



(19) **United States**

(12) **Patent Application Publication**
WU et al.

(10) **Pub. No.: US 2020/0224325 A1**

(43) **Pub. Date: Jul. 16, 2020**

(54) **SURFACE TREATMENT METHOD**

C25D 5/48 (2006.01)

C25D 5/56 (2006.01)

(71) Applicant: **Purity (Xiamen) Sanitary Ware Co., Ltd.**, Xiamen City (CN)

(52) **U.S. Cl.**

CPC *C25D 5/14* (2013.01); *C25D 5/40*

(2013.01); *C23C 28/023* (2013.01); *C25D 5/56*

(2013.01); *C25D 5/48* (2013.01)

(72) Inventors: **James WU**, Taichung City (TW); **Alex WU**, Taichung City (TW); **Ce-Wen YANG**, Xiamen City (CN)

(57)

ABSTRACT

(73) Assignee: **Purity (Xiamen) Sanitary Ware Co., Ltd.**, Xiamen City (CN)

A surface treatment method is disclosed. The surface treatment method forms a matte nickel plating layer on a substrate, followed by the brushed finishing and degreasing processes. The degreasing processes includes ultrasonic degreasing and electrolytic degreasing. Next, an acid activation is performed before the formation of a non-leveling nickel plating layer. Finally, a chromium plating layer and a PVD chromium film are sequentially formed. The present invention provides a high quality metal appearance and enhanced corrosion resistance with reduced cost.

(21) Appl. No.: **16/244,814**

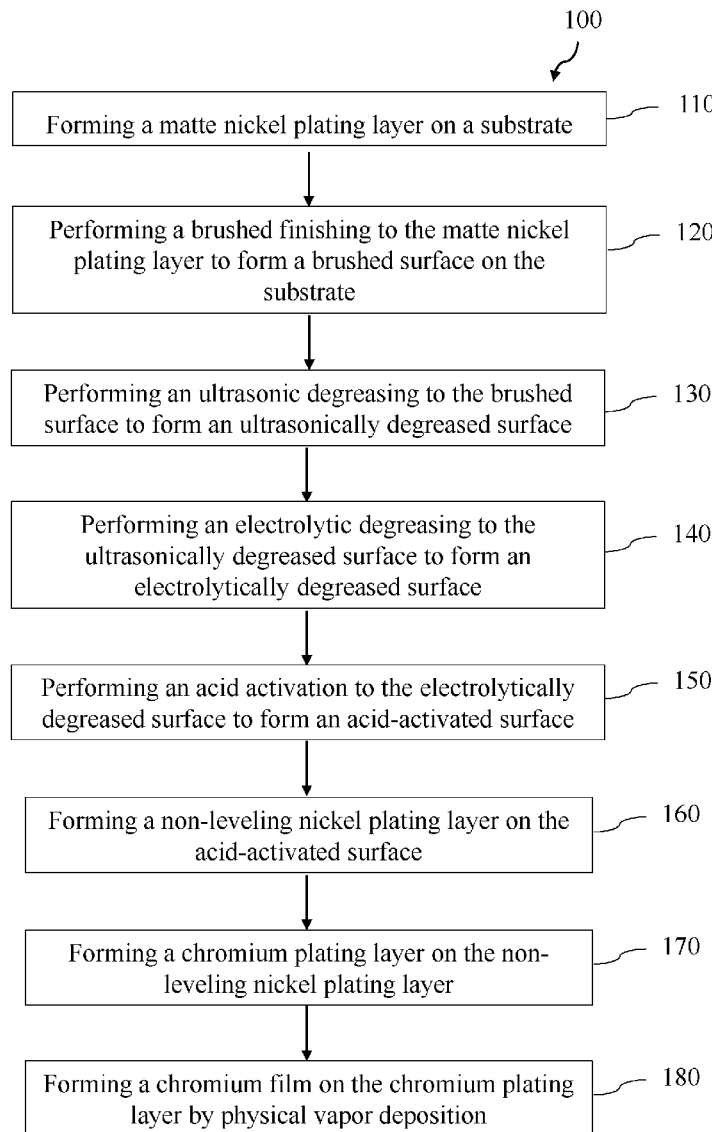
(22) Filed: **Jan. 10, 2019**

Publication Classification

(51) **Int. Cl.**

C25D 5/14 (2006.01)

C25D 5/40 (2006.01)



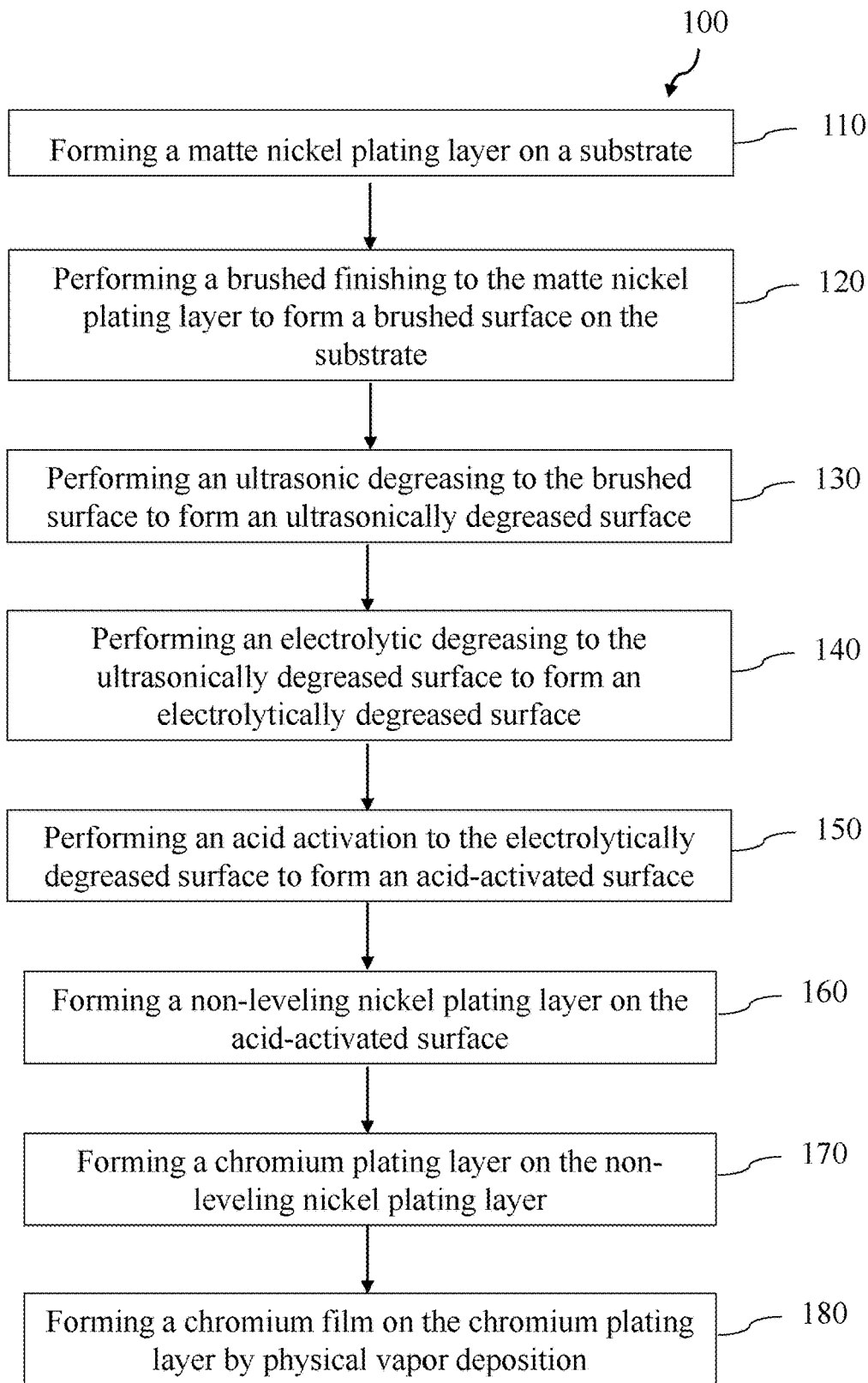


FIG. 1

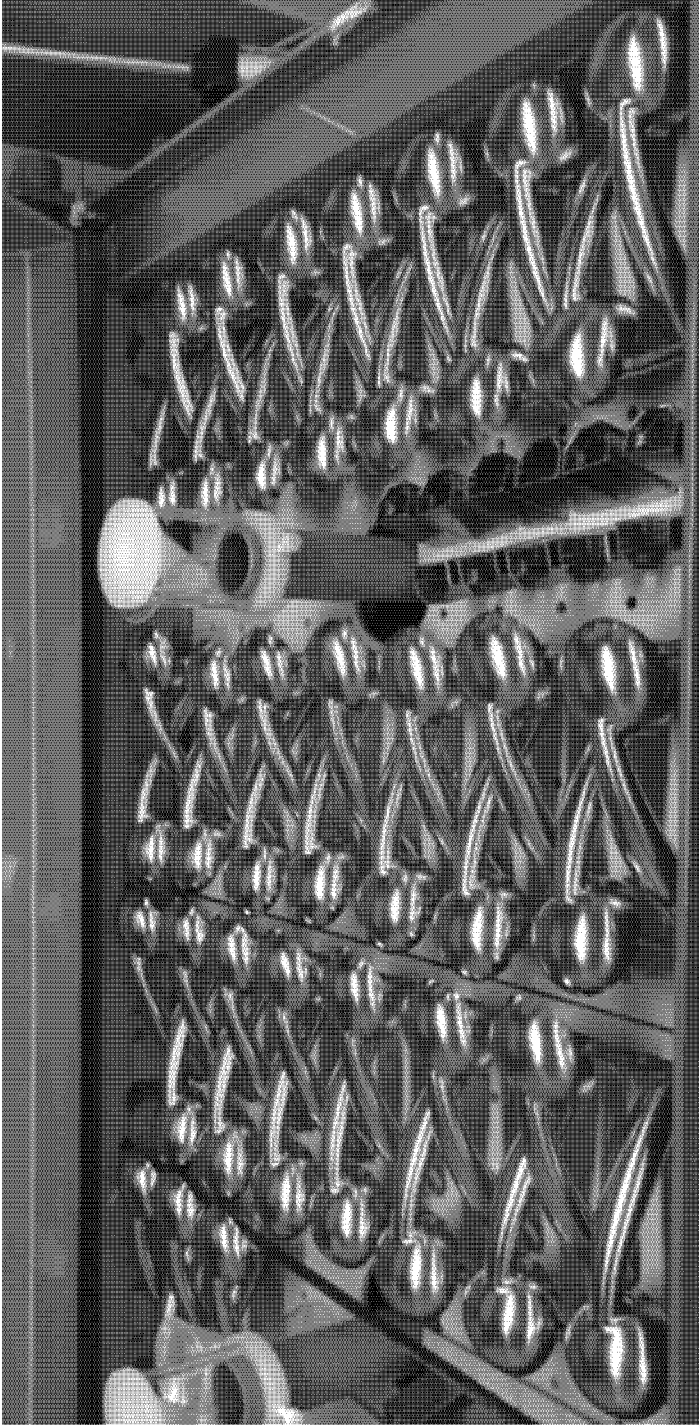


FIG. 2

SURFACE TREATMENT METHOD

BACKGROUND OF THE INVENTION

Technical Field

[0001] The present invention is related to a surface finishing method, and, more particularly, to a surface treatment method that can provide a corrosion-resistant surface with high quality metal appearance.

Description of Related Art

[0002] Chromium plating is a process that has been utilized for many years to provide a decorative chromium finish on a metal surface of a metal or plastic base material. Chromium plating may be applied to a variety of products, such as the bathroom fittings, consumer electronics, automobiles, etc., where the appearance of metal finishes is a significant concern. While chromium plating of metal surfaces has been utilized for many years, it is expensive and has corrosion issues.

[0003] Over time, alternatives to these metal chromium plating processes have been developed. Some of these developments were made in response to concerns over the use and disposal of hexavalent chromium and heavy metals typically used in the plating process. Additionally, regulations surrounding the use of hexavalent chromium have become more restrictive, causing efforts aimed at developing alternative technologies to correspondingly increase. A number of commercial chemistries using trivalent chromium have been offered as replacements for hexavalent chromium in the plating process to address these concerns. Processes using these chemistries, however, provide decreased corrosion protection and are significantly more expensive.

[0004] It would therefore be desirable for economic and environmental reasons to develop an alternative technique or process capable of providing corrosion resistance that can be utilized in industries where the surfaces would be subjected to environmental and mechanical stresses with cost savings.

BRIEF SUMMARY OF THE INVENTION

[0005] In view of the above, the purpose of the present invention is to provide a surface treatment method which can provide a corrosion-resistant surface with high quality metal appearance and reduce cost.

[0006] The present invention provides a surface treatment method including the following steps: forming a matte nickel plating layer on a substrate; performing a brushed finishing to the matte nickel plating layer to form a brushed surface on the substrate; performing an ultrasonic degreasing to the brushed surface to form an ultrasonically degreased surface; performing an electrolytic degreasing to the ultrasonically degreased surface to form an electrolytically degreased surface; performing an acid activation to the electrolytically degreased surface to form an acid-activated surface; forming a non-leveling nickel plating layer on the acid-activated surface; forming a chromium plating layer on the non-leveling nickel plating layer; and forming a chromium film on the chromium plating layer by physical vapor deposition.

[0007] The advantage of the present invention is that the surface treatment method can provide high quality metal appearance comparable with that provided by trivalent chromium process, excellent corrosion resistance, and significant

cost savings. In particular, the issues of brushed copper, such as burring, can be completely eliminated.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0008] The present invention will be best understood by referring to the following detailed description of some illustrative embodiments in conjunction with the accompanying drawings, in which

[0009] FIG. 1 is a flow chart of a surface treatment method according to an embodiment of the present invention; and

[0010] FIG. 2 is a picture showing the arrangement of the test items.

DETAILED DESCRIPTION OF THE INVENTION

[0011] In accordance with the present invention, a surface treatment method is provided. The surface treatment method is advantageous for substrates that are made of plastics or metals. The present invention can be utilized in connection with a variety of applications in a multitude of different industries, such as bathroom fittings (e.g. showers), consumer electronics (e.g. mobile phone), automobiles, etc. Consumer electronics housing components that may be advantageously provided with a highly decorative surface in accordance with this invention include housing components for cellular telephones. The surface treatment method of the present invention provides a decorative metal finish on a metal surface of a plastic or metal article, which yields a high quality finish, is less expensive, and is environmentally friendly.

[0012] A surface treatment method 100 according to an embodiment of the present invention is shown in FIG.1. In step 110, a matte nickel plating layer is formed on a substrate. The substrate is made of acrylonitrile butadiene styrene (ABS) resin. While the embodiment utilizes a plastic substrate, it will be understood that any conductive or non-conductive material may be utilized. For example, in addition to the ABS resin substrate, other non-conductive substrates such as rubber, ceramic, and wood as well as metal substrates such as copper, nickel, chromium, titanium, or zirconium may alternatively be utilized in accordance with the present invention. Before the plating of the matte nickel, the substrate may undergo several cleaning processes, such as ultrasonic wax removal, water washing, ultrasonic oil removal, spray washing, etc., and then roughened to provide sufficient mechanical interlock between the substrate and the overlying layer.

[0013] The matte nickel plating layer may be deposited on the entire surface of the substrate by using the electroless nickel plating, which involves dipping the substrate in a bath of plating solution, where a reducing agent, like hydrated sodium hypophosphite ($\text{NaPO}_2\text{H}_2\cdot\text{H}_2\text{O}$), reacts with the nickel ions to deposit the nickel layer. The plating solution typically has eight components: nickel, a reducing agent, a complexing agent, stabilizers, buffers, brighteners, surfactants, and accelerators. Nickel sulfate is a typical nickel source, and sodium hypophosphite is a typical reducing agent. The complexing agent is necessary to increase phosphate solubility and to prevent the white-out phenomena by slowing the reaction. Carboxylic acids or amines are typical complexing agents. Stabilizers, like lead, sulfur, or organic compounds, slow the reduction by co-deposition with the

nickel. Most complexing agents act as buffers. Brighteners are mostly co-deposited with nickel, and usually are stabilizers, like cadmium or certain organic compounds. Surfactants lower the surface tension to reduce pitting and staining. Accelerators such as sulfur compounds are added to overcome the slow plating rate caused by complexing agents and usually are co-deposited, often discoloring the deposit. Preferably, the thickness of the matte nickel plating layer may be greater than 10 μm . Indeed, the thickness of the matte nickel plating layer is preferably in the range of 10 μm to 100 μm .

[0014] Thereafter, in step **120**, the matte nickel plating layer is brushed to form a brushed surface on the substrate such that the substrate has a textured appearance. The brushed finishing may be carried out using any conventional brushing process, e.g. using a brushing wheel to produce striations on the matte nickel plating layer. Conventionally, the brushing process is carried out on the copper layer, which often causes burring issue and deteriorated functionality. In the present disclosure, the brushing process is performed on the matte nickel plating layer, which has at least 20% higher yield than the conventional brushed copper. In addition, the issues of brushed copper, such as burring or deteriorated functionality, can be completely eliminated in the present invention.

[0015] Next, in step **130**, the brushed surface of the substrate is ultrasonically degreased to remove oils from the brushed surface. The ultrasonic degreasing may be carried out in a hot immersing oil removal tank equipped with an ultrasonic generator and a heater and containing an oil removal powder (such as sodium hydroxide) of a concentration of 30-80 g/L at a temperature of 40-60° C. for 3-15 minutes. Preferably, the temperature is between 45° C. and 55° C. Ultrasonic high frequency energy breaks off oil structure and adhesion thereof to the surface of the substrate, and simultaneously the alkaline degreaser may undergo saponification with the oil to obtain an ultrasonically degreased surface.

[0016] Subsequently, the ultrasonically degreased surface undergoes electrolytic degreasing to remove workpiece surface grease in step **140** before electroplating. The electrolytic degreasing may be carried out in an electrolytic tank equipped with a heater and comprise the following steps: injecting an electrolyte into the electrolytic tank, hanging a workpiece on a fixture, dipping the workpiece into the electrolyte, and electrifying the electrodes at a temperature of 40-60° C. for 0.5-5 minutes. Preferably, the temperature is between 45° C. and 55° C. The electrolyte may contain an electrolytic degreasing powder, such as sodium hydroxide, of a concentration of 30-80 g/L. By the technical scheme of the electrolytic degreasing, the electrolyte can more thoroughly degrease the workpiece, is ideal in degreasing effect, and ensures the quality of the subsequent plating.

[0017] Next, in step **150**, the substrate is immersed in an acid solution in an activation tank for 0.1-2 minutes. The acid solution is comprised of activated acid salt and water. The activated acid salt mainly contains sodium hydrogen sulfate. Afterwards, the acid-activated surface of the substrate may be washed using water, followed by the formation of a non-leveling nickel plating layer in step **160**. The plating process of the non-leveling nickel (Watts) is well known in the art, and, for example, it may use the Watts nickel bath composed of nickel sulfate, nickel chloride, and boric acid as the electrolyte solution. Once the substrate has been prepared, it is immersed into the electrolyte solution and is

used as the cathode. The nickel anode is dissolved into the electrolyte solution to form nickel ions. The ions travel through the solution and deposit on the cathode. In the present embodiment, the non-leveling nickel plating process is carried out at a voltage of 3.5-5 V and a temperature of 45-55° C. for 10 minutes to obtain the non-leveling nickel plating layer of about 2-5 μm .

[0018] Afterwards, in step **170**, a bright chromium layer is plated on the non-leveling nickel plating layer to enhance the salt spray corrosion resistance. The plating process of the bright chromium layer may use an anode made of lead-tin alloy containing 6-8% of tin and an electrolyte composed of a chromic anhydride with a concentration of 270-290 g/L and a sulfuric acid with a concentration of 0.9-1.2 g/L. Preferably, the chromium plating is carried out at a temperature of 38-42° C. for 4-8 minutes. The thickness of the bright chromium layer is preferably in the range of 300 nm to 600 nm.

[0019] Next, in step **180**, the substrate is load into a vacuum chamber of magnetron sputtering equipment to vapor deposit a chromium film by physical vapor deposition (PVD) on the chromium plating layer. For example, a chromium sputtering target of 99% purity can be utilized. Preferably, the chromium is applied to form a uniform layer that is about 100-200 nm thick and that comprises at least about 99% chromium by weight. The chromium film is utilized to provide the overall coating with hardness so that the coating is significantly resistant to corrosion.

Corrosion Resistance Test

[0020] To further illustrate the efficacy of the present invention, 45 test items of hand shower were prepared according to the surface treatment method of the present invention for corrosion resistance test following ASTM B368 test standard. The corrosion resistance test is conducted through the salt spray test method, which uses the CASS test solution of Table 1 and the process parameters of Table 2. The test items of hand shower were arranged as shown in FIG. 2.

TABLE 1

CASS test solution	
Distilled water 95% (L)	19.0
NaCl 5% (g)	1000
CuCl ₂ •2H ₂ O (g)	5.7538
Acetic acid (ml)	21
Specific gravity	1.036
PH	3.08

TABLE 2

Process parameters	
Air pressure (MPa)	0.10
Temp. of saturation tower (° C.)	62.5
Temp. of chamber (° C.)	49.0
Collected solution volume (ml/hr/80 cm ²)	1.5
Collected solution gravity	1.031
Collected solution PH	3.24

[0021] After the test duration of 40 hours, no visible defect was observed on the surface of all the test items, which

means all the test items passed the corrosion resistance test following ASTM B368 test standard using CASS test solution.

[0022] It must be pointed out that the embodiments described above are only some embodiments of the present invention. All equivalent steps which employ the concepts disclosed in this specification and the appended claims should fall within the scope of the present invention.

What is claimed is:

1. A surface treatment method comprising:
forming a matte nickel plating layer on a substrate;
performing a brushed finishing to the matte nickel plating layer to form a brushed surface on the substrate;
performing an ultrasonic degreasing to the brushed surface to form an ultrasonically degreased surface;
performing an electrolytic degreasing to the ultrasonically degreased surface to form an electrolytically degreased surface;
performing an acid activation to the electrolytically degreased surface to form an acid-activated surface;
forming a non-leveling nickel plating layer on the acid-activated surface;
forming a chromium plating layer on the non-leveling nickel plating layer; and
forming a chromium film on the chromium plating layer by physical vapor deposition.
2. The surface treatment method as claimed in claim 1, wherein the substrate is made of a plastic or a metal.
3. The surface treatment method according to claim 2, wherein the plastic is acrylonitrile butadiene styrene (ABS) resin.

4. The surface treatment method according to claim 2, wherein the metal is copper, nickel, chromium, titanium, or zirconium.

5. The surface treatment method according to claim 1, wherein the ultrasonic degreasing uses an oil removal powder.

6. The surface treatment method according to claim 5, wherein the oil removal powder contains sodium hydroxide.

7. The surface treatment method according to claim 1, wherein the ultrasonic degreasing is performed at a temperature of 45-55° C.

8. The surface treatment method according to claim 1, wherein the electrolytic degreasing uses an electrolytic degreasing powder.

9. The surface treatment method according to claim 8, wherein the electrolytic degreasing powder contains sodium hydroxide.

10. The surface treatment method according to claim 1, wherein the electrolytic degreasing is performed at a temperature of 45-55° C.

11. The surface treatment method according to claim 1, wherein the acid activation is performed by immersing the substrate in an acid solution.

12. The surface treatment method according to claim 11, wherein the acid solution is comprised of activated acid salt and water.

13. The surface treatment method according to claim 1, wherein the non-leveling nickel plating layer is formed by using the Watts nickel bath.

* * * * *