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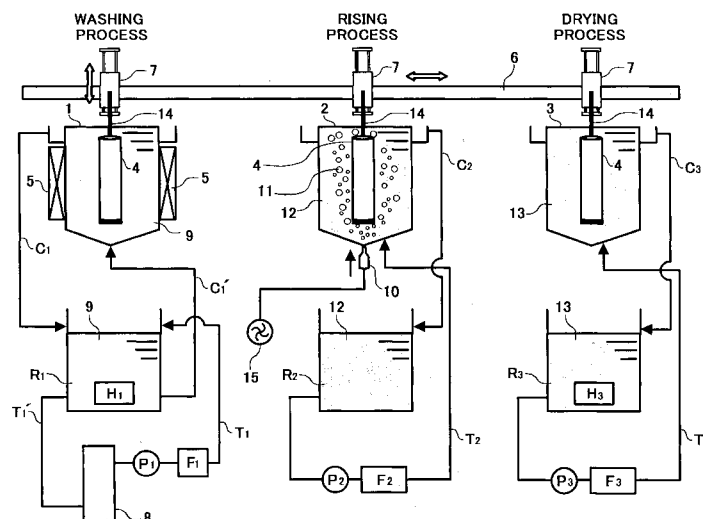
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(54) **Method and apparatus for washing substrate of electrophotographic photoreceptor**

(57) A method for washing a substrate including: de-greasing the substrate with a washing liquid; then rinsing the substrate with rinsing liquid; and then drying the substrate, wherein the washing liquid is alkaline ionized water having a temperature of from 20 °C to 90 °C. An apparatus for washing a substrate (4) for an electrophotographic photoreceptor including: a washing container (1) configured to contain alkaline ionized water (9) to

wash the substrate (4); a heater (H₁) configured to heat the alkaline ionized water (9) to a temperature of from 20 °C to 90 °C; a rinsing container (2) configured to contain rinsing liquid (12) to rinse the washed substrate (4); a warming container (3) configured to contain pure water (13) to warm the rinsed substrate (4); a holder (14) configured to support the substrate; and a lifter (7) configured to up and down the substrate (4) and oscillate the substrate (4).



Description**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] The present invention relates to a method and an apparatus for washing a substrate. Particularly, the present invention relates to a method and apparatus for washing a substrate of an electrophotographic photoreceptor before forming a photosensitive layer thereon.

Discussion of the Background

[0002] As the method for manufacturing a cylindrical substrate for an electrophotographic photoreceptor, a method in which a substrate is prepared by ironing, cold drawing or the like, and a method in which a substrate which is obtained by ironing, cold drawing or the like is turned, are typically used.

[0003] However, a high viscosity oil used during the plastic forming process of the substrate, which is obtained by the above-mentioned ironing or cold drawing method adheres on the substrate. In addition, a turning oil used during the turning process adheres on the substrate.

[0004] An electrophotographic photoreceptor is manufactured by coating a coating liquid including a photosensitive material on an outer circumference of an electroconductive substrate, resulting in formation of a photosensitive layer on the outer circumference of the substrate. When the photosensitive layer is formed by dipping a substrate, on which oils, foreign materials or the like are adhered, in a coating liquid, the coating liquid is polluted with the oils, foreign materials or the like adhered on the substrate, resulting in deterioration of the coating liquid, and thereby a photosensitive layer having a desired characteristic cannot be formed. In addition, coating defects such as uneven coating are formed due to the oils and foreign materials. Therefore, the substrate is necessary to be washed before the coating liquid including a photosensitive material is coated on the outer circumference thereof.

[0005] Recently, halogenated hydrocarbon solvents which have been used for washing a substrate are hardly used in order to prevent occurrence of environmental problems such as ozone depletion, warming of the earth, air pollution, and problems concerning human bodies.

[0006] Published unexamined Japanese Patent Application Nos. 6-118663 discloses a method for washing a substrate with water including a surfactant using ultrasound. However, a large quantity of surfactant has to be added to the washing liquid to obtain good washing effect and in addition a long period of time is necessary to remove the surfactant from the substrate.

[0007] Published unexamined Japanese Patent Application Nos. 9-6031 discloses a method for washing a substrate using a brush. However, the brush often damages the surface of the substrate.

[0008] Published unexamined Japanese Patent Application Nos. 2000-225381 discloses a method for washing a substrate using an alkaline solution. However, when the alkaline solution is prepared, there is a problem in handling because a strong alkali has to be used when preparing the alkali solution. In addition, it is not easy to remove such a strong alkali from the substrate.

SUMMARY OF THE INVENTION

[0009] Accordingly, an object of the present invention is to provide a method and an apparatus for washing a substrate of an electrophotographic photoreceptor, wherein oils adhered on a surface of a substrate is removed without damaging the substrate.

[0010] Another object of the present invention is to provide a washing liquid without a dangerous operation such as handling a strong alkali material.

[0011] To achieve such objects, the present invention contemplates the provision of a method for washing a substrate of an electrophotographic photoreceptor including degreasing the substrate with a washing liquid; then rinsing the substrate with pure water; and then drying the substrate, wherein the washing liquid is alkaline ionized water having a temperature of from 20 °C to 90 °C.

[0012] It is preferable that an external force is applied to the substrate in order to improve the washing effect of the alkaline ionized water.

[0013] In addition, it is preferable that the external force is applied using supersonic and/or a brush.

[0014] Further, it is preferable that the substrate is oscillated while the substrate is dipped in the alkaline ionized water.

[0015] Furthermore, it is preferable that a bubble having a diameter of from 5 mm to 100 mm is insufflated onto the substrate in the rinsing process.

[0016] It is preferable that the quantity of air used for generating bubbles is from 10 L/minute to 80 L/minute.

[0017] It is preferable that in the drying process, the substrate is dipped into pure water heated at a temperature of from 60 °C to 95 °C to be heated and then taken out of the pure water to dry water adhered to the surface of the substrate._

[0018] It is preferable that the pure water has a resistivity not less than 1MΩ · cm.

[0019] It is preferable that the drawing speed of the substrate in the drying process is from 3 to 20mm/second.

[0020] As another aspect of the present invention, an apparatus for washing a substrate for an electrophotographic photoreceptor including:

- a washing container configured to contain a washing liquid to wash the substrate;
- a heater configured to heat the washing liquid to a temperature of from 20 °C to 90 °C;
- a rinsing container configured to contain water or pure water to rinse the washed substrate;
- a warming container configured to contain warm pure water to warm the rinsed substrate;
- a holder configured to support the substrate; and
- a lifter configured to up and down the substrate and oscillate the substrate.

[0021] These and other objects, features and advantages of the present invention will become apparent upon consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

[0022] Figure is a schematic diagram illustrating an example of the washing apparatus of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Various lubricants used in the manufacturing processes of a substrate for an electrophotographic photoreceptor are strongly adhered onto the substrate to an extent such that the lubricating property of the lubricants does not deteriorate even when the lubricants are brought into contact with a cutter or a die, i.e. , such that the oil slick formed on the substrate is not easily removed.

[0024] In the present invention, it becomes possible to remove the lubricants adhered strongly on the substrate without damaging the substrate by using alkaline ionized water while properly adjusting the temperature of the alkaline ionized water and applying an external force to the substrate.

[0025] The method of the present invention including degreasing the substrate with a washing liquid; then rinsing the substrate with pure water; and then drying the substrate, wherein the washing liquid is alkaline ionized water having a temperature of from 20 °C to 90 °C.

[0026] The lubricants adhered strongly on the substrate can be removed by using this method.

[0027] The washing method of the present invention includes the following processes.

(A) Washing process

[0028] As illustrated in Figure, a substrate 4 is transferred from a previous process by a slider 6, and dipped into a washing container 1 containing alkaline ionized water 9 by a lifter 7 to degrease the substrate 4. When the substrate 4 is degreased, the substrate 4 is drawn up by the lifter 7. Numeral 14 denotes a substrate holder. Numeral 5 denotes ultrasonic oscillators serving as an external force applier and configured to apply an ultrasound to the washing liquid 9.

[0029] The alkaline ionized water 9, which is circulated between the washing container 1 and a reservoir container R₁ through passages C₁ and C₁', is preferably heated by a heater H₁ so as to effectively act on oils and the like materials adhered on the substrate 4. The oils removed from the substrate and mixed with the alkaline ionized water 9 are separated from the alkaline ionized water by a separator 8.

[0030] In addition, the alkaline ionized water 9 is circulated between the reservoir container R₁ and the separator 8 through passages T₁ and T₁'. A pump P₁ and a filter F₁ are provided at a position of the passages T₁.

(B) Rinsing process

[0031] The substrate 4 is transferred from the washing process to the rinsing process by the slider 6, and dipped into a rinsing container 2 containing pure water 12 by the lifter 7. Pure water 12 in a reservoir container R₂ is poured into the rinsing container 2 containing pure water 12 to remove the alkaline ionized water adhered on the substrate 4. Numeral 11 denotes bubbles which are generated for effectively rinsing the substrate 4 . Numeral 10 denotes nozzles configured to blow airs to form the bubbles 11. Numeral 15 denotes an air blower configured to blow air to generate

the bubbles 11.

[0032] In addition, the pure water 12 is circulated between the rinsing container 2 and the reservoir container R_2 through passages T_2 and C_2 . A pump P_2 and a filter F_2 are provided at a position of the passages T_2 .

5 (C) Drying process

[0033] The substrate 4 is transferred from the rinsing process to the drying process by the slider 6, and dipped into the warming container 3 containing warm pure water 13 by the lifter 7 to heat the substrate 4. The heated substrate is drawn up from the warm pure water 13 and water adhered thereon is naturally dried because the substrate 4 is heated.

10 **[0034]** In addition, the warm pure water 13 is circulated between the warming container 3 and the reservoir container R_3 through passages T_3 and C_3 . A pump P_3 and a filter F_3 are provided at a position of the passages T_3 . Character H_3 denotes a heater configured to heat the pure water 13.

[0035] Hereinafter, each process will be explained in detail.

15 (A) Washing process

[0036] The temperature of the alkaline ionized water for use in the present invention is preferably from 20 °C to 90 °C, more preferably from 30 °C to 80 °C, and even more preferably from 40 °C to 60 °C.

20 **[0037]** Alkaline ionized water having too low temperature produces a low effect, to the contrary, alkaline ionized water having too high temperature does not function as the alkaline ionized water. It is possible to cleanly remove the oils adhered on a substrate for an electrophotographic photoreceptor when the temperature of the alkaline ionized water is properly controlled.

[0038] Alkaline ionized water is known as reduced water or super alkaline ionized water.

25 **[0039]** Alkaline ionized water is explained in detail in page 95 "MIZU NO HYAKKAJITEN (encyclopedia of water)" published by Maruzen Co., Ltd. under the editorship of Takahashi, et al.

[0040] Specifically, alkaline ionized water is prepared as follows. An electrolyte is dissolved at a low concentration in water contained in a container in which an anode chamber and a cathode chamber are formed by a diaphragm. When the water is electrolyzed, the water showing alkalinity contained in the cathode chamber is the alkaline ionized water.

30 **[0041]** Specific examples of the electrolyte include salts of alkali metals such as sodium chloride, calcium chloride and salt of organic acid such as sodium lactate, calcium lactate, etc.

[0042] The alkaline ionized water has a pH greater than 7. The pH thereof depends on the quantity of the electrolyte added and the quantity of electricity applied during the electrolysis.

35 **[0043]** Alkaline ionized water having a pH of from 8 to 11 is preferably used in the present invention. As such alkaline ionized water, water in the cathode chamber maybe used when the pH thereof falls in a range of from 8 to 11 during the electrolysis. Alternatively, it is possible to use alkaline ionized water prepared by a method in which the electrolysis is continued until the pH reaches a pH not less than 13, and then the resultant alkaline ionized water is diluted with neutral water so as to have a pH of from 8 to 11.

40 **[0044]** Alkaline ionized water can effectively remove organic foreign materials such as oils adhered on the surface of a substrate. In addition, inorganic foreign materials such as aluminum powders, sand powders, etc. adhered on the surface of the substrate can also be removed.

[0045] Alkaline ionized water having a pH less than 8 has poor washing ability. In addition, a large sized facility is necessary when alkaline ionized water having a pH greater than 13 is used.

45 **[0046]** As mentioned above, alkaline ionized water has an effect of removing oils, foreign materials and the like adhered on a surface of a cylindrical substrate. In a case of light adhesion of an organic material, the organic material can be removed by dipping a cylindrical substrate into alkaline ionized water. However, good washing effect can be obtained by applying a physical force to the substrate, for example, by performing contact washing.

50 **[0047]** Specific examples of the method utilizing a physical force are a method in which a temperature of alkaline ionized water is increased, a method in which ultrasound is used when the substrate is dipped in alkaline ionized water, a method in which a gas is injected in alkaline ionized water for bubbling and a method in which a brush, a sponge and the like material are used for wiping the substrate.

[0048] In addition, the washing ability can be improved by oscillating the substrate in the vertical direction while an external force is applied thereto utilizing ultrasonic oscillators, bubbling, brushes, sponges or the like.

[0049] Hereinafter, the conditions of ultrasound utilized in the washing process will be concretely explained.

55 **[0050]** When an ultrasound having a low frequency not greater than 40 kHz is used, a problem which occurs is that fine turning burrs which are generated when a substrate is turned, and fine defects which are generated in the longitudinal direction thereof by aluminum foreign materials adhered on the substrate when the cylindrical substrate is subjected to plastic forming tend to be raised. Therefore, the substrate is preferably washed with a high frequency

ultrasound oscillator having a frequency of from 100 kHz to 150 kHz, so that the surface of the substrate is not damaged.

[0051] When the material of the substrate is aluminum, various aluminum compositions can be used. For example, aluminum alloys of A1000 group, aluminum alloys of A3000 group and aluminum alloys of A6000 group can apply thereto, and other aluminum alloys can apply without problems.

[0052] When the substrate to be washed is made of an aluminum alloy of A1000 group, the strength of the applied ultrasound is preferably 20 percent lower than in the case when other alloys are ultrasonically washed.

[0053] In addition, the washing method of the present invention can also be applied to washing of a nickel seamless belt prepared by electroforming. In this case, the strength of the ultrasound is preferably decreased.

[0054] The seamless belt materials are preferably washed using a high frequency ultrasonic oscillator oscillating an ultrasound having a frequency of from 100 kHz to 150 kHz.

[0055] Oscillation of the substrate is performed in order to avoid uneven washing of the ultrasonic irradiation, and length of the oscillation in the vertical direction is preferably not less than 50 mm.

[0056] It is preferable that at least two ultrasonic oscillators 5, which are illustrated in Figure, are arranged so as to be located in or in the vicinity of the washing container 1 containing alkaline ionized water while horizontally opposed to each other.

[0057] In addition, it is preferable that two ultrasonic oscillators are arranged such that one of the at least two ultrasonic oscillators is dislocated in the vertical direction.

[0058] Further, it is preferable that the one of the two ultrasonic oscillators is dislocated at an angle of from 3° to 15°.

[0059] Hereinafter, a case in which a brush is used for applying a physical force to the substrate will be explained.

[0060] When the diameter of the pile of the brush contacting to the substrate is greater than 1 mm, defects such as scratches are formed on a surface of the substrate when the brush is strongly contacted thereto.

[0061] In addition, when the length of the pile is less than 3 mm, defects such as scratches are formed on a surface of the substrate when the brush is strongly contacted thereto.

[0062] In contrast, when the length of the pile is too long, the ability of the brush to remove a foreign material is low.

[0063] The density of the pile is preferably not less than 10 pieces/cm².

[0064] Specific examples of the materials for use as the pile include nylon, polypropylene, rayon, polyester, poly-tetrachloroethylene type fluorocarbon resin, mixture thereof, animal hairs and the like.

[0065] The number of rotations of the brush is determined depending on the diameter and the rotating speed of the brush. When the rotating speed is too low, the ability of the brush to remove foreign materials is low.

[0066] The brush and the substrate should rotate in the same direction. By rotating the brush and the substrate in the same direction, the brush and the substrate have different running directions at the contact region thereof, so that a good washing effect can be obtained.

[0067] The rotating speed of the brush and the substrate at the contact region is preferably not less than 5 m/minute.

[0068] In addition, when the brush is contacted with the substrate to wash the substrate, the substrate or the brush is preferably oscillated in the axis direction of the substrate to avoid uneven washing.

[0069] The washing effect can be improved by using a combination of ultrasound with a brush.

[0070] When the materials to be washed are remarkably dirty, it is effective to remove the remarkable stains by a washing method using a known surfactant or the like material before washing with alkaline ionized water. The quantity of the surfactant can be decreased by combining the washing method using a known surfactant and the washing method using alkaline ionized water compared to a case in which a known surfactant or the like is used alone.

(B) Rinsing process

[0071] Next, the rinsing process performed in the rinsing container will be explained referring to Figure. An object of the rinsing process is to remove the alkaline ionized water adhered on the substrate in the washing process performed in the washing container.

[0072] Water or pure water is suitably used as the rinsing liquid in the rinsing process.

[0073] As the rinsing method, ultrasonic rinsing with an ultrasonic oscillator, and bubbling rinsing using bubbles are suitable. Among these methods, the bubbling rinsing is advantageous, when the amount of capital investment is taken into consideration.

[0074] When forming bubbles 11, having a diameter of from 5 mm to 100 mm are preferably used. Bubbles having a size of less than 5 mm and greater than 100 mm are inferior in rinsing ability. The size of the bubbles 11 can be adjusted by changing the quantity of blown air (i.e., the air pressure). When the air pressure is greater than 0.1 Mpa, bubbles are united, resulting in formation of large bubbles having a size not less than 10 mm.

[0075] Therefore the air pressure is preferably not greater than 0.1 Mpa, and more preferably from 0.03 Mpa to 0.07 Mpa, in order to form bubbles having a size of from 3 mm to 5 mm.

[0076] In addition, the quantity of blown air used for generating the bubbles is from 10 L/minute to 80 L/minute, preferably from 20 L/minute to 60 L/minute, and more preferably from 40 L/minute to 50 L/minute.

[0077] When the blown air is less than 10 L/minute, the number of the generated bubbles is small. In contrast, when the blown air is greater than 80 L/minute, the volume of the blown air is so large that the rinsing ability deteriorates.

[0078] It is preferable to provide at least two air-blowing nozzles to generate bubbles for one substrate.

[0079] It is preferable to use a circular or plate-form sintered ceramic or sintered plastic porous material as the nozzles 10.

[0080] Bubbles of uniform size are obtained when a sintered ceramic porous material or a sintered plastic porous material are used.

[0081] The average pore diameter of the porous material is preferably not greater than 100 μm , and more preferably from 30 μm to 60 μm .

[0082] The bubbles generated by the nozzles 10 rise along the surface and the inside of the substrate while removing the remaining washing liquid and foreign materials. The rinsing effect is high when the diameter of the bubbles 11 is not greater than 10 mm. The bubbles 11 preferably have a uniform size of not less than 3 mm and not greater than 5 mm.

[0083] The air for use in generating bubbles preferably has a clean level not lower than class 100, and more preferably not lower than class 10, in order not to mix foreign materials such as dust, oils and the like with pure water 12.

[0084] When the average pore diameter of the nozzles 10 is greater than 100 μm , uniform size bubbles of from 3 mm to 5 mm cannot be formed.

[0085] When a circular sintered ceramic porous material or a circular sintered plastic porous material having a diameter greater than 50 mm is used as the nozzles 10, a large number of bubbles are formed in the center portion of the porous material but a small number of the bubbles are formed in the edge portions of the porous material, and thereby uniform size bubbles cannot be generated from the nozzles 10.

[0086] In order to form bubbles uniformly, the diameter of the circular porous material is preferably not greater than 50 mm, and more preferably from 25 mm to 35 mm. When a plate-form sintered ceramic porous material or a sintered plastic porous material is used, the size is preferably 50 mm square, and more preferably from 25 mm square to 35 mm square.

[0087] It is preferable to arrange plural nozzles to correspond to the possible largest size of the substrate 4. In this case, the bubbles 11 can be contacted with the surface and inside of all kinds of substrates to be washed without changing the nozzles when the kind of the substrates to be washed is changed.

[0088] The lifter 7 and the substrate holder 14 provided on the lifter 7 have an opening in order not to disturb the bubbles 11 coming from the lower portion of the rinsing container 2 to be contacted with a surface and inside of the substrate 4. The substrate 4 is oscillated in the vertical direction by the lifter 7 to agitate pure water around the substrate 4, resulting in improvement of the rinsing effect.

(C) Drying process

[0089] Next, the drying process using warm pure water will be explained referring to Figure.

[0090] In this process, at first the substrate 4 is dipped into warm pure water 13 in the warming container 3 to be heated up to the temperature of the pure water. Then the substrate is drawn up at a certain speed. Since the substrate 4 is heated, the pure water adhered on the circumferential surface of the substrate 4 can be easily evaporated and dried.

[0091] The temperature of the pure water 13 is preferably from 60 °C to 95 °C, more preferably from 70 °C to 80 °C, and even more preferably 75 °C $\pm$ 3 °C, considering a drying speed and a change of a state of a surface of the substrate.

[0092] When the temperature of the pure water 13 is less than 70 °C, a drying spot will be formed on the surface of the substrate 4 even after the pure water adhered to the surface of the substrate 4 is evaporated.

[0093] In addition, when the substrate 4 is dipped into the warm pure water 13 having a resistivity less than 1 M Ω ·cm, a hydroxide layer tends to be formed on the surface of the substrate 4. It is not preferable for the substrate 4 to have such a hydroxide layer because the layer affects the electric property of a photosensitive layer which is to be formed thereon.

[0094] In addition, the drawing speed of the substrate 4 from the warm pure water 13 is preferably from 3 to 20 mm/second.

[0095] When the speed is faster than 20 mm/second, a large quantity of water is adhered on the substrate, and the substrate 4 is hard to dry.

[0096] The washing method of the present invention can also be applied for washing the substrates other than the above-mentioned aluminum-alloy-based substrate. For example, the washing method can also be applied to a washing a nickel seamless belt prepared by electroforming, and nickel sulfamate and the like compounds remaining thereon can be removed.

[0097] In addition, the washing method can be effectively used for washing a synthetic polymer substrate, and releasing agents remaining thereon can be effectively removed.

[0098] Further, the size of an object (substrate) to be washed is not limited as long as the object can fit into the washing, rinsing and warming containers.

[0099] Having generally described this invention, further understanding can be obtained by reference to certain specific examples which are provided herein for the purpose of illustration only and are not intended to be limiting.

EXAMPLES

(Example 1)

[0100] An A3100 aluminum-alloy-based tube having an outer diameter of 100.7 mm, an inner diameter of 97.5 mm and a length of 360 mm was prepared by drawing processing. The tube was turned with a turning machine using a polycrystalline diamond as a turning tool, so that the outer diameter becomes 100 mm. (Hereinafter, this tube is referred to as a substrate)

[0101] In this case, kerosene was used as a turning oil, and the substrate was turned with spraying kerosene to the turning portion. Therefore, a small quantity of kerosene was adhered on the surface of the substrate.

[0102] A contact washing was performed five times with a washing apparatus as illustrated in Figure using alkaline ionized water having a pH of 10.8 as a washing liquid.

<Conditions of washing apparatus>

Washing process

[0103] Temperature of alkaline ionized water: 50 °C

Rinsing process

No bubbles

[0104] Drying process

Temperature of pure water: 70 °C

Resistivity: 1.5 MΩ·cm

Drawing speed: 10 mm/second

[0105] The substrate was washed twice with tap water, rinsed with pure water three times, and then dried after dipped into the warm pure water.

[0106] The following components were dispersed with a ball mill for 12 hours to prepare an undercoat layer coating liquid.

Formation of undercoat layer

[0107]

Preparation of undercoat layer coating liquid	
Alkyd resin (BEKKOZOL 1307-60-EL from Dainippon Ink & Chemicals, Inc.)	10 parts
Methyl ethyl ketone	150 parts
Titanium oxide powder (CR-EL from Ishihara Sangyo Kaisha, Ltd.)	90 parts

[0108] The undercoat layer coating liquid was coated on the washed substrate by a dip coating method, and then dried at 140 ° C for 20 minutes. Thus, an undercoat layer having a thickness of 4.5 μm was formed.

[0109] When the condition of the undercoat layer formed on the substrate was observed with naked eyes, a coating defect or any unevenly coated portion was not found.

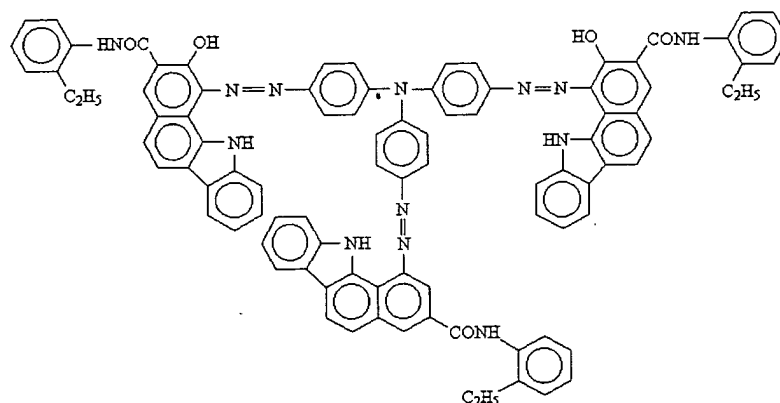
Formation of charge generation layer (photosensitive layer)

Preparation of charge generation layer coating liquid

[0110] Next, the following components were dispersed in a ball mill for 48 hours.

Polyvinyl butyral resin (S-LEC BL-S manufactured by Sekisui Chemical Co., Ltd.)	4 parts
Methyl ethyl ketone	10 parts

[0111] Charge generation material having the following formula:



[0112] Further, 210 parts of methyl ethyl ketone was added thereto and dispersed for 3 hours.

[0113] After the mixture was dispersed in a ball mill, the mixture was transferred to a container. The mixture was diluted with methyl ethyl ketone, so as to have a solid content of 1.5 %. In addition, a polyether-modified silicone oil having a viscosity of 120 cs (hydrophilic silicone oil SH-3746 manufactured by Dow Corning Toray Silicone Co., Ltd.) was added in an amount of 0.02 % based on the total weight of the liquid to prepare a charge generation layer coating liquid.

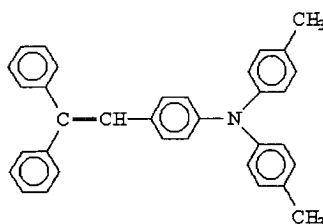
[0114] The charge generation layer coating liquid was coated on the substrate including the undercoat layer by a dip coating method, and then dried at 130 °C for 20 minutes. Thus, a generation layer having a thickness of 0.2 μm was formed.

[0115] When the film condition of the thus prepared charge generation layer was observed with naked eyes, any coating defect or any unevenly coated portion was not found.

Formation of charge transport layer (photosensitive layer) Preparation of charge transport layer coating liquid

[0116] Ten (10) parts of a Z-form polycarbonate resin having 40,000 of viscosity average molecular weight were dissolved in 85 parts of methylene chloride, and 9 parts of a charge transport material having the below-mentioned formula (2) were added thereto to be dissolved therein. Thus, a charge transport layer coating liquid was prepared.

Formula (2)



[0117] The charge transport layer coating liquid was coated on the charge generation layer formed overlying the substrate by a dip coating method, and then dried at 130 °C for 20 minutes. Thus, a charge transport layer having a thickness of 20 μm was formed.

[0118] When the film condition of thus prepared charge transport layer was observed with naked eyes, a coating defect or an unevenly coated portion was not found.

[0119] Thus, an electrophotographic photoreceptor was prepared.

(Image formation and evaluation)

[0120] Flanges were attached at both edges of the thus prepared electrophotographic photoreceptor. Then the photoreceptor was set in an Imagio MF-6550 to print half tone images. The print images were observed to evaluate the image qualities. As a result, any abnormal image was not produced and the print images have good image qualities.

(Example 2)

[0121] The procedure for preparation and evaluation of the photoreceptor in Example 1 was repeated except that a brush on which a pile having a diameter of 0.1 mm, and a length of 20 mm is provided at a density of 30 pieces/cm² was used for rubbing the substrate in the washing process. The resultant print images have good image qualities.

[0122] The washing time was the same as that in Example 1. As a result of the observation of the washing process, this method could remove stains faster than the method in Example 1.

(Example 3)

[0123] The procedure for preparation and evaluation of the photoreceptor in Example 1 was repeated except that an ultrasound of 100 kHz irradiated the substrate in the washing process. The resultant print images have good image qualities.

[0124] The washing time was the same as that in Example 1. As a result of the observation of the washing process, this method could remove stains faster than the method in Example 1.

(Example 4)

[0125] The procedure for preparation and evaluation of the photoreceptor in Example 1 was repeated except that bubbles having a diameter of 120 mm were applied to the substrate by blowing air at a flow rate of 50 L/minute. The resultant print images have good image qualities.

[0126] The washing time was the same as that in Example 1. As a result of the observation of the washing process, this method could remove stains faster than the method in Example 1.

(Example 5)

[0127] The procedure for preparation and evaluation of the photoreceptor in Example 1 was repeated except that bubbles having a diameter of 50 mm were applied to the substrate by blowing air at a flow rate of 50 L/minute. The resultant print images have good image qualities.

[0128] The washing time was the same as that in Example 4. As a result of the observation of the washing process, this method could remove stains faster than the method in Example 4.

(Comparative Example)

[0129] The procedure for preparation of the A3100 aluminum-alloy-based tube in Example 1 was repeated.

[0130] Next, the procedure for washing the substrate in Example 1 was repeated except that a washing liquid in which a surfactant "SUNWASH FM-950" manufactured by Lion Corp. was diluted with water so that the mixture has a pH of 10.8 was used in the washing process.

[0131] Next, the procedure for preparation of the undercoat layer in Example 1 was repeated. Thus, an undercoat layer having a thickness of 4.5 μm was formed on the above-prepared substrate.

[0132] The undercoat layer formed on the substrate was observed with naked eyes, several circular coating defects in which the coating liquid were repelled were found.

[0133] Next, the procedure for preparation of the charge generation layer in Example 1 was repeated. Thus, a charge generation layer having a thickness of 0.2 μm was formed.

[0134] The thus prepared charge generation layer was observed with naked eyes, several coating defects in which the amount of the charge generation layer coating liquid adhered on the circular coating defects on the undercoat layer was small (i.e., the coating defects of the undercoat layer repelled the charge generation layer coating liquid).

[0135] Next, the procedure for preparation of the charge transport layer in Example 1 was repeated. Thus, a charge transport layer having a thickness of 20 μm was formed.

[0136] The thus prepared charge transport layer was observed with naked eyes, coating defects in which the coating liquid was repelled were found.

[0137] Thus a comparative electrophotographic photoreceptor was prepared.

[0138] Finally, flanges were attached at both edges of the thus prepared electrophotographic photoreceptor. Then the photoreceptor was set in an Imagio MF-6550 to print half tone images. The print images were observed to evaluate the image qualities. As a result, undesired images were formed, which correspond to the coating defects of the photoreceptor.

[0139] It is found that alkaline ionized water itself can remove oils adhered on a substrate, and, oils and the like materials can be effectively removed by using additionally an ultrasound and a brush to apply an external force to the

substrate.

[0140] This document claims priority and contains subject matter related to Japanese Patent Applications No. 2003-031951 filed on February 10, 2003, No. 2002-262378, filed on September 9, 2002 and No. 2002-136130, filed on May 10, 2002, incorporated herein by reference.

Claims

1. A method for washing a substrate comprising:

degreasing the substrate with a washing liquid;
then rinsing the substrate with rinsing liquid; and
then a drying the substrate,

wherein the washing liquid is alkaline ionized water having a temperature of from 20 °C to 90 °C.

2. The method according to Claim 1, wherein the degreasing is performed while applying an external force to the substrate.

3. The method according to Claim 2, wherein the external force is applied to the substrate using at least one of supersonic and a brush.

4. The method according to any one of Claims 1 to 3, wherein the degreasing is performed while the substrate is oscillated vertically in the washing liquid.

5. The method according to any one of Claims 1 to 4, wherein the rinsing further comprises:

blowing air into the rinsing liquid to insufflate bubbles of from 5 mm to 100 mm onto the substrate.

6. The method according to Claim 5, wherein the air is blown into the rinsing liquid at a rate of from 10 L/minute to 80 L/minute.

7. The method according to any one of Claims 1 to 6, wherein the drying comprises:

dipping the substrate into pure water having a temperature of from 60 °C to 95 °C to heat the substrate; and
then drawing up the substrate to dry a liquid adhered on a surface of the substrate.

8. The method according to Claim 7, wherein the pure water has a resistivity not less than 1MΩ · cm.

9. The method according to Claim 7 or 8, wherein the drawing is performed at a speed of from 3 to 20 mm/second.

10. An apparatus for washing a substrate (4) comprising:

a washing container (1) configured to contain alkaline ionized water (9) to wash the substrate (4);
a first heater (H₁) configured to heat the alkaline ionized water (9) to a temperature of from 20 °C to 90 °C;
a rinsing container (2) configured to contain rinsing liquid (12) to rinse the washed substrate (4);
a warming container (3) configured to contain pure water (13) to warm the rinsed substrate (4);
a holder (14) configured to support the substrate (4); and
a lifter (7) configured up and down the substrate (4) and to oscillate the substrate (4).

11. The apparatus according to Claim 10, further comprising:

an external force applier (5) configured to apply an external force to the substrate (4).

12. The apparatus according to Claim 11, wherein the external force applier (5) applies an external force using ultrasound or a brush.

13. The apparatus according to any one of Claims 10 to 12, wherein the lifter (7) oscillates the substrate (4) in the

washing liquid (9).

14. The apparatus according to any one of Claims 10 to 13, further comprising:

5 an air blower (15) configured to blow air through nozzles (10) to generate the bubbles (11) in the rinsing liquid (12) in the rinsing container (2).

15. The apparatus according to Claim 14, wherein the air blower blows air at a rate of from 10 L/minute to 80 L/minute.

10 16. The apparatus according to Claim 10 to 15, further comprising:

a second heater (H_3) configured to heat the pure water (13) to a temperature of from 60 °C to 95 °C.

15 17. The apparatus according to any one of Claims 10 to 16, wherein the pure water (13) has a resistivity not less than $1M\Omega \cdot cm$.

18. The apparatus according to any one of Claims 10 to 17, wherein the lifter (7) draws up the substrate (4) from the pure water (13) at a speed of from 3 to 20 mm/second.

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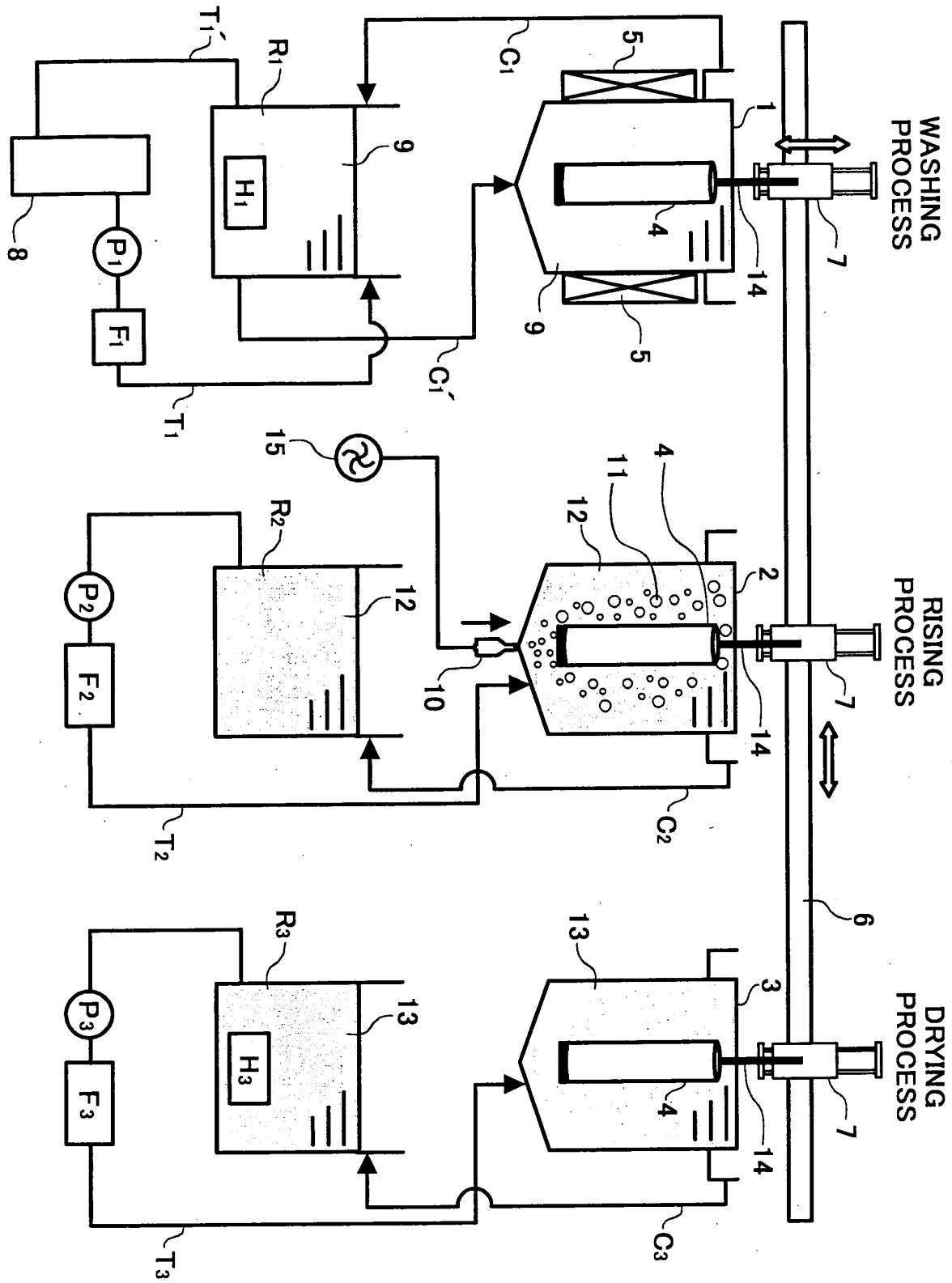
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Application Number
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