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(54) IMAGE FORMING METHOD

(57) An image forming method is provided which includes: forming a toner image on a transfer medium with an image forming toner using an electrophotographic image forming apparatus; forming an undercoat layer on the toner image with an undercoat layer forming toner; heating and pressing an image receiving substrate and the undercoat layer together to transfer and fix the image on the transfer medium to the image receiving substrate, at a transfer and fixation temperature P_T [°C] satisfying the following relational equation (1); and separating the image transferred and fixed to the image receiving substrate from the transfer medium.

$$UT_{fb} < P_T < UT_{1/2} \quad (1)$$

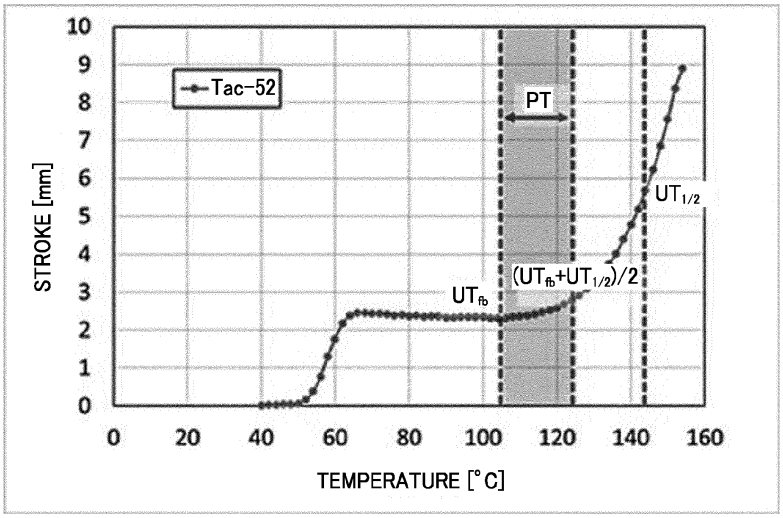

FIG. 1

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Description

BACKGROUND

Technical Field

[0001] The present disclosure relates to an image forming method.

Related Art

[0002] In an electrophotographic method for forming a visible image by developing an electrostatic latent image with a developer, an electrostatic latent image is formed on an electrostatic latent image bearer (also referred to as "photoconductor") containing a photoconductive substance, then the electrostatic latent image is developed with a developer containing a toner to form a toner image, and the toner image is transferred to a transfer material such as paper and then fixed to the transfer material by heating and pressurization to form a fixed image.

[0003] To form a full-color image by the electrophotographic method, a toner set containing cyan, magenta, yellow, and black toners referred to as process colors in combination is generally used.

[0004] In recent years, as electrophotographic color image forming apparatuses have become widespread, the uses of the printed products formed by the apparatus have also been diversified. Especially in the field of custom-designed general consumer goods, there is a growing need for electrophotographic printing on materials that cannot be printed (or fixed) with conventional electrophotographic toners intended for printing on paper media. Specifically, there is a growing need for printing on fabric media such as sports team uniforms, shoes, and bags.

[0005] Japanese Patent No. 5847277 describes an image forming method in which a first developer image is formed on a transfer medium using a color developer, then a second developer image is formed on the first developer image using a white developer, which is thermally transferred to a fabric.

[0006] For printing an image on a fabric medium, it is preferable that adhesiveness is firm so that the image can be fixed to fabric fibers with many irregularities and is not peeled off by washing, and when printing an image on a fabric with various colors, especially a deep-colored fabric, the color of the deep-colored fabric is opacified to prevent impairment of image colors. For an ideal state where these problems are cleared up, an image forming method should be very carefully selected. A practical and simple method for forming images on fabric, which clears up these problems has not yet been proposed, and no practical method has been provided.

SUMMARY

[0007] An object of the present disclosure is to solve the aforementioned problems .

[0008] That means, an object of the present disclosure is to provide an image forming method allowing formation of images that can be fixed to fabric media to which images have not fixed by conventional image forming methods, the images exhibiting adequate washing resistance and having adequate chroma even on a deep-colored fabric medium.

[0009] The present disclosure provides an image forming method that includes:

forming a toner image on a transfer medium with an image forming toner using an electrophotographic image forming apparatus;
forming an undercoat layer on the toner image with an undercoat layer forming toner;
heating and pressing an image receiving substrate and the undercoat layer together to transfer and fix the toner image on the transfer medium to the image receiving substrate, at a transfer and fixation temperature P_T [°C] satisfying the following relational equation (1); and
separating the toner image transferred and fixed to the image receiving substrate from the transfer medium.

$$UT_{fb} < P_T < UT_{1/2} \qquad (1)$$

where in Equation (1), UT_{fb} [°C] represents an outflow starting temperature of the undercoat layer forming toner, and $UT_{1/2}$ [°C] represents a 1/2 outflow temperature of the undercoat layer forming toner.

[0010] The present disclosure provides images that can be fixed to fabric media to which images have not fixed by conventional image forming methods, the images exhibiting adequate washing resistance and having adequate chroma

even on a deep-colored fabric.

BRIEF DESCRIPTION OF THE DRAWING

[0011] A more complete appreciation of the disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawing, wherein:
the drawing is a diagram illustrating a stroke displacement in a flow tester measurement.

[0012] The accompanying drawing is intended to depict embodiments of the present invention and should not be interpreted to limit the scope thereof. The accompanying drawing is not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

[0013] In describing embodiments illustrated in the drawing, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

[0014] Referring now to the drawing, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

(Image Forming Method)

[0015] The image forming method according to the present disclosure refers to a method for transferring and fixing an image on a transfer medium to an image receiving substrate, including a series of the following processes 1 to 4:

process 1: forming a toner image on the transfer medium with an image forming toner using an electrophotographic image forming apparatus;
process 2: forming an undercoat layer on the toner image with an undercoat layer forming toner;
process 3: heating and pressing the image receiving substrate and the undercoat layer together to transfer and fix the toner image on the transfer medium to the image receiving substrate; and
process 4: separating the toner image transferred and fixed to the image receiving substrate from the transfer medium.

(Electrophotographic Image Forming Apparatus)

[0016] The electrophotographic image forming apparatus may be any apparatus that can print process color toners and undercoat layer toners on a transfer medium. As such an image forming apparatus, for example, a printer may be used that has improved such that an undercoat layer toner and an image forming toner can be set to stations for any color in RICOH Pro C7200S manufactured by RICOH COMPANY,LTD., or the like.

(Image Receiving Substrate)

[0017] As the image receiving substrate in the present disclosure, all of artificial and natural fibers such as cotton, polyester, and silk can be used.

(Transfer Medium)

[0018] As the transfer medium, for example, transfer paper or release paper with surface treatment, having appropriate fixability and mold-releasing property adaptable to the aforementioned image forming process can be used, such as WOW LIGHT 8.0, WOWi SHEET 7A, and WOWm SHEET 7 manufactured by Piotec Co.,Ltd., and CLAPp-MULT manufactured by EUROPORT.Co.Ltd.

(Heating and Pressing Means)

[0019] Heating and pressing means may be any means that can provide a temperature and a pressure suitable for fixing the toner to the image receiving substrate, and, for example, Model HTP234PS1, Model 728, and Model 201

manufactured by Piotec Co.,Ltd., and HERCULES PH-4634, HERCULES WIDE PH-5040, GAIA PGA-5040, and ZEUS PZ-130110D manufactured by EUROPORT.Co.Ltd., and the like can be used. Also, an iron may be used as the heating and pressing means.

(Trassfer and Fixation Temperature)

[0020] From the viewpoint of allowing the undercoat layer forming toner to stay on the surface without excessive permeation into the inside of the image receiving substrate and to exhibit good opacifying property and adhesiveness, the transfer and fixation temperature is preferably a temperature P_T [°C] that satisfies the following relational equation (1).

$$UT_{fb} < P_T < UT_{1/2} \quad (1)$$

where in Equation (1), UTfb [°C] represents an outflow starting temperature of the undercoat layer forming toner, and $UT_{1/2}$ [°C] represents a 1/2 outflow temperature of the undercoat layer forming toner.

[0021] Furthermore preferably, the transfer and fixation temperature P_T [°C] satisfies the following relational equation (2).

$$UT_{fb} < P_T < \frac{UT_{fb} + UT_{1/2}}{2} \quad (2)$$

[0022] Preferably, a 1/2 outflow temperature $CT_{1/2}$ [°C] of the image forming toner and the 1/2 outflow temperature $UT_{1/2}$ [°C] of the undercoat layer forming toner satisfy the following relational equation (3).

$$CT_{1/2} < UT_{1/2} \quad (3)$$

(Method for Measuring Outflow Starting Temperature and 1/2 Outflow Temperature)

[0023] The outflow starting temperature and the 1/2 outflow temperature are measured as follows: using a flow tester (CFT-500D, manufactured by SHIMADZU CORPORATION), a load of 1.96 MPa is applied to 1.0 g of sample by a plunger while heating at a temperature rising rate of 6°C/min, and extruded from a nozzle having a diameter of 1.0 mm and a length of 1.0 mm to obtain a plot of a plunger descending quantity of the flow tester with respect to the temperature as illustrated in FIG. 1. In the curve of the plunger descending quantity vs. the temperature illustrated in FIG. 1, a temperature of an inflection point at which a stable state with a plunger descending quantity of zero is turned into a rising state is defined as an outflow starting temperature (UT_{fb}), and a temperature at which half of the sample outflows is defined as a 1/2 outflow temperature ($UT_{1/2}$).

(Fixation Pressure and Nip Time)

[0024] A heating and pressing time for the transfer and fixation is not particularly limited, but preferably the pressure is adjusted to a range of from 100 to 800g/cm^2, and the time is adjusted to a range of from 5 to 60 seconds depending on a thermal conductivity, a thickness, and a surface roughness of the image receiving substrate.

(Image Forming Toner)

[0025] As the image forming toner, a process color toner for use in electrophotographic image forming apparatuses can be used.

(Undercoat Layer Forming Toner)

[0026] As the undercoat layer forming toner, a toner including constituent materials equivalent to the process color toner can be used. Although the toner may have any color, preferably a transparent toner with no pigment or a white

toner with white pigment as a pigment is used. In particular, use of the white toner is most desirable from the viewpoint of opacifying a color of an image receiving substrate with deep color such as black and dark blue, and preventing impairment of a color of a process color.

[0027] From the viewpoint of achieving preferable bonding between the undercoat layer forming toner and the process color toner and preventing mix between the undercoat layer forming toner and the process color toner, it is preferable that the 1/2 outflow temperature of the undercoat layer forming toner is higher than the 1/2 outflow temperature of the process color toner.

[0028] Next, materials constituting the toner will be mentioned.

<Binder Resin>

[0029] In the present disclosure, for a binder resin (fixation resin) used as the toner material, a conventionally known resin can be used. Examples of the binder resin include, but are not limited to, styrene-based resins (e.g., homopolymers and copolymers including styrene or a styrene-substituted body) such as styrene, poly-α-methylstyrene, styrene-chlorostyrene copolymer, styrene-propylene copolymer, styrene-butadiene copolymer, styrene-vinyl chloride copolymer, styrene-vinyl acetate copolymer, styrene-maleic acid copolymer, styrene-acrylate copolymer, styrene-methacrylate copolymer, styrene-methyl α-chloroacrylate copolymer, and styrene-acrylonitrile-acrylate copolymer, as well as epoxy resins, vinyl chloride resins, rosin-modified maleic acid resins, phenol resins, polyethylene resins, polypropylene resins, petroleum resins, polyurethane resins, ketone resins, ethylene-ethyl acrylate copolymers, xylene resins, and polyvinyl butyrate resins. The production method for these resins is also not particularly limited, and any of bulk polymerization, solution polymerization, emulsion polymerization, and suspension polymerization can be employed.

[0030] In the present disclosure, the binder resin (resin for fixation) preferably includes a polyester resin. Particularly preferably, the binder resin includes a polyester resin as a main component. Generally, polyester resins are fixable at lower temperatures while maintaining heat-resistant storage stability, compared with other resins. Therefore, polyester resins are suitable for the binder resin of the present disclosure.

[0031] The polyester resin used in the present disclosure is obtained by polycondensation of an alcohol with a carboxylic acid.

[0032] Examples of the alcohol for use include, but are not limited to: glycols such as ethylene glycol, diethylene glycol, triethylene glycol, and propylene glycol; etherified bisphenols such as 1,4-bis(hydroxymethyl)cyclohexane and bisphenol A; and divalent alcohol monomers and trivalent or higher polyvalent alcohol monomers.

[0033] Examples of the carboxylic acid include, but are not limited to: divalent organic acid monomers such as maleic acid, fumaric acid, phthalic acid, isophthalic acid, terephthalic acid, succinic acid, and malonic acid; and trivalent or higher polyvalent carboxylic acid monomers such as 1,2,4-benzenetricarboxylic acid, 1,2,5-benzenetricarboxylic acid, 1,2,4-cyclohexanetricarboxylic acid, 1,2,4-naphthalenetricarboxylic acid, 1,2,5-hexanetricarboxylic acid, 1,3-dicarboxyl-2-methylenecarboxypropane, and 1,2,7,8-octanetetracarboxylic acid.

(Wax)

[0034] The toner according to the present disclosure may include a wax. The type of the wax is not particularly limited and can be suitably selected to suit to a particular application. One type of wax may be used alone, or two or more types of waxes may be used in combination. Examples of a usable release agent include, but are not limited to: aliphatic hydrocarbons such as liquid paraffin, micro-crystalline wax, natural paraffin, synthetic paraffin, and polyolefin wax, and partial oxides, fluorides, and chlorides of these aliphatic hydrocarbons; animal oils such as beef tallow and fish oil; vegetable oils such as coconut oil, soybean oil, rapeseed oil, rice bran wax, and carnauba wax; higher aliphatic alcohols and higher fatty acids such as montan wax; fatty acid amides and fatty acid bisamides; metal soaps such as zinc stearate, calcium stearate, magnesium stearate, aluminum stearate, zinc oleate, zinc palmitate, magnesium palmitate, zinc myristate, zinc laurate, and zinc behenate; fatty acid esters; and polyvinylidene fluoride.

(Colorant)

[0035] The toner according to the present disclosure may contain a colorant. The colorant is not particularly limited, and commonly used colorants can be appropriately selected and used.

[0036] Preferred examples of colorants for black toner include, but are not limited to, carbon black alone, and a mixture of carbon black as a main component with copper phthalocyanine or the like, with adjusted hue and lightness.

[0037] Preferred examples of colorants for cyan toner include, but are not limited to, copper phthalocyanine that is Pigment Blue 15:3, and a mixture of copper phthalocyanine with aluminum phthalocyanine.

[0038] Examples of colorants for magenta toner include, but are not limited to, Pigment Red 53:1, Pigment Red 81, Pigment Red 122, Pigment Red 269, and combinations of these colorants.

[0039] Examples of colorants for yellow toner include, but are not limited to, Pigment Yellow 74, Pigment Yellow 155, Pigment Yellow 180, Pigment Yellow 185, and combinations of these colorants. Preferred is Pigment Yellow 185 alone or a mixture of Pigment Yellow 185 with Pigment Yellow 74 for chroma and storability.

[0040] Examples of the white pigments include, but are not limited to, titanium dioxide which is surface-treated with silicon, zirconia, aluminum, or polyol.

[0041] Examples of colorants for green toner include, but are not limited to, Pigment Green 7, which should be used paying attention to safety.

[0042] Examples of colorants for blue toner include, but are not limited to, Pigment Blue 15:1 and Pigment Violet 23.

<Charge Controlling Agent>

[0043] The electrophotographic developing toner according to the present disclosure may contain a charge controlling agent.

[0044] Examples of the charge controlling agent include, but are not limited to: nigrosine and modified products with fatty acid metal salts; onium salts such as phosphonium salt and lake pigments of these salts; triphenylmethane dyes and lake pigments of these dyes, metal salts of higher fatty acids; diorganotin oxides such as dibutyltin oxide, dioctyltin oxide, and dicyclohexyltin oxide; diorganotin borates such as dibutyltin borate, dioctyltin borate, and dicyclohexyltin borate; as well as organometallic complexes, chelate compounds, monoazo metal complexes, acetylacetone metal complexes, metal complexes based on aromatic hydroxycarboxylic acids or aromatic dicarboxylic acid, and quaternary ammonium salts. Examples of the charge controlling agent further include, but are not limited to, aromatic hydroxycarboxylic acids, aromatic mono- and poly- carboxylic acids and metal salts of aromatic mono- and poly- carboxylic acids, anhydrides, esters, and phenol derivatives such as bisphenol. Each of these charge controlling agents can be used alone or in combination with others.

(Inorganic Particles as External Additives)

[0045] Examples of inorganic particles as external additives used in the present disclosure include, but are not limited to, silica, alumina, titanium oxide, barium titanate, magnesium titanate, calcium titanate, strontium titanate, zinc oxide, silica sand, clay, mica, wollastonite, diatomaceous earth, chromium oxide, cerium oxide, red iron oxide, antimony trioxide, magnesium oxide, zirconium oxide, barium sulfate, barium carbonate, calcium carbonate, silicon carbide, and silicon nitride. Particularly, silica, alumina, and titanium oxide are preferred.

[0046] The inorganic particles may be particles with surface treated with a hydrophobizing agent. Preferred examples of the hydrophobizing agent include, but are not limited to, silane coupling agents, silylation agents, silane coupling agents having a fluorinated alkyl group, organic titanate coupling agents, and aluminum coupling agents, as surface treating agents. Also, silicone oils are adequately effective as the hydrophobizing agent.

[0047] Next, the developer will be mentioned.

<Two-Component Developer>

[0048] The electrophotographic developing toner according to the present disclosure can be used in both electrophotographic image forming methods: a one-component developing system using a toner as a developer; and a two-component developing system using a mixture of the toner with a carrier as a two-component developer.

[0049] When a two-component developing system is employed, fine particles of a magnetic material can be used as a magnetic carrier. Examples of the magnetic materials include, but are not limited to: magnetite; spinel ferrites containing gamma iron oxide; spinel ferrites containing at least one metal (e.g., Mn, Ni, Zn, Mg, and Cu) other than iron; magnetoplumbite-type ferrites such as barium ferrite; and particulate iron or alloy having an oxidized layer on its surface.

[0050] The magnetic material may be in any of granular, spherical, or needle-like shape.

[0051] Particularly when high magnetization is performed, ferromagnetic fine particles made of iron or the like are preferably used.

[0052] For chemical stability, magnetite, spinel ferrites containing gamma iron oxide, or magnetoplumbite-type ferrites such as barium ferrite are preferably used.

[0053] A resin carrier may also be used which has a desirable magnetization by containing an appropriate type of ferromagnetic fine particles in an appropriate amount.

[0054] In relation to magnetic characteristics, such a carrier preferably has a magnetization strength of 30 to 150 emu/g at 1,000 oersted.

[0055] Such a resin carrier may be produced by spraying a melt-kneaded product of magnetic fine particles with an insulating binder resin by a spray dryer, or dispersing magnetic fine particles in a condensation-type binder resin by reacting/curing a monomer or prepolymer in an aqueous medium in the presence of magnetic fine particles.

[0056] Chargeability of the magnetic carrier may be controlled by fixedly adhering positively- or negatively-chargeable fine particles or conductive fine particles to the surface of the magnetic carrier, or coating the magnetic carrier with a resin.

[0057] Examples of the surface coating material (resin) include, but are not limited to, silicone resin, acrylic resin, epoxy resin, and fluorine-based resin. These resins may contain positively- or negatively-chargeable fine particles or conductive fine particles for coating. Among these resins, silicone resin and acrylic resin are preferred.

<Method for Producing Toner>

[0058] To make toner in the present disclosure, first, the binder resin, the colorant, the release agent, and optionally charge controlling agent are combined and thoroughly mixed in a mixer such as HENSCHEL MIXER and SUPER MIXER.

[0059] The mixture is then melt-kneaded by a heat melt kneader such as a heat roll, a kneader, and an extruder, so that the materials are thoroughly mixed. The kneaded mixture is cooled to solidify, then pulverized into fine particles, and the fine particles are classified by size to obtain a toner.

[0060] The pulverizing process may be of a jet mill process in which a high-speed airflow incorporates toner particles to let the toner particles collide with a collision plate and be pulverized by the collision energy, an inter-particle collision process which lets toner particles collide with each other in an airflow, or a mechanical pulverizing process in which toner particles are supplied to a narrow gap formed with a rotor rotating at a high speed to be pulverized.

[0061] The toner according to an embodiment of the present invention may also be prepared by a dissolution suspension method. In this method, an oil phase is dispersed in an aqueous medium. Here, the oil phase comprises toner materials and an organic solvent dissolved or dispersed in the pol phase. After a reaction for forming a resin is conducted, removal of the solvent, filtration, washing, and drying are conducted, thus obtaining toner base particles.

EXAMPLES

[0062] 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. "Parts" represents "parts by mass", and "percent" represents "percent by mass" unless otherwise specified in the following description.

(Preparation of Toner)

[Production of White Toner 1]

[0063] Components described below were used as toner raw materials.

- polyester resin RN-290 (manufactured by Kao Corporation): 94.7 parts
- carnauba wax WA-05 (manufactured by CERARICA NODA Co., Ltd.): 5.3 parts
- zirconium salicylate CCA TN-105 (manufactured by HODOGAYA CHEMICAL CO.,LTD.): 0.5 part
- titanium dioxide white pigment PF-739 (manufactured by ISHIHARA SANGYO KAISHA, LTD.): 60.0 parts

[0064] The toner raw materials listed above were preliminarily mixed using a HENSCHEL MIXER (FM20B manufactured by NIPPON COKE & ENGINEERING CO., LTD.) and melt-kneaded using a single-shaft kneader (BUSS CO-KNEADER manufactured by Buss AG) at a temperature of from 100 to 130°C. The kneaded product was cooled to room temperature and coarsely pulverized using a ROTOPLEX to have a diameter of from 200 to 300 μm. The resulted particles were further finely pulverized using a counter jet mill (100AFG manufactured by Hosokawa Micron Corporation) to have a predetermined number average particle diameter distribution while appropriately adjusting the pulverization air pressure. The resulted particles were classified by size using an air classifier (EJ-LABO manufactured by MATSUBO Corporation) to have a predetermined number average particle diameter distribution while appropriately adjusting an opening of a louver. Thus, toner base particles were prepared. Subsequently, 100 parts of toner base particles were stirred and mixed with 3.0 parts of an external additive (hydrophobized silica HDK-2000, manufactured by Clariant AG) using Henschel mixer to prepare [White toner 1].

[Production of White Toner 2]

[0065] [White toner 2] was prepared in the same way as for [White toner 1] except that the following toner raw materials were used.

- polyester resin RN-290 (manufactured by Kao Corporation): 94.7 parts

- carnauba wax WA-05 (manufactured by CERARICA NODA Co., Ltd.): 5.3 parts
- zirconium salicylate CCA TN-105 (manufactured by HODOGAYA CHEMICAL CO.,LTD.): 1.0 part
- titanium dioxide white pigment PF-739 (manufactured by ISHIHARA SANGYO KAISHA, LTD.): 60.0 parts

[Production of Color Toner 1]

[0066] [Color toner 1] was produced in the same way as for [White toner 1] except that the following toner raw materials were used.

- polyester resin RN-290 (manufactured by Kao Corporation): 94.7 parts
- carnauba wax WA-05 (manufactured by CERARICA NODA Co., Ltd.): 5.3 parts
- zirconium salicylate CCA TN-105 (manufactured by HODOGAYA CHEMICAL CO.,LTD.): 1.0 part
- copper phthalocyanine cyan pigment FG-7351 (manufactured by TOYO INK CO., LTD.): 10.0 parts

[Production of Color Toner 2]

[0067] [Color toner 2] was produced in the same way as for [White toner 1] except that the following toner raw materials were used.

- polyester resin RN-290 (manufactured by Kao Corporation): 94.7 parts
- carnauba wax WA-05 (manufactured by CERARICA NODA Co., Ltd.): 5.3 parts
- zirconium salicylate CCA TN-105 (manufactured by HODOGAYA CHEMICAL CO.,LTD.): 1.0 part
- copper phthalocyanine cyan pigment FG-7351 (manufactured by TOYO INK CO., LTD.): 10.0 parts

[0068] [Color toner 3] was produced in the same way as for [White toner 1] except that the following toner raw materials were used.

[Production of Color Toner 3]

[0069]

- polyester resin RN-290 (manufactured by Kao Corporation): 62.6 parts
- polyester resin RN-263 (manufactured by Kao Corporation): 32.1 parts
- carnauba wax WA-05 (manufactured by CERARICA NODA Co., Ltd.): 5.3 parts
- copper phthalocyanine cyan pigment FG-7351 (manufactured by TOYO INK CO., LTD.): 10.0 parts

(Evaluation of Outflow Starting Temperature and 1/2 Outflow Temperature of Toner)

[0070] For the white toners and the color toners obtained above, the outflow starting temperatures and the 1/2 outflow temperatures of the toners were evaluated according to the method described in "Method for Measuring Outflow Starting Temperature and 1/2 Outflow Temperature" above.

[0071] The evaluation results are presented in Table 1.

(Production of Two-Component Developer)

<Preparation of Carrier>

[0072]

- Silicone resin (organo straight silicone): 100 parts
- Toluene: 100 parts
- γ-(2-aminoethyl) aminopropyl trimethoxysilane: 5 parts
- Carbon black: 10 parts

[0073] The above mixture was dispersed by a homomixer for 20 minutes to prepare a coating layer forming liquid. Manganese (Mn) ferrite particles having a weight average particle diameter of 35 μm as core materials were coated with the coating layer forming liquid using a fluidized bed coating device while controlling the temperature inside the fluidized bed to 70°C, followed by drying, so that the coating layer was formed on the surface of the core materials with

an average film thickness of 0.20 μm. The resulting carrier was burnt in an electric furnace at 180°C for 2 hours. Thus, a carrier A was prepared.

<Preparation of Two-Component Developer>

[0074] Each of the prepared white toners and color toners was uniformly mixed with the carrier A by a TURBULA mixer (manufactured by Willy A. Bachofen (WAB) AG) at a revolution of 48 rpm for 5 minutes to be charged. Thus, each two-component developer was prepared. The mixing ratio of the toner to the carrier was 7% by mass, which was equal to the initial toner concentration in the developer in the test machine.

(Evaluation)

[0075] Images were formed using the two-component developer obtained above and evaluated for image colors and washing fastness.

[0076] The evaluation results are presented in Table 2. The evaluation methods and conditions were as follows.

(Image Creating Condition)

[0077]

(1) The color toner two-component developer obtained above was set in a cyan station of RICOH Pro C7200S (manufactured by RICOH COMPANY,LTD.). The developing and transferring conditions were adjusted using a process controller such that a toner deposition amount was 0.40 mg/cm^2, and an unfixed cyan solid image was output onto a transfer paper (WOW LIGHT 8.0 manufactured by Piotec Co.,Ltd.).
(2) The white toner two-component developer obtained above was set in a fifth station of RICOH Pro C7200S (manufactured by RICOH COMPANY,LTD.). The developing and transferring conditions were adjusted using a process controller such that a toner deposition amount was 1.0 mg/cm^2, and an unfixed solid color of white toner was overlaid and output onto the unfixed cyan solid image on the transfer paper.
(3) The unfixed solid image on the transfer paper was overlaid on a 100% polyester T-shirt fabric, which was set in a hot press (Model HTP234PS1 manufactured by Piotec Co.,Ltd.), heated and pressurized at a temperature Pt (°C) and a pressure of 600 g/cm^2 for 20 seconds, and then the transfer paper was removed, so that the toner image was transferred and fixed to the T-shirt.

(Evaluation of Image Color)

[0078] For the resulting fixed images, image colors (chroma) were visually evaluated in accordance with the following criteria.

[Evaluation Criteria]

[0079]

AA: Vivid color image
A: Slightly dark image
B: Slightly dark image, with slightly faint points
C: Slightly dark image, with faint points due to irregularities of fabric fibers

(Evaluation of Washing Fastness)

[0080] The fixed images used for the above evaluation of image colors were evaluated by a washing fastness test according to a test method of Japanese Industrial Standard (JIS) 0844:2011 in accordance with the following criteria.

[Evaluation Criteria]

[0081]

A: Grey scale for assessing change in color in JIS 0844 is Rank 5
B: Grey scale for assessing change in color in JIS 0844 is Rank 4 to 3

C: Grey scale for assessing change in color in JIS 0844 is Rank 2 to 1

[0082] The formulation and evaluation results are presented in Table 2.

Table 1

Component			White toner 1	White toner 2	Color toner 1	Color toner 2	Color toner 3
Polyester resin		RN-290	94.7	94.7	94.7	94.7	62.6
		RN-263					32.1
Wax		WA-05	5.3	5.3	5.3	5.3	5.3
Charge controlling agent		TN-105	0.5	1.0	0.1	0.5	
Pigment	White	PF-739	60.0	60.0			
	Cyan	FG-7351			10.0	10.0	10.0
External additive		HDK2000	3.0	3.0	3.0	3.0	3.0
Evaluation result		$UT_{1/2}$ (°C)	140.0	150.0			
		UT_{fb} (°C)	105.0	110.0			
		$CT_{1/2}$ (°C)			130.0	140.0	120.0
		CT_{fb} (°C)			102.0	105.0	99.0

Table 2

	Example 1	Comparative Example 1	Example 2	Example 3	Comparative Example 2	Example 4	Example 5	Example 6
White toner No.	1	1	1	1	1	1	1	2
Color toner No.	1	1	1	1	1	1	2	3
Pt (°C)	135	100	106	125	142	110	110	125
Image color	B	C	AA	AA	C	AA	A	A
Washing fastness	B	C	A	A	C	A	B	B

[0083] The present disclosure provides the following image forming methods (1) to (4).

(1) An image forming method including:

forming a toner image on a transfer medium with an image forming toner using an electrophotographic image forming apparatus;
forming an undercoat layer on the toner image with an undercoat layer forming toner;
heating and pressing an image receiving substrate and the undercoat layer together to transfer and fix the image on the transfer medium to the image receiving substrate, at a transfer and fixation temperature P_T [°C] satisfying the following relational equation (1); and
separating the image transferred and fixed to the image receiving substrate from the transfer medium,

$$UT_{fb} < P_T < UT_{1/2} \qquad (1)$$

where in Equation (1), UTfb [°C] represents an outflow starting temperature of the undercoat layer forming toner, and $UT_{1/2}$ [°C] represents a 1/2 outflow temperature of the undercoat layer forming toner.

(2) The image forming method according to the above (1), wherein the outflow starting temperature UTfb [°C] and the 1/2 outflow temperature $UT_{1/2}$ [°C] of the undercoat layer forming toner, and the transfer and fixation temperature P_T [°C] satisfy the following relational equation (2).

$$UT_{fb} < P_T < \frac{UT_{fb} + UT_{1/2}}{2} \qquad (2)$$

(3) The image forming method according to the above (1) or (2), wherein a 1/2 outflow temperature $CT_{1/2}$ [°C] of the image forming toner and the 1/2 outflow temperature $UT_{1/2}$ [°C] of the undercoat layer forming toner satisfy the following relational equation (3).

$$CT_{1/2} < UT_{1/2} \qquad (3)$$

(4) The image forming method according to any one of the above (1) to (3), wherein the undercoat layer forming toner is a white toner or a transparent toner.

Claims

1. An image forming method comprising:

forming a toner image on a transfer medium with an image forming toner using an electrophotographic image forming apparatus;
forming an undercoat layer on the toner image with an undercoat layer forming toner;
heating and pressing an image receiving substrate and the undercoat layer together to transfer and fix the toner image on the transfer medium to the image receiving substrate, at a transfer and fixation temperature P_T [°C] satisfying the following relational equation (1); and
separating the toner image transferred and fixed to the image receiving substrate from the transfer medium,

$$UT_{fb} < P_T < UT_{1/2} \qquad (1)$$

where in Equation (1), UTfb [°C] represents an outflow starting temperature of the undercoat layer forming toner,

and $UT_{1/2}$ [°C] represents a 1/2 outflow temperature of the undercoat layer forming toner.

2. The image forming method according to claim 1, wherein the outflow starting temperature UTfb [°C] and the 1/2 outflow temperature $UT_{1/2}$ [°C] of the undercoat layer forming toner, and the transfer and fixation temperature P_T [°C] satisfy the following relational equation (2).

$$UT_{fb} < P_T < \frac{UT_{fb} + UT_{1/2}}{2} \qquad (2)$$

3. The image forming method according to claim 1 or 2, wherein a 1/2 outflow temperature $CT_{1/2}$ [°C] of the image forming toner and the 1/2 outflow temperature $UT_{1/2}$ [°C] of the undercoat layer forming toner satisfy the following relational equation (3).

$$CT_{1/2} < UT_{1/2} \qquad (3)$$

4. The image forming method according to any one of claims 1 to 3, wherein the undercoat layer forming toner is a white toner or a transparent toner.

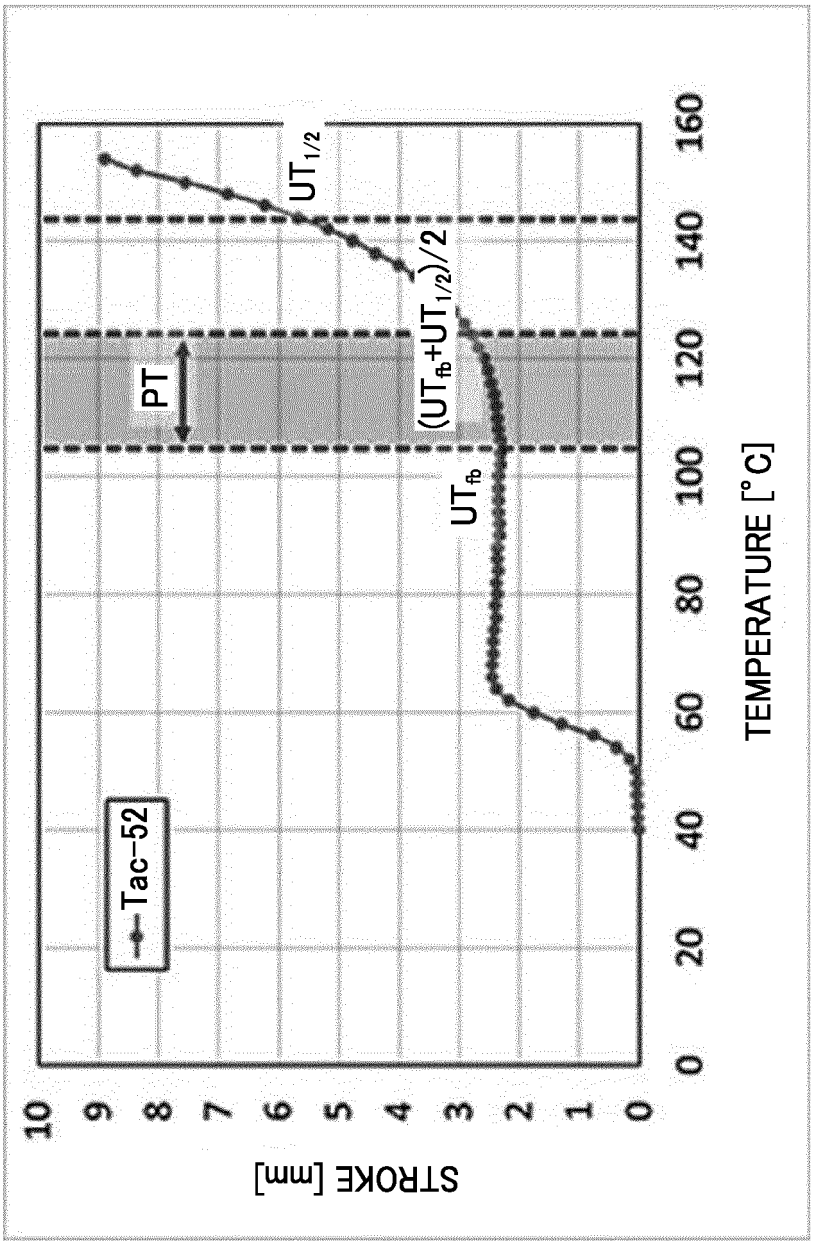
STROKE [mm]
TEMPERATURE [°C]
Tac-52
PT
$UT_{1/2}$
$(UT_{fb}+UT_{1/2})/2$
UT_{fb}
0
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100
120
140
160

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 5271

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 686 680 A1 (OKI DATA KK [JP]) 29 July 2020 (2020-07-29) * paragraphs [0060], [0063], [0076], [0100], [0113]; figures 10a-d *	1-4	INV. G03G15/00

TECHNICAL FIELDS SEARCHED (IPC)

G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 February 2023	Mandreoli, Lorenzo

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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06-02-2023

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		JP 2020118896 A	06-08-2020
		US 2020241460 A1	30-07-2020

EPO FORM P0459

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