by a complex process. However, with the method for manufacturing a polyaniline in accordance with the embodiment, a polyaniline solution containing an antirust additive may be obtained without a process of mixing the polyaniline and the antirust additive. Therefore, the coating material manufacturing process may be simplified. Furthermore, because the polyaniline in accordance with the embodiment is soluble in at least one of water and an organic solvent, the coating material may be easily formed.

[0045] The structure of the polyaniline in accordance with the embodiment obtained by using an anionic surfactant may be assumed to be represented by a General Formula (1) below.

[0046]

[General Formula (1)]



[0047] In the General Formula (1), M^{n+} represents a metal cation derived from the metal phosphate, A^{n-} represents a phosphoric acid anion derived from the metal phosphate, R^+ represents a cationic residue of an anionic surfactant, H^+ represent proton,

and "m" represents integer of 1 and more.

[0048] The anionic surfactant is assumed to form a salt with the polyaniline. As a result, the polyaniline in accordance with the embodiment apparently has solubility in at least one of water and an organic solvent.

[0049] Because the polyaniline in accordance with the embodiment has excellent antirust ability, it may be advantageously used as a metal surface treatment agent or a coating material additive having an antirust function. Further, the polyaniline in accordance with the embodiment may be also advantageously used as an electrically conductive polymer, a substituent material for plating, an antistatic agent, and an electromagnetic wave shielding agent.

[0050] A typical polyaniline has been reported to passivate iron due to its own redox property. Further, it has also been reported that in a corrosion test in which a typical polyaniline is used as an antirust coating material, without mixing with a coating material, and coated on an iron plate and the coating surface is then damaged, a self-repair action is demonstrated due to which the damaged zone is passivated (restored). However, the antirust ability thereof seems to be insufficient for use as an antirust material for automobiles. By using a polyaniline doped with a metal phosphate in accordance with the embodiment, it is possible to increase dramatically the antirust ability, and such polyaniline may be also advantageously used as an antirust material for automobiles.

[0051] By using the polyaniline in accordance with the embodiment as an antirust material for automobiles, it is possible to increase antirust ability of joints (edge portions) of steel sheets in the automobile body. Furthermore, the progress of chipping corrosion may be inhibited. In addition, the sealing process may be reduced and simplified due to improved antirust properties of the edge portion. In addition, manual sealer application is not required in closure mono-sections such as hoods and doors and the number of manual operations is reduced. Furthermore, manual brush repair of the sealer is unnecessary, and the appearance of sealer portions is improved. As a result, the cost and process length may be reduced.

[0052] The coating material in accordance with the embodiment may contain the

polyaniline in accordance with the embodiment and may also use the polyaniline-containing solution in accordance with the embodiment as a coating material. If necessary, a matrix resin may be added or an antirust additive other than the metal phosphate may be added.

[0053] Examples of the matrix resin that may be used in the coating material in accordance with the embodiment include acrylic resins, epoxy resins, and polyester resins.

[0054] Examples of the antirust additives other than the metal phosphate, include powdered red earth, a cyanamide powder, zinc white, and zinc chromate.

[0055] When a matrix resin is contained in the coating material in accordance with the embodiment, the polyaniline in accordance with the embodiment is preferably added at a ratio of 1 to 4 wt.%, more preferably 2 to 3 wt.% to the matrix resin. By adding the polyaniline in accordance with the embodiment at a ratio of 1 to 4 wt.% to the matrix resin, it is possible to improve adhesivity of the coating film formed by the coating material in accordance with the embodiment.

[0056] The present invention will be described below in greater detail based on examples thereof, but the present invention is not limited to the examples.

[0057] First, Test Example 1 will be described. An aniline mixed solution was prepared by adding 3.56 g (8 mmol) of a surfactant (Aerosol OT, manufactured by Tokyo Kasei), 500 mL of phosphoric acid (1M), 3.56 g (8 mmol) of zinc phosphate, and 3.73 g (40 mmol) of aniline to 100 mL of toluene and stirring. A total of 3.56 g (8 mmol) of ammonium persulfate was added to the aniline mixed solution maintained at 0°C, and a reaction was performed for 24 h under stirring to obtain the polyaniline-containing solution.

[0058] The obtained polyaniline-containing solution was added to an acrylic coating material (Kinol 200TW, manufactured by Kansai Paint) to obtain a content ratio of the polyaniline of 2 wt.% based on a resin component in the coating material and a polyaniline-containing coating material was obtained.

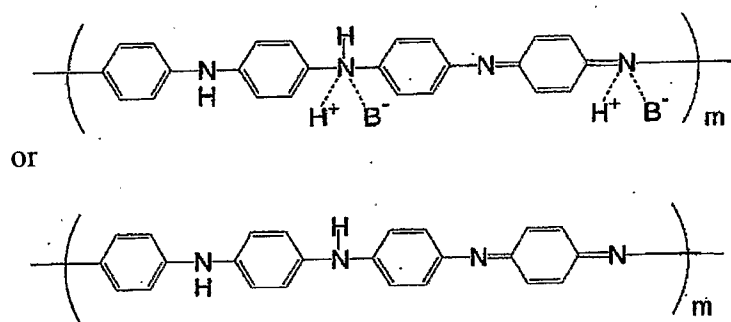
[0059] An Evaluation Sample 1 was obtained by coating the polyaniline-containing

coating material on a SPC steel sheet by using an applicator and drying for 20 min at 140°C. The dry thickness of the coating film of Evaluation Sample 1 was measured with an electromagnetic film thickness meter. The result was about 20 µm.

[0060] Test Example 2 will be explained below. A commercial polyaniline-containing coating material (normally dry type) manufactured by ORMECON was coated on a SPC steel sheet by using an applicator and dried over a week at room temperature to obtain Evaluation Sample 2. The dry thickness of the coating film was approximately 25 µm. The structure of polyaniline contained in the polyaniline-containing coating material manufactured by ORMECON is represented by a General Formula (2) below.

[0061]

[General Formula (2)]



[0062] In the General Formula (2), B⁻ represents an anionic residue of a sulfonic acid, H⁺ represents proton, and “m” represents integer of 1 or more.

[0063] The evaluation will be explained below. A polyethylene cylinder was disposed on the side of each of the Evaluation Sample 1 and Evaluation Sample 2 where the coating film was formed, a 3% aqueous solution of sodium chloride was injected into the portion surrounded by the surface on which the coating film was formed and the inner surface of the cylinder and the samples were allowed to stay at 25°C. The external appearance of the coating film was observed and the alternating current impedance was measured in 30 min, 7 days, 14 days, 21 days, and 28 days thereafter.

[0064] The measurement results of alternating current impedance are shown in FIG. 1 (Evaluation Sample 1) and FIG. 2 (Evaluation Sample 2). In FIGS. 1 and 2, a

frequency is plotted against the abscissa and a corrosion resistance is plotted against the ordinate. The alternating current impedance was measured using PARSTAT 2273 manufactured by Princeton-Applied-Research.

[0065] In the measurement results on the alternating current impedance, the resistance of the high-frequency range indicates the resistance of aqueous solution of sodium chloride – coating film, and the resistance in the medium-to-low frequency range indicates the resistance of the coating film interface – SPC steel sheet surface. High corrosion resistance represents a state in which the corrosion progress is impeded.

[0066] FIG. 1 demonstrates that in the coating film (Evaluation Sample 1) including the polyaniline in accordance with the test Example 1, the corrosion resistance in the medium-to-low frequency range rises with the increase in duration of contact with the aqueous solution of sodium chloride. On the other hand, in the coating film (Evaluation Sample 2) including the polyaniline manufactured by ORMECON, the corrosion resistance in the medium-to-low frequency range rises with the increase in duration of contact with the aqueous solution of sodium chloride.

[0067] As for the observation results relating to the external appearance of the coating film, the observation results for Evaluation Sample 1 are shown in FIGS. 3A to 3E, and the evaluation results for Evaluation Sample 2 are shown in FIGS. 4A to 4E. Here, FIGS. 3A and 4A show the external appearance of the coating film after it was allowed to stay for 30 min, FIGS. 3B and 4B – after 7 days, FIGS. 3C and 4C – after 14 days, FIGS. 3D and 4D – after 21 day, and FIGS. 3E and 4E – after 28 days. In Evaluation Sample 1, no changes in the external appearance of the coating film were observed even after the film was allowed to stay for 28 days, whereas red rust appeared in Evaluation Sample 2 with time.

[0068] The results shown in FIGS. 1 to 4 indicate that doping polyaniline with zinc phosphate makes it possible to increase dramatically the antirust function.

[0069] In Test Example 3, the polyaniline-containing solution that was obtained in Test Example 1 was mixed with an acrylic coating material (Kinol 200TW) manufactured by Kansai Paint so as to obtain a content ratio of polyaniline of 1, 2, 3, 4, 5, and 10 wt.%.

As a result, polyaniline-containing coating materials of 6 types with different content ratios of polyaniline were obtained. The obtained polyaniline-containing coating materials and an acrylic coating material (Kinol 200TW) manufactured by Kansai Paint were coated on an SPC steel sheet with an applicator and dried for 20 min at 140°C to produce Evaluation Sample 3 (polyaniline content ratio: 1 wt.%), Evaluation Sample 4 (polyaniline content ratio: 2 wt.%), Evaluation Sample 5 (polyaniline content ratio: 3 wt.%), Evaluation Sample 6 (polyaniline content ratio: 4 wt.%), Evaluation Sample 7 (polyaniline content ratio: 5 wt.%), Evaluation Sample 8 (polyaniline content ratio: 10 wt.%), and Evaluation Sample 9 (Kinol 200TW; polyaniline content ratio: 0 wt.%).

[0070] The Evaluation Samples 3 to 7 and Evaluation Sample 9 were then tested according to JIS K5400 to evaluate adhesiveness. The evaluation results are shown in FIGS. 5A to 5F. FIG. 5A shows the evaluation results obtained for Evaluation Sample 9. FIG. 5B shows the evaluation results obtained for Evaluation Sample 3. FIG. 5C shows the evaluation results obtained for Evaluation Sample 4. FIG. 5D shows the evaluation results obtained for Evaluation Sample 5. FIG. 5E shows the evaluation results obtained for Evaluation Sample 6. FIG. 5F shows the evaluation results obtained for Evaluation Sample 7. FIGS. 5A to 5F indicate that excellent adhesiveness is obtained when the content ratio of polyaniline is equal to or less than 4 wt.% based on the resin component of the coating material.

[0071] A polarization resistance value will be explained below. A resin cylinder was disposed on the side of each of the Evaluation Sample 3 to Evaluation Sample 9 where the coating film was formed, a 3% aqueous solution of sodium chloride was injected into the portion surrounded by the surface on which the coating film was formed and the inner surface of the cylinder, and the samples were allowed to stay at 25°C for 24 days. The polarization resistance value was measured using an under-film corrosion tester (HL201) manufactured by Hokuto Denko. The results obtained are shown in FIG. 6. FIG. 6 demonstrates that excellent polarization resistance value is obtained when the content ratio of polyaniline is 1 to 4 wt.% based on the resin component of the coating material.

[0072] While the invention has been described with reference to exemplary embodiments thereof, it should be understood that the invention is not limited to the exemplary embodiments or constructions. To the contrary, the invention is intended to cover various modifications and equivalent arrangements. In addition, while the various elements of the exemplary embodiments are shown in various combinations and configurations, which are exemplary, other combinations and configuration, including more, less or only a single element, are also within the spirit and scope of the invention.

CLAIMS

1. A method for manufacturing a polyaniline, comprising:

preparing an aniline mixed solution in which an antirust additive and at least one of aniline and aniline derivatives are mixed; and

polymerizing at least one of the aniline and the aniline derivatives by adding a polymerization initiator to the aniline mixed solution.

2. The method for manufacturing a polyaniline according to claim 1, wherein the aniline mixed solution is prepared by adding the antirust additive and at least one of the aniline and the aniline derivatives to an organic solvent immiscible with water.

3. The method for manufacturing a polyaniline according to claim 2, wherein the aniline mixed solution is prepared by adding a surfactant, water, and a water-soluble protonic acid to the organic solvent immiscible with water.

4. The method for manufacturing a polyaniline according to any one of claims 1 to 3, wherein the antirust additive is one of a metal phosphate, powdered red earth, a cyanamide powder, zinc white, and zinc chromate.

5. A method for manufacturing a polyaniline, comprising:

preparing an aniline mixed solution by adding a surfactant, water, a water-soluble protonic acid, a metal phosphate, and at least one of aniline and aniline derivatives to an organic solvent immiscible with water; and

polymerizing at least one of the aniline and the aniline derivatives by adding a polymerization initiator to the aniline mixed solution.

6. The method for manufacturing a polyaniline according to claim 3 or 5, wherein the water-soluble protonic acid is one of phosphoric acid, hydrochloric acid, sulfuric acid, and nitric acid.

7. The method for manufacturing a polyaniline according to claim 3 or 5, wherein the water-soluble protonic acid is phosphoric acid.

8. The method for manufacturing a polyaniline according to any one of claims 4 to 7, wherein the metal phosphate is one of zinc phosphate, iron phosphate, and manganese phosphate.

9. The method for manufacturing a polyaniline according to any one of claims 4 to 7, wherein the metal phosphate is zinc phosphate.

10. The method for manufacturing a polyaniline according to any one of claims 1 to 9, wherein the polymerization initiator is one of ammonium persulfate, hydrogen peroxide, and ferric chloride.

11. The method for manufacturing a polyaniline according to any one of claims 1 to 9, wherein the polymerization initiator is ammonium persulfate.

12. The method for manufacturing a polyaniline according to any one of claims 3 or 5 to 11, wherein the surfactant is one of an anionic surfactant, a cationic surfactant, and a nonionic surfactant.

13. The method for manufacturing a polyaniline according to any one of claims 3 or 5 to 11, wherein the organic solvent immiscible with water has a solubility parameter of about 7 to 12.

14. The method for manufacturing a polyaniline according to any one of claims 2 or 3 or 5 to 12, wherein the organic solvent immiscible with water is one of benzene, toluene, chloroform, xylene, and ethyl acetate.

15. A polyaniline manufactured by the method for manufacturing a polyaniline according to any one of claims 1 to 14.
16. A polyaniline-containing solution manufactured by the method for manufacturing a polyaniline according to any one of claims 1 to 14.
17. A coating material containing the polyaniline according to claim 15.
18. The coating material according to claim 17, wherein a matrix resin is further contained, and the polyaniline is contained at 1 to 4 wt.% based on the matrix resin.
19. The coating material according to claim 17, wherein a matrix resin is further contained, and the polyaniline is contained at 2 to 3 wt.% based on the matrix resin.
20. The coating material according to claim 18 or 19, wherein the matrix resin is one of acrylic resins, epoxy resins, and polyester resins.

FIG. 1

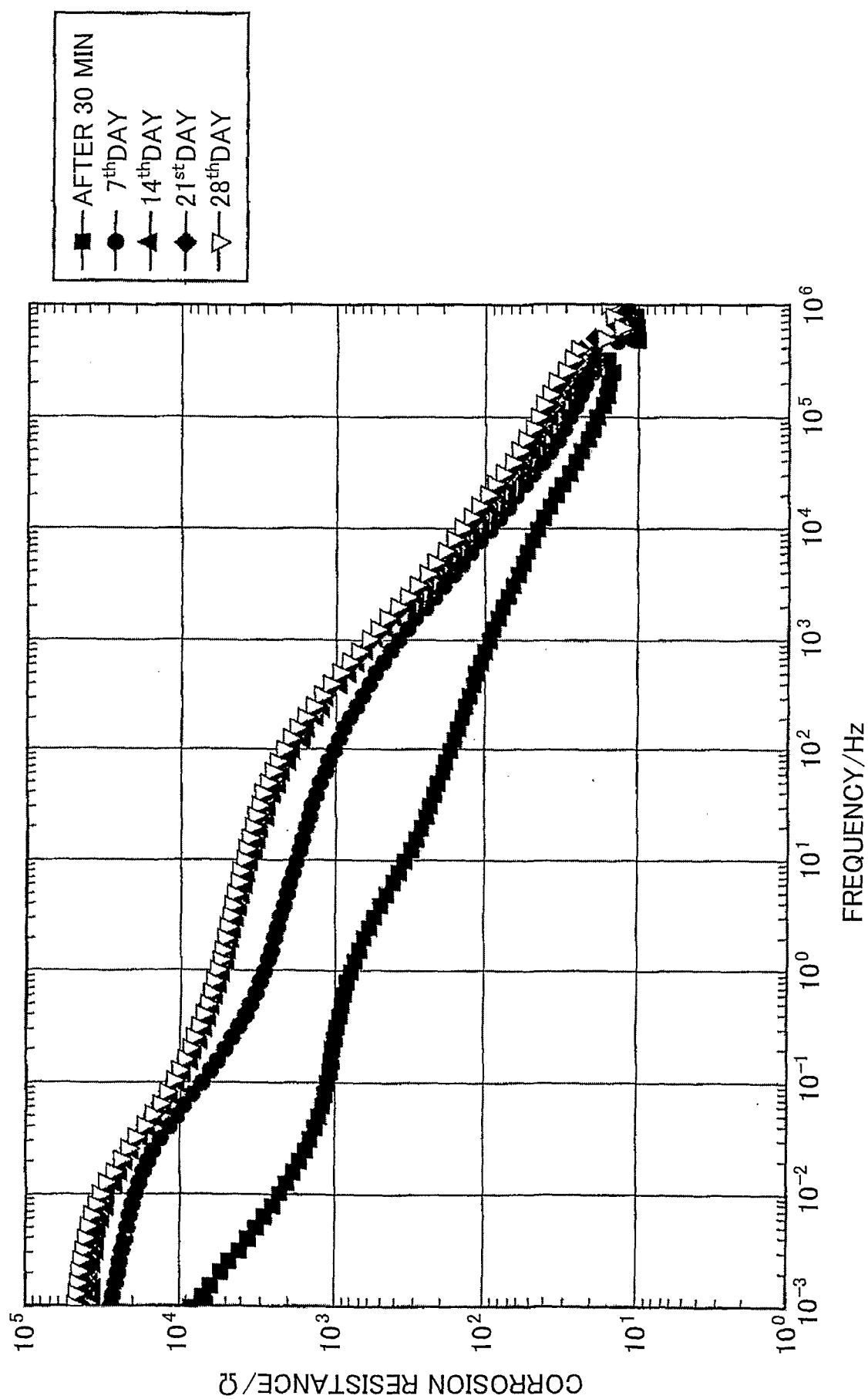


FIG. 2

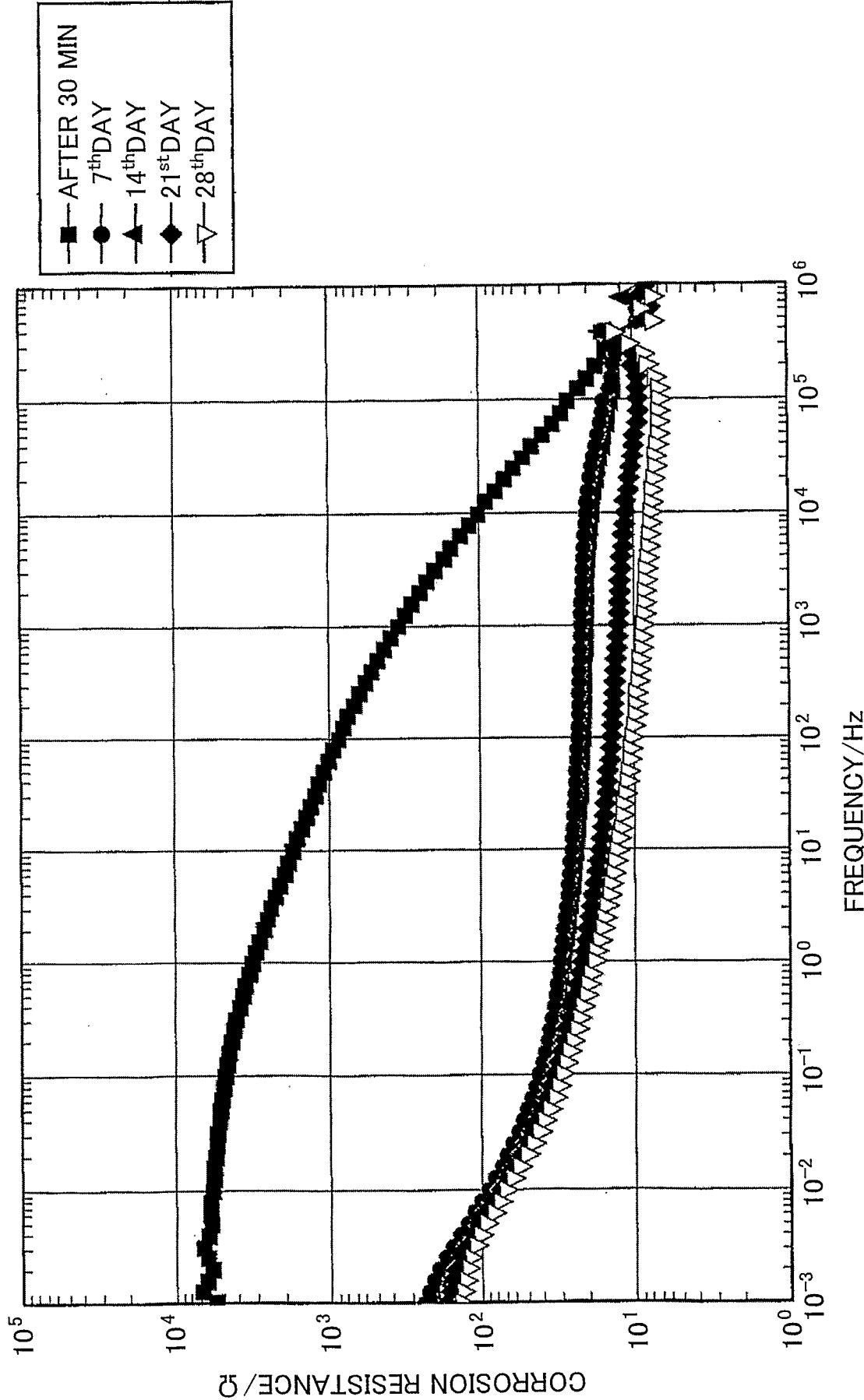


FIG. 3A

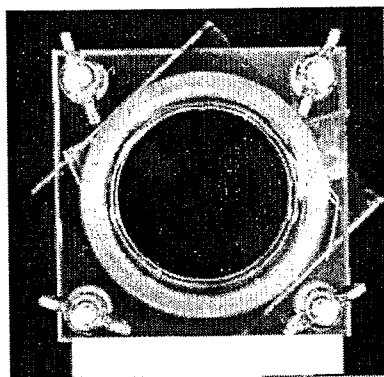


FIG. 3B

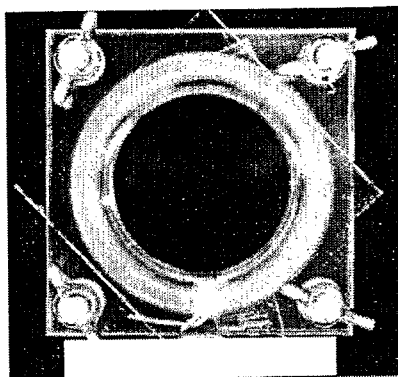


FIG. 3C

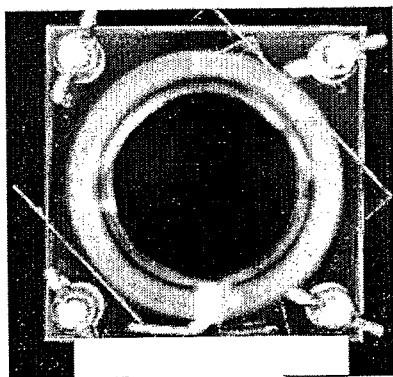
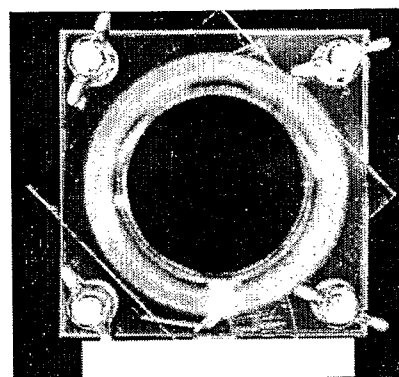


FIG. 3D

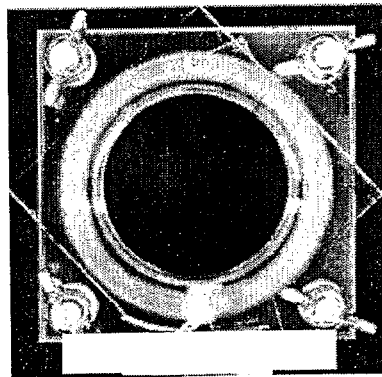


FIG. 3E

FIG. 4A FIG. 4B FIG. 4C

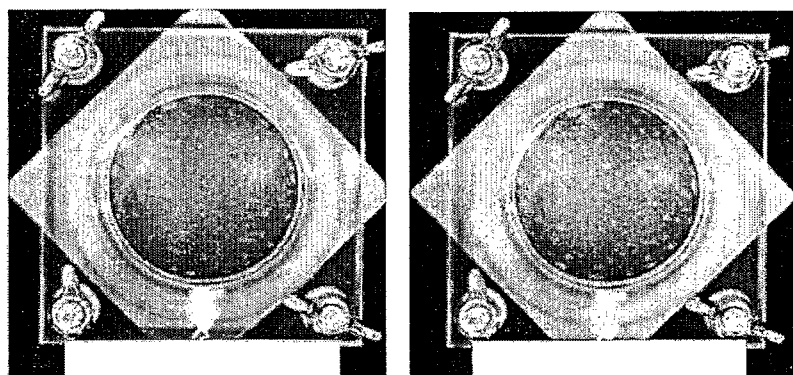
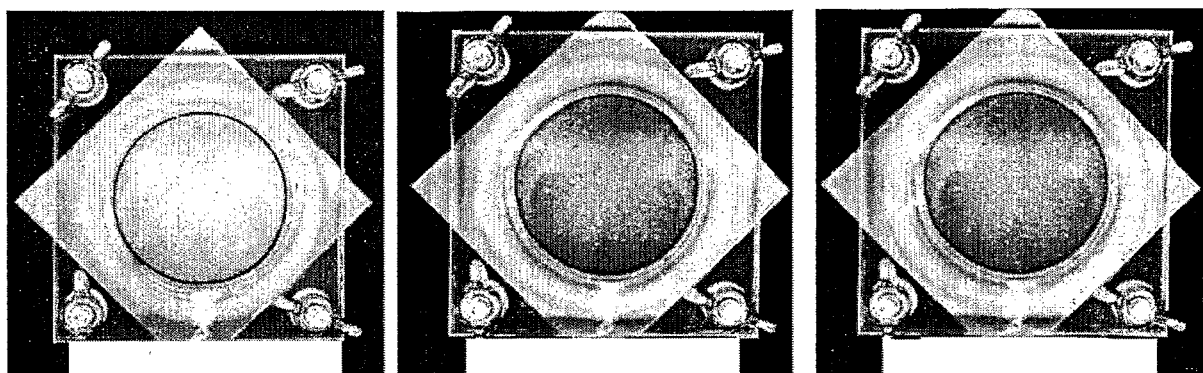


FIG. 4D FIG. 4E

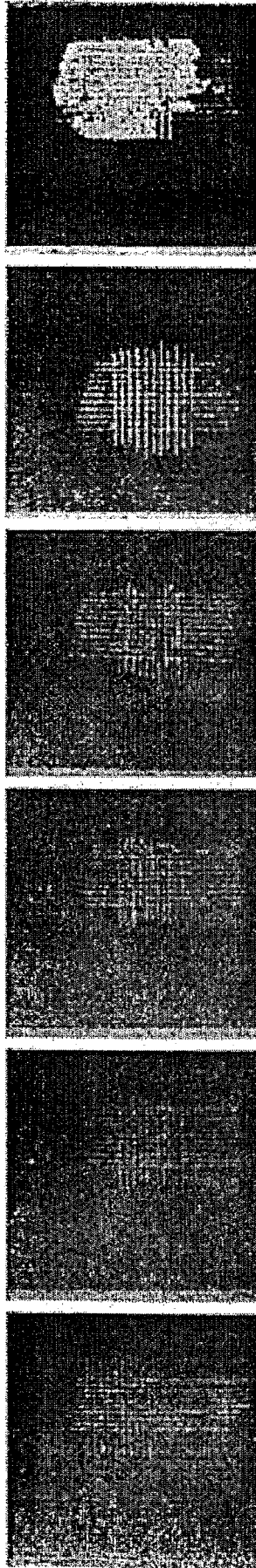


FIG. 5A FIG. 5B FIG. 5C FIG. 5D FIG. 5E FIG. 5F

FIG. 6

