(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 439 183 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.10.2024 Bulletin 2024/40

(21) Application number: **24161859.4**

(22) Date of filing: **06.03.2024**

(51) International Patent Classification (IPC):
G03G 9/087 *(2006.01)* ***G03G 9/09*** *(2006.01)*
G03G 9/08 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
G03G 9/0902; G03G 9/0819; G03G 9/08797; G03G 9/0926

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **14.03.2023 JP 2023039912**

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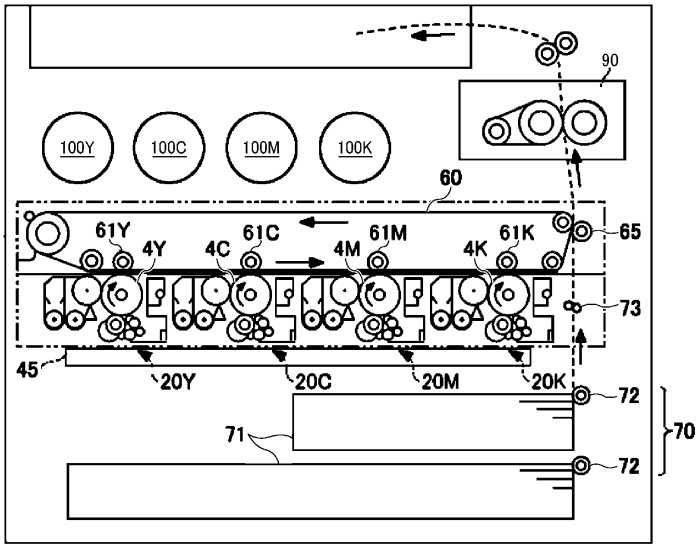
(54) TONER, TONER STORAGE CONTAINER, IMAGE FORMING APPARATUS, AND IMAGE FORMING METHOD

(57) Provided is a toner containing a phosphorescent pigment that contains Al element and Sr element, wherein the toner has an acid value of 10 mgKOH/g or more, the toner shows an Al intensity of from 180 kcps to 600 kcps when irradiated with fluorescent X-rays, a ratio (G/F) of an Al intensity measured when P80 to P85 particles (G) in a number-based particle size distribution of the toner are irradiated with fluorescent X-rays to an Al intensity measured when P20 to P25 particles (F) in the number-based particle size distribution of the toner is from 1.05 to 1.25, and a content of the phosphorescent pigment is 45% by mass or less.

FIG. 1



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Description

BACKGROUND

Technical Field

[0001] The present disclosure relates to a toner, a toner storage container, an image forming apparatus, and an image forming method.

Related Art

[0002] The electrophotographic method of forming a visual image by developing an electrostatic latent image with a developer includes forming an electrostatic latent image on an electrostatic latent image bearer, developing the electrostatic latent image with a developer containing a toner to form a toner image, transferring the toner image onto a transfer material such as paper, and fixing the toner image with heat and pressure to form the fixed image on the transfer material.

[0003] A phosphorescent toner containing at least a binder resin and a phosphorescent pigment, which is a metal aluminate, is proposed as a toner in the related art (see, for example, Japanese Unexamined Patent Application Publication No. 2002-323798).

[0004] A toner containing a phosphorescent substance and a binder resin as main components is also proposed (see, for example, Japanese Unexamined Patent Application Publication No. 2007-057703).

[0005] Also, a toner containing 20 parts by mass or less of a pigment is proposed (see, for example, Japanese Unexamined Patent Application Publication No. 1997-101628).

[0006] Furthermore, a phosphorescent toner, a developer, and a sheet made thereof are proposed (see, for example, Japanese Unexamined Patent Application Publication No. 2004-061975).

SUMMARY

[0007] An object of the present invention is to provide a toner that suppresses staining of a photoconductor and has excellent phosphorescence.

[0008] As a means to solve the above problem, a toner according to an embodiment of the present invention includes a phosphorescent pigment that contains Al element and Sr element. The toner has an acid value of 10 mgKOH/g or more. The toner shows an Al intensity of 180 kilo counts per second (kcps) to 600 kcps when irradiated with fluorescent X-rays. A ratio (G/F) of an Al intensity measured when P80 to P85 particles (G) in a number-based particle size distribution of the toner are irradiated with fluorescent X-rays to an Al intensity measured when P20 to P25 particles (F) in the number-based particle size distribution of the toner is 1.05 to 1.25. A content of the phosphorescent pigment is 45% by mass or less.

[0009] According to the present disclosure, a toner that suppresses staining of a photoconductor and has excellent phosphorescence can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete appreciation of embodiments of the present 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 drawings, wherein:

FIG. 1 is a schematic view of an image forming apparatus according to an embodiment of the present disclosure;
FIG. 2 is a schematic view of a toner image forming unit according to an embodiment of the present disclosure; and
FIG. 3 is a schematic view of a configuration of an image forming apparatus having five developing devices according to another embodiment of the present disclosure.

[0011] The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are 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

[0012] In describing embodiments illustrated in the drawings, 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.

[0013] Referring now to the drawings, 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.

(Toner)

[0014] A toner according to an embodiment of the present disclosure contains a phosphorescent pigment, preferably contains a binder resin, a release agent, and a charge control agent and if necessary, further contains other components.

[0015] Toner which is designed to obtain high phosphorescence in an image output by an electrophotographic process generally contains a large amount of phosphorescent pigment with the pigment present inside the toner as large particles as possible. However, there is a trade-off problem to be solved that when a phosphorescent pigment is likely to release from the toner, or is present alone or exposed too much on the surface of the toner, the phosphorescent pigment may contaminate to other members or cause scratches thereon, and image printing is not appropriately performed.

[0016] Also, dispersing and introducing a large amount of phosphorescent pigment into the toner are likely to cause scratches and scraping of a photoconductor since the phosphorescent pigment is likely to release from the toner base particles and present on the toner surface in a large amount. Furthermore, as it is difficult to introduce the pigment into the toner in a certain amount or above, phosphorescence may be insufficient.

[0017] As a result of intensive study, the inventors of the present invention found that uniform dispersion and introduction of phosphorescent pigment particles into toner particles is possible by using a binder resin having a specific acid value and a specific phosphorescent pigment. The inventors also found that as uniform dispersion and introduction of phosphorescent pigment particles into toner particles becomes possible, the rate of exposure or release of such a phosphorescent pigment that is hard on the toner surface is reduced, and the toner is prevented from being worn when used in an apparatus.

[0018] The acid value of the toner is 10 mgKOH/g or more, and preferably from 12 mgKOH/g to 30 mgKOH/g. When the acid value is 10 mgKOH/g or more, uniform dispersion and introduction of phosphorescent pigment particles into toner particles becomes possible, the rate of exposure of the phosphorescent pigment that is hard on the toner surface is reduced, and the toner is prevented from being worn when used in an apparatus. Also, when the acid value is 10 mgKOH/g or more, the toner can ensure high phosphorescence with an increased number average particle diameter of phosphorescent pigment and hold the phosphorescent pigment inside the toner even when the number average particle diameter is large.

[0019] A method of measuring the above acid value is not particularly limited and may be properly selected according to a purpose. For example, the acid value can be measured according to a method that is similar to that described in Japanese Industrial Standards (JIS) K0070 in which the measuring solvent is replaced with a mixture solvent of acetone and toluene (with a volume ratio 1:1).

[0020] When the toner is irradiated with fluorescent X-rays, the toner shows an Al intensity of from 180 kilo counts per second (kcps) to 600 kcps, preferably from 180 kcps to 550 kcps. When the Al intensity is 180 kcps or more, a toner having excellent phosphorescence can be obtained. Also, when the Al intensity is 600 kcps or less, loads on a process due to contamination or scratches of members can be suppressed and thereby defects of image formation or a formed image can be prevented.

[0021] A method of measuring the Al intensity is not particularly limited and may be properly selected according to a purpose. For example, the intensity can be measured according to a method described below.

<Measurement method with fluorescent X-rays>

[0022] According to an embodiment of the present disclosure, the Al intensity (kcps) can be measured in accordance with the following device and conditions.

[0023] First, a toner of 3.00 g is formed into a pellet sample having a diameter of 3 mm and a thickness of 2 mm to obtain a measurement sample. At the time of measurement, correction is performed using aluminum standard samples (manufactured by Rigaku Corporation). The measurement sample is subjected to qualitative analysis by a fluorescent X-ray analysis device to calculate a net intensity of Al-Kα ray as an Al intensity (kcps).

Measurement device: ZSX Primus IV (manufactured by Rigaku Corporation)

X-ray tube lamp: Rh
X-ray tube voltage: 50 kV
X-ray tube current: 10 mA

[0024] A ratio (G/F) of an Al intensity measured when P80 to P85 particles (G) in a number-based particle size distribution of the toner are irradiated with fluorescent X-rays to an Al intensity measured when P20 to P25 particles (F) in the number-based particle size distribution of the toner is from 1.05 to 1.25, preferably from 1.09 to 1.25, and more preferably from 1.10 to 1.20. When the ratio (G/F) is 1.05 or more, a toner having excellent phosphorescence can be obtained. When the ratio (G/F) is 1.25 or less, the dispersed pigment particles which are insoluble into a resin and have a large particle diameter are prevented from releasing from the toner. Thus, the amount of the pigment particles introduced into the toner, that is, the content of the pigment particles dispersed in the toner becomes sufficient.

[0025] By classifying the toner to obtain the particles (G) and the particles (F) and calculating a ratio of the particles (G) and the particles (F) in Al intensity measured when being irradiated with fluorescent X-rays, it is possible to ensure that the phosphorescent pigment is sufficiently introduced into the particles (F) in the toner (in the case of a pigment that is sufficiently smaller than the toner or an external additive having a small diameter, the ratio (G/F) is as close to 1.0 as it can be).

[0026] In the present disclosure, the "P20 to P25 particles (F)" refer to particles obtained by classifying the toner such that P50 of the resulting particles (F) is in the range of from P20 to P25 of the toner, and the "P80 to P85 particles (G)" refer to particles obtained by classifying the toner such that P50 of the resulting particles (G) is in the range of from P80 to P85 of the toner. Here, P20, P25, P50, P80, and P85 refer to particle sizes at which, in a number-based cumulative particle size distribution, the cumulative amounts are 20%, 25%, 50%, 80%, and 85%, respectively.

[0027] For example, when P20, P25, P80, and P85 of the toner are 4.0 μm, 4.5 μm, 7.0 μm, and 7.5 μm, respectively, the "P20 to P25 particles (F)" are obtained by classifying the toner such that P50 of the resulting particles (F) is in the range of from 4.0 μm to 4.5 μm (e.g., P50 of the resulting particles (F) is 4.2 μm), and the "P80 to P85 particles (G)" are obtained by classifying the toner such that P50 of the resulting particles (G) is in the range of from 7.0 μm to 7.5 μm (e.g., P50 of the resulting particles (G) is 7.2 μm).

<Phosphorescent pigment>

[0028] The phosphorescent pigment contains Al element and Sr element, and if necessary, further contains other components.

[0029] "Phosphorescence" in the phosphorescent pigment refers to properties that accumulate sunlight or light from luminaries as energy and release the accumulated light over time, thereby continuing to gradually emit light after light is no longer given. Specifically, the phosphorescence in the phosphorescent pigment refers to a phosphorescent luminance of 3 mcd/m^2 or more as measured by the following phosphorescent luminance test. The phosphorescent luminance test can measure phosphorescent luminance in accordance with the following conditions and procedures.

-Phosphorescent luminance test-

[0030] A sample to be measured is stored in a dark room with outside light blocked at a temperature of 23±2°C and a relative humidity of (50±5)% for 48 hours or more as defined in JIS Z 8703, followed by ultraviolet (UV) irradiation using a xenon lamp as defined in JIS Z 8902 at a UV intensity of 400 μW/cm^2 (measured in the wavelength range from 360 nm to 480 nm) for 60 minutes. The phosphorescent luminance after 120 minutes after irradiation stopped is measured.

[0031] The phosphorescent pigment is not particularly limited as long as the phosphorescent pigment contains Al element and Sr element and may be properly selected according to a purpose. However, a metal aluminate is preferable.

[0032] Examples of the metal aluminate include, but are not limited to, strontium aluminate such as $SrAl_2O_4$ and $Sr_4Al_{14}O_{25}$. These may be used alone or in combination.

[0033] The phosphorescent pigment containing strontium aluminate may be a commercially available product.

[0034] The commercially available product is not particularly limited and may be properly selected according to a purpose. Examples thereof include, but are not limited to, G-300C (manufactured by Nemoto & Co., Ltd.), G-300M (manufactured by Nemoto & Co., Ltd.), G-300F (manufactured by Nemoto & Co., Ltd.), G-300FF (manufactured by Nemoto & Co., Ltd.), BG-300M (manufactured by Nemoto & Co., Ltd.), BG-300F (manufactured by Nemoto & Co., Ltd.), GGL-300FF (manufactured by Nemoto & Co., Ltd., number average particle diameter: from 2.5 μm to 3.0 μm, composition: $SrAl_2O_4$; Eu, Dy, green or yellow green phosphorescent pigment), GLL-300FF (manufactured by Nemoto & Co., Ltd., number average particle diameter: from 2.5 μm to 3.0 μm), and BGL-300FF (manufactured by Nemoto & Co., Ltd., number average particle diameter: from 2.5 μm to 3.0 μm, composition: $Sr_4Al_{14}O_{25}$; Eu, Dy, blue phosphorescent pigment).

[0035] When being used for a toner, the commercially available product is preferably GGL-300FF, GLL-300FF, and

BGL-300FF having a number average particle diameter adjusted to from 2.5 μm to 3.0 μm.

[0036] The phosphorescent pigment containing strontium aluminate may be the commercially available product with a smaller diameter or a classified product made by classifying the commercially available product.

[0037] For the classified product, when a pulverization process is performed to decrease the particle size, a ball mill, a beads mill, or the like may be used. In the case where the classified product is pulverized by a ball mill, a beads mill, or the like, the particle diameter can be adjusted by controlling a pulverization time.

[0038] The pulverization time is not particularly limited and may be properly selected according to a purpose but preferably from 2 to 16 hours.

[0039] The classification may be performed by an ultra-fine particle classifier DONASELEC (manufactured by Koei Sangyo Co., Ltd.) so that the number average particle diameter be 0.5 μm or more and less than 1 μm.

[0040] The number average particle diameter of the phosphorescent pigment with a smaller diameter or the classified product made by classifying the phosphorescent pigment is not particularly limited depending on use, and for more uniform dispersibility in a thin film, a thin layer formation, or media with a low viscosity, is preferably 0.5 μm or more.

[0041] Other components contained in the phosphorescent pigment are not particularly limited and may be properly selected according to a purpose and examples of the other components include, but are not limited to, europium (Eu), dysprosium (Dy), and neodymium (Nd).

[0042] The number average particle diameter of the phosphorescent pigment is not particularly limited, may be properly selected according to a purpose, and is preferably from 0.5 μm to 5 μm, more preferably from 1 μm to 4 μm, particularly preferably from 1 μm to 3 μm. When the number average particle diameter is 0.5 μm or more, sufficient phosphorescence can be obtained. When the number average particle diameter is 5 μm or less, uniform dispersion and introduction of the phosphorescent pigment into a toner becomes possible and the rate of exposure of the phosphorescent pigment that is hard on the toner surface is reduced. Thus, the toner is prevented from being worn in an apparatus.

[0043] The larger the particle diameter of the phosphorescent pigment, the greater the expression and intensity of the phosphorescence. For this reason, it is preferable to have as large a single particle as possible. Therefore, a particle diameter suitable for the toner is selected based on the above.

[0044] In addition, during the pulverization process, the pigment particles that tend to serve as the pulverization interface are released, resulting in the presence of a large amount of separated pigment particles on the classified fine particle side after classification. As a result, generally, the efficiency of introduction of pigment particles into the classified toner base decreases and the content of pigment particles on the classified fine particle side turns to be higher than the content of pigment particles in the toner base. However, in the present embodiment, since the pigment particles have good affinity with a binder resin, the content of pigment particles on the classified fine particle side is less than the content of pigment particles in the classified toner base, i.e., the release phenomenon is suppressed and the pigment particles efficiently exist inside the toner base, which significantly reduces wear caused by pigment particles in a manufacturing apparatus.

[0045] From the viewpoint of color developability and color reproducibility, inorganic pigments contained in a toner generally have a number average particle diameter of about 0.2 μm or less. In this case, the inorganic pigments are uniformly dispersed in any portion of the toner, so that even during normal production, the intensities of the classified fine particle, the classified base, and the classified coarse particle measured with fluorescent X-rays are the same level of intensity. Furthermore, this is also the case when the toner itself is classified. In a case where inorganic pigments are introduced as a filler, the content of inorganic pigments in the classified fine particle tends to increase due to the relation between the volume of one toner particle and the particles to be dispersed, if the number average particle diameter of inorganic pigments exceeds 1 μm. This is likely to be largely due to the effect of release during pulverization.

[0046] As for the particle diameter of the particles, it is possible to ensure good uniformity if the particle diameter is 1/12 or more with respect to the particle diameter of the toner base particles. In a case where the particle diameter of the particles is from 1/12 to 1/4 of the particle diameter of the toner base particle, even if the introduced particles are released and become more numerous on the classified fine particle side, it is possible to suppress the number of released particles (released introduced particles) alone in the classified toner base or toner to almost none or a small amount. When the particle diameter of the particle is 1/4 or less of the particle diameter of the toner base particle, the number of released particles can be suppressed and process contamination (scratches, etc.) by the released particles can be prevented.

[0047] In the present disclosure, the inventors have found that a specific inorganic pigment with a particle diameter of 1 μm or more and 1/4 or more of P50 of the toner can be introduced into the toner in combination with a specific acid value of a binder resin, with little pigment release during pulverization and classification, even in areas where the number of parts of pigment is high. The inventors also have confirmed that it is possible to introduce enough pigment even when the particle diameter is about 1/2 of P50 of the toner. However, when the particle diameter exceeds 1/2 of P50 of the toner, wear resistance is significantly reduced. Since it is undesirable to have a large number of such particles, it is important to set the dispersed particle diameter based on the acceptable range in the process.

[0048] The content of the phosphorescent pigment is 45% by mass or less, preferably from 10% by mass to 45% by

mass, more preferably from 20% by mass to 45% by mass based on the toner.

[0049] When the content is 45% by mass or less, the staining of a photoconductor due to the toner can be prevented.

<Binder resin>

[0050] The binder resin is not particularly limited, may be properly selected according to a purpose, and examples of the binder resin include, but are not limited to, a low acid value resin having an acid value of less than 10 mgKOH/g, and a high acid value resin having an acid value of 15 mgKOH/g or more.

[0051] The low acid value resin is not particularly limited as long as the acid value is less than 10 mgKOH/g, may be properly selected according to a purpose, and examples thereof include, but are not limited to, RN-306 (with an acid value of 7 mgKOH/g, manufactured by Kao Corporation), and RN-306SF (with an acid value of 8 mgKOH/g, manufactured by Kao Corporation).

[0052] The high acid value resin is not particularly limited as long as the acid value is 15 mgKOH/g or more, may be properly selected according to a purpose, and examples thereof include, but are not limited to, RN-290 (acid value 27 mgKOH/g, manufactured by Kao Corporation).

[0053] The content of the low acid value resin is not particularly limited, may be properly selected according to a purpose, and is preferably from 10% by mass to 60% by mass, more preferably from 25% by mass to 50% by mass.

[0054] The content of the high acid value resin is not particularly limited, may be properly selected according to a purpose, and is preferably from 10% by mass to 60% by mass, more preferably from 15% by mass to 45% by mass.

[0055] The binder resin is not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, a polyester resin.

[0056] The polyester resin is preferably contained as a main component. The polyester resin can be fixed at low temperature while maintaining heat-resistant storage stability compared to other binder resins in general, and thus can be suitably used as a binder resin of the toner according to an embodiment.

[0057] The polyester resin is not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, a polyester resin obtained by condensation polymerization of alcohol and carboxylic acid.

[0058] The alcohol is not particularly limited, may be properly selected according to a purpose, and examples thereof 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, other divalent alcohol monomers, and trivalent or higher polyvalent alcohol monomers.

[0059] The carboxylic acid is not particularly limited, may be properly selected according to a purpose, and examples thereof 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.

[0060] The glass transition point (also referred to as "glass transition temperature") Tg of the binder resin is not particularly limited, may be appropriately selected according to a purpose, and is preferably from 50°C to 75°C.

[0061] A measurement method of the glass transition point Tg is not particularly limited, may be properly selected according to a purpose, and can be measured by, for example, a differential scanning calorimetry (DSC).

<Other binder resins>

[0062] The toner according to an embodiment can contain a binder resin component other than the polyester resin and polyolefin described above. Examples of other binder resins include, but are not limited to, known binder resins including styrene-based resins (homopolymer or copolymer containing styrene or styrene substitute) such as styrene, poly-α-styryl styrene, styrene-chlorostyrene copolymer, styrene-propylene copolymer, styrenebutadiene copolymer, styrene-vinyl chloride copolymer, styrene-vinyl acetate copolymer, styrene-maleic acid copolymer, styrene-acrylic acid ester copolymer, styrene-methacrylic acid ester copolymer, styrene-methyl α-chloroacrylate copolymer, and styrene-acrylonitrile-acrylic acid ester copolymer; 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 copolymer, xylene resins, and polyvinyl butylate resins.

[0063] A production method of the binder resin is not particularly limited, may be properly selected according to a purpose, and for example, a known production method such as bulk polymerization, solution polymerization, emulsion polymerization, and suspension polymerization can be used.

<Release agent>

[0064] The release agent is not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, low-molecular-weight polyolefin waxes such as low-molecular-weight polyethylene and low-molecular-weight polypropylene, synthetic hydrocarbon waxes such as Fischer-Tropsch wax, natural waxes such as bees wax, carnauba wax, candelilla wax, rice wax, and montan wax, petroleum waxes such as paraffin wax and microcrystalline wax, higher fatty acids such as stearic acid, palmitic acid and myristic acid, metal salts of the higher fatty acids, higher fatty acid amides, and synthetic ester waxes, and various modified waxes of the above waxes. These may be used alone or in combination. Among these, carnauba wax, modified carnauba wax, polyethylene wax, or synthetic ester waxes are preferred.

[0065] The content of the release agent is not particularly limited, may be properly selected according to a purpose, and is preferably from 2% by mass to 15% by mass, more preferably from 2.5% by mass to 10% by mass, based on the binder resin of the toner. When the content is 2% by mass or more, hot offset can be prevented and when the content is 15% by mass or less, a decrease in transferability and durability can be prevented.

[0066] The melting point of the release agent is not particularly limited, may be properly selected according to a purpose, and is preferably from 60°C to 150°C, more preferably from 65°C to 120°C. When the melting point is 60°C or higher, a decrease in heat-resistant storage stability of the toner can be prevented. When the melting point is 150°C or lower, the effect of the release agent can be exhibited.

<Charge control agent>

[0067] The charge control agent is not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, nigrosine and modified products thereof modified by fatty acid metal salt or the like; onium salts such as phosphonium salt and lake pigments thereof; triphenylmethane dyes and lake pigments thereof, metal salts of higher fatty acids; diorganotin oxides such as dibutyltin oxide, dioctyltin oxide, dicyclohexyltin oxide; diorganotin borates such as dibutyltin borate, dioctyltin borate, dicyclohexyltin borate; organic metal complexes; chelate compounds; monoazo metal complexes; acetylacetone metal complexes; aromatic hydroxycarboxylic acid; aromatic dicarboxylic acid metal complexes; quaternary ammonium salts; salicylic acid metal compounds; aromatic hydroxycarboxylic acids; aromatic mono- and poly-carboxylic acids and metal salts thereof; anhydrides; esters; and phenol derivatives such as bisphenol.

[0068] The content of the charge control agent is not particularly limited, may be properly selected according to a purpose, and is preferably from 0.1% by mass to 10% by mass, more preferably from 1% by mass to 5% by mass, based on the binder resin of the toner.

<Other components>

[0069] The other components are not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, a colorant, an external additive, a fluidity improving agent, a cleanability improving agent, and a magnetic material.

-Colorant-

[0070] A colorant is not particularly limited and a commonly-used colorant may be appropriately selected and used.

[0071] A colorant for black toner is preferably carbon black alone or a mixture of carbon black as a main component with copper phthalocyanine or the like in which hue and brightness are adjusted.

[0072] A colorant for cyan toner is preferably copper phthalocyanine that is Pigment Blue 15:3 or copper phthalocyanine mixed with aluminum phthalocyanine.

[0073] For a magenta toner, Pigment Red 53:1, Pigment Red 81, Pigment Red 122, Pigment Red 269, or the like may be used. The above-described pigments may be used alone or in combination.

[0074] For a yellow toner, Pigment Yellow 74, Pigment Yellow 155, Pigment Yellow 180, Pigment Yellow 185, or the like may be used. The above-described pigments may be used alone or in combination. Among them, Pigment Yellow 185 or a mixture of Pigment Yellow 74 and Pigment Yellow 185 is preferable in terms of saturation and storage stability.

[0075] For a white pigment, titanium dioxide having a surface treatment with silicon, zirconia, aluminum, polyol, or the like may be used.

[0076] For a green toner, Pigment Green 7 or the like may be used, but it is necessary to pay attention to safety.

[0077] For a blue toner, Pigment Blue 15: 1, Pigment Violet 23, or the like may be used.

[0078] The toner is preferably white or transparent (i.e., containing no colorant) in order not to impair the color tint of the toner overlapping the white or transparent toner. When the toner according to an embodiment is used as an underlying

layer (i.e., the layer on which an image is formed, on the side nearest to the recording medium) and a color toner layer is formed thereon as an upper layer, impairing of the color tint of the color toner can be reduced.

-External additives-

[0079] The external additives are not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, inorganic fine particles.

[0080] The inorganic fine particles are not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, silica, alumina, titanium oxide, barium titanate, magnesium titanate, calcium titanate, strontium titanate, zinc oxide, silica sand, clay, mica, silica limestone, 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. Among them, silica, alumina, and titanium oxide are preferable.

[0081] In addition, the inorganic fine particles may be surface treated with a hydrophobization treatment agent. Suitable examples of the hydrophobization treatment agents as a surface treatment agent include, but are not limited to, silane coupling agents, silylating agents, silane coupling agents having fluorinated alkyl groups, organic titanate-based coupling agents, and aluminum-based coupling agents. Also, silicone oil can be used as a hydrophobization treatment agent to obtain a sufficient effect.

-Fluidity improving agent-

[0082] The fluidity improving agent is not particularly limited as long as the surface treatment improves the hydrophobicity and suppresses deterioration of the fluidity or the charge characteristic even under high humidity and may be properly selected according to a purpose. Examples thereof include, but are not limited to, silane coupling agents, silylating agents, silane coupling agents having a fluorinated alkyl group, organic titanate-based coupling agents, aluminum-based coupling agents, silicone oil, and modified silicone oil.

[0083] The silica and the titanium oxide are particularly preferably subjected to the surface treatment with the above-described fluidity improving agent, and used as hydrophobic silica and hydrophobic titanium oxide, respectively.

- Cleanability improving agent-

[0084] The cleanability improving agent is not particularly limited as long as the cleanability improving agent is added to the toner to remove a developer remaining on a photoconductor or a primary transfer medium after a transfer process and may be properly selected according to a purpose.

[0085] The cleanability improving agent is not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, aliphatic acid metal salts of zinc stearate, calcium stearate, stearic acid, or the like, and polymer fine particles manufactured by soap-free emulsion polymerization using polymethylmethacrylate fine particles, polystyrene fine particles, or the like.

[0086] A volume average particle diameter of the polymer fine particles is not particularly limited, may be properly selected according to a purpose, and is preferably from 0.01 μm to 1 μm as a particle size distribution is relatively narrow.

-Magnetic material-

[0087] The magnetic material is not particularly limited, may be properly selected according to a purpose, and examples thereof include, but are not limited to, iron powder, magnetite, and ferrite. Among them, a white material is preferable from the viewpoint of the color tone.

<Method of Manufacturing Toner>

[0088] A method of manufacturing the toner will be described. The method of manufacturing the toner according to an embodiment includes a step of obtaining a mixture of a binder resin (mixing step); a step of obtaining a kneaded material of the mixture (melting and kneading step); a step of obtaining a solidified material of the kneaded material (solidification step); a step of obtaining a pulverized material of the solidified material (pulverizing step); and a step of classifying and collecting the pulverized material (classification step).

[0089] First, a binder resin, a colorant, a release agent, and if necessary, a charge control agent and the like are mixed by a mixer such as a HENSCHEL mixer or a super-mixer, to obtain a mixture (mixing step).

[0090] The mixture is then melted and kneaded using a thermal melt kneader such as a heat roll, a kneader, an extruder, or the like, to obtain a kneaded material (melting and kneading step).

[0091] The kneaded material is then cooled and solidified to obtain a solidified material (solidification step). A method of cooling and a method of solidifying are not particularly limited, and any suitable methods may be used.

[0092] The solidified material is then pulverized to obtain a pulverized material (pulverization step). The solidified material can be pulverized using known pulverizing methods. Examples of the pulverization method include, but are not limited to, a jet mill method in which toner particles are included in a high-speed airflow and solidified materials are pulverized by the energy of collision of the toner particles with a collision plate, an interparticle collision method in which toner particles collide with each other in an airflow, and a mechanical pulverizing method in which toner particles are supplied to a narrow gap formed with a fast-rotating rotor to be pulverized.

[0093] The pulverized material is then classified so that a pulverized material with a predetermined volume average particle diameter is collected. According to the above-described processes, the toner can be obtained (classification step). The classification method is not particularly limited, and any suitable method may be used.

[0094] The toner according to an embodiment can be manufactured using a dissolution suspension method. When the toner is manufactured using the dissolution suspension method, an oil phase in which toner materials, such as a binder resin, a colorant, a release agent, and, if necessary, a charge control agent and the like, are dissolved or dispersed in an organic solvent is dispersed in an aqueous medium (aqueous phase) to cause the binder resin to react. Thus, a dispersion liquid containing dispersoids (oil droplets) containing a prepolymer, in which the toner material is emulsified or dispersed, is obtained. Subsequently, the organic solvent is removed from the dispersion liquid, followed by filtration, washing, drying, and classification, as necessary. Thus, toner base particles are manufactured. The toner according to an embodiment can be obtained by granulating the base particles by the dissolution suspension method.

[0095] The organic solvent is not particularly limited and may be appropriately selected depending on a purpose. The organic solvent that has a boiling point of lower than 150°C is preferable, since such an organic solvent can be easily removed.

[0096] The organic solvent with a boiling point of lower than 150°C is not particularly limited and may be appropriately selected according to a purpose. Examples of the organic solvent include, but are not limited to, toluene, xylene, benzene, carbon tetrachloride, methylene chloride, 1,2-dichloroethane, 1, 1,2-trichloroethane, trichloroethylene, chloroform, monochlorobenzene, dichloroethylidene, methyl acetate, ethyl acetate, methyl ethyl ketone, and methyl isobutyl ketone. The above-described solvents may be used alone or in combination. Among the above-described organic solvents, ethyl acetate, toluene, xylene, benzene, methylene chloride, 1,2-dichloroethane, chloroform, carbon tetrachloride, or the like are preferable, and ethyl acetate is more preferable.

[0097] The aqueous medium is not particularly limited and may be appropriately selected according to a purpose. Examples of the aqueous medium include, but are not limited to, water, solvents miscible with water, and mixtures thereof. The above-described aqueous media may be used alone or in combination. Among the above-described media, water is preferable.

[0098] The solvent miscible with water is not particularly limited and may be appropriately selected according to a purpose. Examples of the solvent miscible with water include, but are not limited to, alcohols, lower ketones, dimethylformamide, tetrahydrofuran, and cellosolves. The alcohol is not particularly limited and may be appropriately selected according to a purpose and examples of the alcohol include, but are not limited to, methanol, isopropanol, and ethylene glycol. The lower ketones may be appropriately selected according to a purpose and examples of the lower ketones include, but are not limited to, acetone, and methyl ethyl ketone.

[0099] The method of removing the organic solvent from the dispersion liquid is not particularly limited and may be appropriately selected according to a purpose. Examples of the method of removing the organic solvent from the dispersion liquid include, but are not limited to, a method in which an entire reaction system is gradually heated to vaporize the organic solvent in the oil droplet, and a method in which the dispersion liquid is sprayed in a dry atmosphere so as to remove the organic solvent in the oil droplet.

[0100] The classification may be performed by removing the fine particle portions by a cyclone, a decanter, a centrifugation, or the like in a liquid, or by classifying the pulverized materials after drying the dispersion liquid.

[0101] Furthermore, the toner according to an embodiment has a low melting point and can be made difficult to crystallize, so that the toner exhibits excellent heat-resistant storage stability. The heat-resistant storage stability can be evaluated by measuring an amount of aggregates occurring in the toner after the toner is stored under an environment of high temperature and high humidity (for example, 40°C and 70 RH%) for a long term (for example, 14 days).

<Developer>

[0102] The developer according to an embodiment contains the toner according to an embodiment and may further contain other components appropriately selected, such as a carrier, as necessary.

[0103] The developer may be a single-component developer or a two-component developer. However, in the case where a high-speed printer or the like corresponding to an improvement in the information processing speed in recent years is used, a two-component developer is preferably used from the viewpoint of improving the life of the printer.

[0104] In the case of using the toner according to an embodiment as the one-component developer, even when supply and consumption of toner are performed, fluctuations of the particle size of the toner are small, and filming of the toner on a developing roller or fusing of the toner to a member such as a blade for thinning the toner is reduced. Therefore, even for long-term agitation in the developing device, good and stable developing properties and images can be obtained.

[0105] When the developer according to an embodiment is used as the two-component developer, the developer can be mixed with a carrier and used as a developer. In the case of using the toner according to an embodiment as the two-component developer, even when the supply and consumption of toner are performed for a long period, the fluctuations of the particle size of the toner are small, and good and stable developing properties and images can be obtained even for long-term agitation in the developing device.

[0106] The content of the carrier in the two-component developer can be appropriately selected according to a purpose and is preferably from 90 parts by mass to 98 parts by mass, and more preferably from 93 parts by mass to 97 parts by mass, based on 100 parts by mass of the two-component developer.

[0107] The developer according to an embodiment can be suitably used for image formation by using various known electrophotographic methods, such as magnetic one-component development methods, non-magnetic one-component development methods, and two-component development methods.

[Carrier]

[0108] Magnetic particles can be used as the carrier. Examples of the magnetic particles include, but are not limited to, particles of spinel ferrite such as magnetite or gamma iron oxide, spinel ferrite containing one or more metals other than iron (Mn, Ni, Zn, Mg, Cu, or the like), magneto plumbite ferrite such as barium ferrite, or iron or alloy having an oxide layer on the surface. In view of the chemical stability, spinel ferrite containing magnetite or gamma iron oxide, or magneto plumbite ferrite such as barium ferrite, is preferably used. Specific examples thereof include, but are not limited to, MFL-35S, MFL-35HS (manufactured by Powdertech Co., Ltd.), DFC-400M, DFC-410M, and SM-350NV (manufactured by Dowa Iron Powder Co., Ltd.).

[0109] Particularly, in the case where high magnetization of the carrier is required, ferromagnetic fine particles such as iron are preferably used as the carrier.

[0110] The shape of the carrier may be any of granular, spherical, or needle-like.

[0111] A resin carrier having desired magnetization can be used if an appropriate type of the carrier and an appropriate content of the carrier are selected. The magnetic characteristic of the resin carrier at this time is preferably that the magnetization strength at 1000 oersted is within a range from 30 emu/g to 150 emu/g.

[0112] As the above-described resin carrier, a resin carrier in which the carrier is dispersed in a condensation type binder, can be manufactured by spraying a melt-kneaded material of the carrier and an insulating binder resin by using a spray dryer, or by reacting a monomer or prepolymer in an aqueous medium in the presence of the carrier to cure the monomer or the prepolymer.

[0113] The chargeability can be controlled by causing positively or negatively charged fine particles or conductive fine particles to adhere to the surface of the carrier or by coating the surface of the carrier with a resin.

[0114] The surface coat material (resin) may be a silicone resin, an acrylic resin, an epoxy resin, a fluorine-based resin, or the like. Furthermore, it is also possible to coat the surface by containing positively or negatively charged fine particles or conductive fine particles. Among them, silicone resin and acrylic resin are preferable.

[0115] The weight ratio of the carrier in the developer stored in the developing device is preferably 85% by mass or more and less than 98% by mass. If the weight ratio is 85% by mass or more and less than 98% by mass, scattering of the toner from the developing device can be easily suppressed, and generation of a defective image can be suppressed. In addition, since it is possible to suppress an excessive increase in the charging amount of the toner for electrophotographic development or a shortage of the supply amount of the toner for electrophotographic development, the occurrence of a defective image due to a decrease in an image density can be suppressed.

<Developer Storage Container>

[0116] A developer storage container according to an embodiment stores a developer according to an embodiment. The developer storage container is not particularly limited, and can be appropriately selected from publicly known containers. Examples thereof include, but are not limited to, a container having a container body and a cap.

[0117] In addition, the size, shape, structure, and material of the container body are not particularly limited. The container body preferably has a cylindrical shape, and has irregularities formed in a spiral shape on the inner peripheral surface. By rotating the container body, the developer stored in the container is easily transferred toward a discharge port. Further, a part or all of the irregularities are preferably formed in a bellows-like shape.

[0118] According to this shape, the developer is more easily transferred toward the discharge port. Further, the material of the container is not particularly limited, but a material with high dimensional accuracy is preferably used. Examples

thereof include, but are not limited to, resin materials such as polyester resin, polyethylene resin, polypropylene resin, polystyrene resin, polyvinyl chloride resin, polyacrylic acid, polycarbonate resin, ABS resin, and polyacetal resin.

[0119] Since the developer storage container is easy to store, transport, and the like, and is excellent in handling property, the developer storage container can be detachably mounted on an image forming apparatus, a process cartridge, or the like, which will be described later, and used for replenishing a developer.

<Toner Set>

[0120] A toner set according to an embodiment may include a color toner containing a binder resin and a colorant, and the toner according to an embodiment.

[0121] The color toner is not particularly limited, and can be selected appropriately from known color toners depending on a purpose. The binder resin is not particularly limited and can be appropriately selected depending on a purpose. For example, the binder resin that is similar to the binder resin contained in the toner according to an embodiment may be used. The colorant is not particularly limited and can be appropriately selected from known colorants according to a purpose.

[0122] Since the toner set according to an embodiment is mounted on the image forming apparatus to form an image, image formation is performed using the toner according to an embodiment. Thus, image formation can be performed utilizing the characteristics of the toner having excellent fixability to a cloth.

<Toner Storage Unit>

[0123] A toner storage unit according to an embodiment stores the toner according to an embodiment. The toner storage unit according to an embodiment refers to a unit that has a function of storing toner and that stores the toner. Here, examples of the toner storage unit include, but are not limited to, a toner storage container, a developing device, and a process cartridge.

[0124] The toner storage container refers to a container that stores toner.

[0125] The developing device is a device provided with a means for storing toner and a means for performing the developing process.

[0126] The process cartridge is a combination of at least an electrostatic latent image bearer (also referred to as an image bearer) and a developing device to store the toner and detachable from the image forming apparatus. The process cartridge may further be provided with at least one selected from a charging device, an exposure device, and a cleaning device.

[0127] The toner storage unit according to an embodiment stores the toner according to an embodiment. Since the toner storage unit according to an embodiment is mounted on the image forming apparatus to form an image, image formation is performed using the toner according to an embodiment. Thus, image formation can be performed utilizing the characteristics of the toner having excellent fixability to a cloth.

(Toner Set)

[0128] A toner set according to an embodiment includes a color toner containing a binder resin and a colorant, and the toner according to an embodiment.

[0129] The color toner is not particularly limited, and can be selected appropriately from known color toners depending on a purpose.

[0130] The binder resin is not particularly limited and can be appropriately selected depending on a purpose. For example, the binder resin may be similar to the binder resin included in the toner according to an embodiment.

[0131] The colorant is not particularly limited and can be appropriately selected from known colorants according to a purpose.

[0132] Since the toner set is mounted to an image forming apparatus, which will be described below, to form an image, image formation is performed using the toner according to an embodiment. Thus, image formation can be performed utilizing the characteristics of the toner having excellent fixability to a cloth.

<Toner Storage Unit>

[0133] A toner storage unit according to an embodiment refers to a unit that has a function of storing toner and that stores the toner according to an embodiment. Here, examples of the toner storage unit include, but are not limited to, a toner storage container, a developing device, and a process cartridge.

[0134] The toner storage container refers to a container storing toner.

[0135] It is noted that when the toner is used as a developer, the toner storage container is also referred to as a

developer storage container.

[0136] The developer storage container is not particularly limited and can be appropriately selected from publicly known containers, and examples thereof include, but are not limited to, a container having a container body and a cap.

[0137] The size, structure, and material of each of the toner storage container and the developer storage container are not particularly limited.

[0138] The shape of the container body of the developer storage container is not particularly limited and can be appropriately selected depending on a purpose, but preferably has a cylindrical shape and has irregularities formed in a spiral shape on the inner peripheral surface. By rotating the container body, the developer stored in the container is easily transferred toward the discharge port. Further, a part or all of the irregularities are preferably formed in a bellows-like shape. According to this shape, the developer is more easily transferred toward the discharge port.

[0139] Further, the material of each of the toner storage container and the developer storage container is not particularly limited and can be appropriately selected depending on a purpose, but a material with high dimensional accuracy is preferably used. Examples thereof include, but are not limited to, resin materials such as polyester resin, polyethylene resin, polypropylene resin, polystyrene resin, polyvinyl chloride resin, polyacrylic acid, polycarbonate resin, ABS resin, and polyacetal resin.

[0140] Since the toner storage container and the developer storage container are easy to store, transport, and the like, and are excellent in handling property, the toner storage container and the developer storage container can be detachably mounted on an image forming apparatus, a process cartridge, or the like, which will be described later, and used for replenishing a toner and a developer.

[0141] The developing device is a device provided with a means for storing toner and a means for performing the developing process.

[0142] The process cartridge is a combination of at least an electrostatic latent image bearer (also referred to as an image bearer) and a developing device to store the toner and detachable from the image forming apparatus. The process cartridge may further be provided with at least one selected from a charging unit, an exposing unit, and a cleaning unit.

[0143] The toner storage unit according to an embodiment stores the toner according to an embodiment. Since the toner storage unit according to an embodiment is mounted on an image forming apparatus to form an image, image formation is performed using the toner according to an embodiment. Thus, image formation can be performed utilizing the characteristics of the toner having excellent fixability to a cloth.

(Image Forming Apparatus and Image Forming Method)

[0144] The image forming apparatus according to an embodiment includes an electrostatic latent image bearer, an electrostatic latent image forming unit that forms an electrostatic latent image on the electrostatic latent image bearer, a developing unit that develops the electrostatic latent image formed on the electrostatic latent image bearer with a toner to form a toner image, a transfer unit that transfers the toner image onto a recording medium, and a fixing unit that fixes the transferred toner image on the recording medium. The image forming apparatus may have other units as required.

[0145] An image forming method according to an embodiment includes an electrostatic latent image forming step of forming an electrostatic latent image on an electrostatic latent image bearer, a developing step of developing the electrostatic latent image to form a toner image, a transfer step of transferring the toner image onto a recording medium, and a fixing step of fixing the transferred toner image on the recording medium. The toner image is formed with the toner according to an embodiment. The image forming method may have other steps as required.

[0146] The image forming method can be preferably performed by the image forming apparatus, the electrostatic latent image forming step can be preferably performed by the electrostatic latent image forming unit, the developing step can be preferably performed by the developing unit, the transfer step can be preferably performed by the transfer unit, the fixing step can be preferably performed by the fixing unit, and the other steps can be preferably performed by the other units.

<Electrostatic Latent Image bearer>

[0147] The material, structure, and size of the electrostatic latent image bearer (also referred to as "photoconductor") are not particularly limited and can be appropriately selected from publicly known ones. Examples of materials of the electrostatic latent image bearer include, but are not limited to, inorganic photoconductors and organic photoconductors.

[0148] Examples of the inorganic photoconductors include, but are not limited to, amorphous silicon and selenium. Examples of the organic photoconductors include, but are not limited to, a multilayer photoconductor having a multilayer structure where a layer in which a charge generation material such as metal-free phthalocyanine or titanyl phthalocyanine is dispersed into a binder resin on a support such as aluminum drum (charge generation layer) and a layer in which a charge transport material is dispersed into the binder resin (charge transport layer) are laminated, and a single-layer photoconductor having a single-layer photoconductor layer where both the charge generation material and the charge

transport material are dispersed into the binder resin on a support. In the single-layer photoconductor, a charge transport material or a charge transport material can be added to a photoconductor layer as a charge transport material. Also, an undercoat layer may be provided between a support and the charge generation layer of the multilayer photoconductor or the photoconductor layer of the single-layer photoconductor.

[0149] The shape of the electrostatic latent image bearer is not particularly limited and may be appropriately selected depending on a purpose, but is preferably cylindrical. The outer diameter of the cylindrical electrostatic latent image bearer is not particularly limited and may be appropriately selected depending on a purpose, but is preferably from 3 mm to 100 mm, more preferably from 5 mm to 50 mm, and further preferably from 10 mm to 30 mm.

<Electrostatic Latent Image Forming Unit and Electrostatic Latent Image Forming Step>

[0150] The electrostatic latent image forming unit in the image forming apparatus according to an embodiment of the present disclosure is not particularly limited and may be appropriately selected depending on a purpose, as long as the electrostatic latent image forming unit is a unit that forms an electrostatic latent image on the electrostatic latent image bearer. The electrostatic latent image forming unit is provided with, for example, a charging device (charger) that uniformly charges a surface of the electrostatic latent image bearer and an exposing device (exposurer) that imagewise exposes the surface of the electrostatic latent image bearer.

[0151] The electrostatic latent image forming step in the image forming method according to an embodiment of the present disclosure is a step of forming an electrostatic latent image on the electrostatic latent image bearer, and includes a charging step of charging a surface of the electrostatic latent image bearer, and an exposing step of exposing the charged surface of the electrostatic latent image bearer to form an electrostatic latent image.

[0152] Charging can be performed by, for example, applying a voltage to the surface of the electrostatic latent image bearer using the charging device (charger).

[0153] Exposing can be performed by, for example, exposing imagewise the surface of the electrostatic latent image bearer using the exposure device (exposurer).

[0154] The electrostatic latent image can be formed, for example, by uniformly charging the surface of the electrostatic latent image bearer and exposing imagewise the surface, which can be performed by the electrostatic latent image forming unit.

-Charging Device (charger)-

[0155] The charger serving as a charging device is not particularly limited and may be appropriately selected depending on a purpose. Examples thereof include, but are not limited to, contact-type chargers having, for example, an electro-conductive or semi-electroconductive roll, a brush, a film and a rubber blade; and non-contact-type chargers utilizing corona discharge such as corotron and scorotron.

[0156] The charger may have any shape other than a roller such as a magnetic brush or a fur brush. The shape thereof may be suitably selected according to the specification or configuration of the image forming apparatus.

[0157] The charger is preferably a device that is disposed in contact or non-contact with the electrostatic latent image bearer and charges the surface of the electrostatic latent image bearer by applying a superimposed direct-current (DC) and alternating-current (AC) voltage. In addition, the charger is preferably a charging roller disposed in non-contact with and adjacent to the electrostatic latent image bearer through a gap tape and charges the surface of the electrostatic latent image bearer by applying a superimposed DC and AC voltage to the charging roller.

[0158] The charger is not limited to the aforementioned contact-type chargers. However, the contact-type chargers are preferably used from the viewpoint of producing an image forming apparatus in which the amount of ozone generated from the charger is reduced.

-Exposing device (exposurer)-

[0159] The exposurer is not particularly limited and may be appropriately selected depending on a purpose, as long as the exposure can desirably expose imagewise the surface of the electrostatic latent image bearer that have been charged with the charger. Examples of the exposurer include, but are not limited to, various exposurers such as a copy optical exposurer, a rod lens array exposurer, a laser optical exposurer, and a liquid crystal shutter optical exposurer.

[0160] A light source used for the exposurer is not particularly limited and may be appropriately selected depending on a purpose. Examples thereof include, but are not limited to, general light-emitting devices such as a fluorescent lamp, a tungsten lamp, a halogen lamp, a mercury lamp, a sodium lamp, a light-emitting diode (LED), a laser diode (LD), and an electroluminescence (EL) device.

[0161] Also, various filters may be used for illuminating only light having a desired wavelength range. Examples of the filters include, but are not limited to, a sharp-cut filter, a band-pass filter, an infrared cut filter, a dichroic filter, an interference

filter, and a color temperature conversion filter.

[0162] In addition, an optical backside system, in which exposure is performed imagewise from the backside of the electrostatic latent image bearer, may be employed.

<Developing Unit and Developing Step>

[0163] The developing unit in the image forming apparatus according to an embodiment of the present disclosure is not particularly limited and may be appropriately selected depending on a purpose, as long as it is a developing unit that develops the electrostatic latent image having been formed on the electrostatic latent image bearer to thereby form a toner image. For example, the developing unit provided with a developing device that stores a toner and provides the toner contactly or non-contactly to an electrostatic latent image is preferably used. The developing device provided with a toner container is preferable.

[0164] The developing step in the image forming method according to an embodiment of the present disclosure is a step of sequentially developing an electrostatic latent image with a plurality of colors of toner to form a toner image. The toner image can be formed, for example, by developing an electrostatic latent image using the toners, and can be performed by a developing device.

[0165] In the developing unit and the developing step, a toner according to an embodiment is used. Preferably, a toner image may be formed by using a developer that contains the toner according to an embodiment and further contains other components such as a carrier as necessary.

[0166] The developing device may be a monochromatic developing device or a multicolor developing device. The developing device preferably has, for example, a stirrer that charges the toner by friction agitation, a magnetic field generator fixed inside, and a developer carrier capable of rotating while carrying a developer containing toner on a surface thereof.

[0167] In the developing device, for example, the toner and the carrier are mixed and stirred, the toner is charged due to friction, the toner is held on a surface of the rotating magnet roller in a pointing state, and a magnetic brush is formed. Since the magnet roller is disposed near the electrostatic latent image bearer (photoconductor), a part of the toner constituting the magnetic brush formed on the surface of the magnet roller moves to the surface of the electrostatic latent image bearer (photoconductor) due to an electrical attractive force. As a result, the electrostatic latent image is developed by the toner, and the toner image is formed on the surface of the electrostatic latent image bearer (photoconductor) by the toner.

[0168] The image forming apparatus according to an embodiment of the present disclosure can be provided with five developing units in total: developing units for color toners (for black, for cyan, for magenta, and for yellow) and a developing unit for the toner according to an embodiment of the present disclosure. The toner according to an embodiment of the present disclosure may be any color, but preferably transparent or white. In the developing unit, the toner according to an embodiment may be used for some or all of the color toners of black, cyan, magenta and yellow.

<Transfer unit and transfer step>

[0169] The transfer unit in the image forming apparatus according to an embodiment of the present disclosure preferably includes a primary transfer unit that transfers a toner image onto an intermediate transfer body to form a composite transfer image, and a secondary transfer unit that transfers the composite transfer image onto a recording medium. It is noted that the intermediate transfer body is not particularly limited and can be appropriately selected from known transfer bodies depending on a purpose. A preferable example includes, but is not limited to, a transfer belt.

[0170] The transfer step in the image forming apparatus according to an embodiment of the present disclosure is a step of transferring the toner image to the recording medium. In the transfer step, it is preferable that an intermediate transfer body is used, so that the toner image is primarily transferred to the intermediate transfer body, and then the toner image is secondarily transferred to the recording medium.

[0171] The transfer step more preferably includes a primary transfer step of transferring the toner image to the intermediate transfer body to form a composite transfer image using two or more colors of toner, preferably the full color toner, and a secondary transfer step of transferring the composite transfer image to the recording medium.

[0172] The above-described transfer step can be performed, for example, by charging the electrostatic latent image bearer (photoconductor) using a charger that transfers a toner image. The transfer step can be performed by the transfer unit.

[0173] The transfer units (the primary transfer unit and the secondary transfer unit) preferably include at least a transfer device that charges and separate the toner image formed on the electrostatic latent image bearer (photoconductor) toward the recording medium. One transfer unit may be provided, or two or more transfer units may be provided.

[0174] Examples of the transfer unit include, but are not limited to, a corona transfer unit by using corona discharge phenomena, a transfer belt, a transfer roller, a pressure transfer roller, and an adhesive transfer device.

[0175] The recording medium is typically plain paper, but is not particularly limited and may be appropriately selected depending on a purpose, as long as an unfixed image after development can be transferred to the recording medium. A release paper, a polyethylene terephthalate (PET) base for overhead projector (OHP), or the like can be also used for the recording medium.

<Fixing unit and fixing step>

[0176] The fixing unit in the image forming apparatus according to an embodiment of the present disclosure is not particularly limited and can be appropriately selected depending on a purpose, but a known heating and pressing unit is preferably used. Examples of the heating and pressing unit include, but are not limited to, a combination of a heating roller and a pressing roller, and a combination of a heating roller, a pressing roller, and an endless belt.

[0177] The fixing step in the image forming apparatus according to an embodiment of the present disclosure is a step of fixing the toner image transferred to the recording medium using the fixing device. The toner image may be fixed each time transferred to the recording medium for each color developer, or the fixing step may be simultaneously performed for laminated toner images transferred to the recording medium for the developers of the respective colors.

[0178] The fixing unit preferably includes a heating body provided with a heating element, a paper or release paper being in contact with the heating body, and a pressing member being in pressure contact with the heating body via the paper or release paper. The fixing unit is preferably a heating and pressing unit in which a recording medium on which an unfixed image is formed is passed between the film and the pressing member, and that heats the recording medium to fix the unfixed image.

[0179] Preferably, heating in the heating and pressing unit is typically performed at a temperature of from 80°C to 200°C.

[0180] The surface pressure of the heating and pressing unit is not particularly limited, and may be appropriately selected depending on a purpose. The surface pressure is preferably from 10 N/cm^2 to 80 N/cm^2.

[0181] In this embodiment, for example, a known optical fixing device may be used with the fixing unit or instead of the fixing unit depending on a purpose.

<Other units and other steps>

[0182] The image forming apparatus according to an embodiment of the present disclosure can include other units that are appropriately selected depending on a purpose, for example, a neutralizer, a cleaning unit, a recycling unit, a controller, and the like.

[0183] The image forming method according to an embodiment of the present disclosure can include other steps that are appropriately selected depending on a purpose, for example, a neutralization step, a cleaning step, a recycling step, and the like.

«Neutralizer and neutralization step»

[0184] The neutralizer is not particularly limited as long as a neutralization bias can be applied to the electrostatic latent image bearer. The neutralizer can be appropriately selected from known neutralization devices. Suitable examples thereof include, but are not limited to, a neutralizing lamp.

[0185] The neutralization step is a step of performing a neutralization process by applying a neutralization bias to the electrostatic latent image bearer, and is preferably performed by the neutralizer.

«Cleaning unit and cleaning step»

[0186] The cleaning unit is not particularly limited as long as toner remaining on the electrostatic latent image bearer can be removed, and may be appropriately selected from known cleaning devices. Examples of the cleaning unit include, but are not limited to, a magnetic brush cleaner, an electrostatic brush cleaner, a magnetic roller cleaner, a blade cleaner, a brush cleaner, and a web cleaner.

[0187] The cleaning step is a step of removing the toner remaining on the electrostatic latent image bearer, and the cleaning step can be preferably performed by the cleaning unit.

[0188] The image forming apparatus according to an embodiment of the present disclosure may have a cleaning unit to improve cleaning performance. That is, by controlling the adhesion between toners, fluidity of the toner is controlled, and the cleaning property can be improved. Further, by controlling characteristics of the toner after deterioration, excellent long-life cleaning quality can be maintained even under severe conditions such as high temperature and humidity. Furthermore, since an external additive can be sufficiently released from the toner on the photoconductor, a deposition layer (dam layer) of the external additive is formed in the cleaning blade nip part. Thus, a high cleaning property can be achieved.

«Recycling unit and recycling step»

[0189] The recycling unit is not particularly limited, and examples thereof include, but are not limited to, a known conveying means. The recycling step is a step of recycling the toner removed by the cleaning step to the developing unit, and is preferably performed by the recycling unit.

«Controller»

[0190] The controller can control the movement of each of the above-described units. The controller is not particularly limited, as long as the movement of each of the above-described units can be controlled, and the controller can be appropriately selected depending on a purpose. Examples of the controller include, but are not limited to, a control device such as a sequencer, and a computer.

[0191] Since the image forming apparatus according to an embodiment can perform image forming using the toner according to an embodiment, the image forming apparatus has excellent fixability to a cloth. Thus, the image forming apparatus can reduce power consumption and stably provide high quality images.

[0192] Next, one aspect of the image forming apparatus according to an embodiment will be described with reference to FIG. 1.

[0193] However, the usage of the present disclosure is not limited to the present embodiment.

[0194] It is noted that in each drawing, the same or similar reference signs are allocated to the same or similar constitutional parts, and duplicated explanations may be omitted. The number of constituent elements and their locations, shapes, and the like are not limited to the present embodiment and can be preferable number, location, shape, and the like.

[0195] FIG. 1 is a schematic view of an image forming apparatus according to an embodiment.

[0196] In the image forming apparatus illustrated in FIG. 1, four toner image forming units 20Y, 20C, 20M, and 20K of yellow, cyan, magenta, and black are arranged in parallel. The image forming apparatus illustrated in FIG. 1 is a so-called tandem-type image forming apparatus in which yellow (Y), cyan (C), magenta (M), and black (K) color toner images formed by the toner image forming units are superimposed one on another to form a full color image. The order of arrangement of the toner image forming units of the four colors is not particularly limited to this order. The image forming apparatus further includes toner storage containers 100Y, 100C, 100M, and 100K storing yellow (Y), cyan (C), magenta (M), and black (K) toners, respectively.

[0197] The toner image forming units 20Y, 20C, 20M, and 20K, respectively, include photoconductor drums 4Y, 4C, 4M, and 4K that are rotationally driven as image bearers. Also, an exposing device 45 is provided that emits laser light or LED light to the photoconductor drums 4Y, 4C, 4M, and 4K based on image information of the respective colors to form latent images respectively.

[0198] An intermediate transfer belt 60 is disposed as an intermediate transfer unit such that the surface of the intermediate transfer belt 60 is movable to face the toner image forming units 20Y, 20C, 20M, and 20K. Primary transfer rollers 61Y, 61C, 61M, and 61K, which transfer the toner images of four colors formed on the photoconductor drums 4Y, 4C, 4M, and 4K, respectively, to the intermediate transfer belt 60, are disposed at positions opposite the photoconductor drums 4Y, 4C, 4M, and 4K via the intermediate transfer belt 60.

[0199] The primary transfer rollers 61Y, 61C, 61M, and 61K sequentially transfer and superimpose the color toner images formed by the toner image forming units 20Y, 20C, 20M, and 20K, respectively, one on another onto the intermediate transfer belt 60 to form a full color image.

[0200] A sheet feeding unit 70 including a paper feeding cassette 71, and a paper feeding roller 72 is provided in the lower part of the image forming apparatus and feeds a transfer sheet toward a registration roller 73. The registration roller 73 feeds the transfer sheet toward the opposite part of the intermediate transfer belt 60 and a secondary transfer device 65 in accordance with the timing of forming the toner image. The full color toner image on the intermediate transfer belt 60 is transferred on the transfer sheet by the secondary transfer device 65, fixed by a fixing device 90, and then ejected to the outside of the image forming apparatus.

[0201] Next, each of the toner image forming units 20Y, 20C, 20M, and 20K will be described. As the toner image forming units 20Y, 20C, 20M, and 20K are almost identical in configuration and operation except for the color of toner to be stored, in the following description, the alphabets Y, C, M, and K for color distinction are omitted, and the configuration and operation of a toner image forming unit 20 will be described. FIG. 2 is a schematic view of the toner image forming unit 20 in an image forming apparatus according to an embodiment.

[0202] The toner image forming unit 20 includes devices that perform electrophotographic processes, such as a charging device 40, a developing device 50, and a cleaning device 30 around a photoconductor drum 4 and forms a toner image of each color on the photoconductor drum 4 in a known operation. The toner image forming unit 20 may be formed as an integrated unit and may be a process cartridge detachable from a main body of the image forming apparatus.

[0203] FIG. 3 is a schematic view of an image forming apparatus having five developing devices according to another embodiment. The description of the same configuration as that of the above image forming apparatus will be omitted.

[0204] The image forming apparatus according to the present embodiment includes photoconductors (photoconductor 5, photoconductor 11, photoconductor 17, photoconductor 23, and photoconductor 29) and around the photoconductors, includes chargers (charger 6, charger 12, charger 18, charger 24, and charger 30), developing devices (developing device 8, developing device 14, developing device 20, developing device 26, and developing device 32), transfer devices (transfer device 10, transfer device 16, transfer device 22, transfer device 28, and transfer device 34), and cleaning devices (cleaning device 9, cleaning device 15, cleaning device 21, cleaning device 27, and cleaning device 33). The photoconductors are exposed with exposure light beams (exposure light beam7, exposure light beam13, exposure light beam19, exposure light beam25, and exposure light beam31).

[0205] Each of developing units (developing unit 35, developing unit 36, developing unit 37, developing unit 38, and developing unit 39) of respective colors include the photoconductor, the charger, the developing device, the cleaning device, and the like. The developing unit 35 develops an image with a white or transparent toner, the developing unit 36 develops an image with a black toner, the developing unit 37 develops an image with a cyan toner, the developing unit 38 develops an image with a magenta toner, and the developing unit 39 develops an image with a yellow toner, followed by transfer to an intermediate transfer belt 40 to form the toner images. The toner images formed on the intermediate transfer belt 40 are transferred to a recording medium by a transfer device 41 and fixed by a fixing device 43. A sheet feeding cassette 1 and a sheet feeding roller 2 are disposed in the lower part of the developing units and feed a transfer sheet toward registration rollers 3 and 4.

[0206] The registration rollers 3 and 4 feed the transfer sheet toward the opposite part of the intermediate transfer belt 40 and the transfer device 41 in accordance with the timing of forming the toner image.

[EXAMPLE]

(Example 1)

<Preparation of toner>

[0207] First, 45 parts by mass of a polyester resin 1 (RN-306SF, manufactured by Kao Corporation) as a binder resin, 50 parts by mass of a polyester resin 2 (RN-290, manufactured by Kao Corporation), 5 parts by mass of an ester wax (WEP-5, manufactured by Nippon Oil & Fats Co., Ltd.) as a release agent, 1 part by mass of zinc salicylate (E-304, manufactured by ORIENT CHEMICAL INDUSTRIES CO., LTD.) as a charge control agent, and 40 parts by mass of GGL-300FF (manufactured by Nemoto & Co., Ltd.) as a phosphorescent pigment (hereinafter, also referred to as "colorant" or "phosphorescent agent") were pre-mixed using a HENSCHEL mixer (FM20B manufactured by Nippon Coke & Engineering Co., Ltd.) and then melted and kneaded by a single-axis kneader (co-kneader kneading machine BUSS Co-Kneader"MDK46-11D", manufactured by Buss Corporation) at a raw material feeding rate of 16 kg/h to a barrel, a screw temperature of 40°C, and a kneading temperature of from 100°C to 130°C (zone barrel temperature: Z1 zone 130°C, Z2Z3 zone 100°C) to obtain a kneaded material.

[0208] The obtained kneaded material was cooled to room temperature and coarsely pulverized to 200 μm to 300 μm with ROTOPLEX. Then, a counter jet mill (100AFG, manufactured by Hosokawa Micron Co., Ltd.) was used to pulverize the particles to have an average mass particle diameter of (8.7±0.5) μm by appropriately adjusting the pulverizing air pressure accordingly. Thereafter, the finely pulverized kneaded material was classified by using an air flow classifier (EJ-LABO, available from MATSUBO Corporation) while appropriately adjusting the opening of the louver so that P50 was (6.0±0.3) μm, and the toner base particles were thus obtained.

[0209] Then, based on 100 parts by mass of the toner base particles, 1.0 part by mass of HDK-2000 (registered trademark) (manufactured by Clariant Co., Ltd.) as an additive and 1.0 part by mass of H05TD (registered trademark) (manufactured by Clariant Co., Ltd.) as an additive were added and stirred and mixed using a HENSCHEL mixer. Thus, the toner 1 was prepared. At this point, the toner particle diameter at P50 was 6.0 μm and the acid value of the toner was 17.8 mgKOH/g.

[0210] The toner 1 was classified, by using an air flow classifier (EJ-LABO, available from MATSUBO Corporation) while appropriately adjusting the opening of the louver, into G powder having a large particle diameter, M powder having a medium particle diameter, and F powder having a small diameter so that P50 of the G powder falls within the range of form P80 to P85 of the toner 1 and P50 of the F powder falls within the range of form P25 to P30 of the toner 1.

[0211] As a result of measuring P50 of the collected G powder and F powder, P50 of the F powder was 4.5 μm that falls within the range of from P25 to 30 of the toner 1, which is from 4.4 μm to 4.7 μm. P50 of the G powder was 7.6 μm that falls within the range of from P80 to 85 of the toner 1, which is from 7.5 μm to 7.8 μm.

[0212] The obtained toner 1 was weighed 3 g and pressurized in a molding machine to make a pellet of 3 cm diameter, and the intensity of Al was measured by the qualitative X-ray fluorescence: EZ mode. The obtained Al intensity was 321 kcps for the toner 1, 329 kcps for the G powder, and 288 kcps for the F powder, respectively.

(Examples 2 to 7 and Comparative Examples 1 to 5)

[0213] In Examples 2 to 7 and Comparative Examples 1 to 5, toners were manufactured in the same manner as Example 1, except that the toner raw material was changed to a combination as described in the following Table 1. The intensity of the fluorescent X-ray was illustrated in Table 1, respectively.

Table 1

			EXAMPLES							COMPARATIVE EXAMPLES				
			1	2	3	4	5	6	7	1	2	3	4	5
Binder resin	Low acid value resin (Polyester resin 1)		45	45	70	45	45	45	45	90	45	45	45	45
	High acid value resin (Polyester resin 2)		50	50	25	50	50	50	50	5	50	50	50	50
Release agent	WEP-5		5	5	5	5	5	5	5	5	5	5	5	5
Charge control agent	E-304		1	1	1	1	1	1	1	1	1	1	1	1
Pigment	Phosphorescent pigment	GGL-300FF	40	40	40	40	20	60	80	40	10	100	-	-
		Classified product of GGL-300FF	-	-	-	-	-	-	-	-	-	-	40	-
	D-1165		-	-	-	-	-	-	-	-	-	-	-	40
Total (part by mass)			141	141	141	141	121	161	181	141	111	201	141	141
Physical properties of toner	Acid value (mgKOH/g)		17.8	18.0	13.2	18.0	18.2	18.1	18.0	9.1	17.9	18.2	18.1	18.0
	Particle diameter	P50	6.0	8.0	6.2	6.1	6.0	5.8	6.0	6.1	6.1	6.1	6.0	6.1
		P20-P25(F powder)	4.5	6.1	4.6	4.5	4.6	4.5	4.6	4.6	4.5	4.6	4.6	4.5
		P80-P85(G powder)	7.6	10.5	7.5	7.6	7.7	7.6	7.6	7.6	7.5	7.7	7.5	7.6
	Al intensity (kcps)	P50	321	330	338	324	193	455	531	230	101	603	174	462
		P20-P25(F powder)	288	295	314	283	159	408	486	276	87	565	172	488
		P80-P85(G powder)	329	340	345	333	196	459	538	208	106	612	177	454
		Ratio (G/F)	1.14	1.15	1.10	1.18	1.23	1.13	1.11	0.75	1.22	1.08	1.03	0.93

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[0214] The materials used in the compositions as illustrated in Table 1 above are as follows.

<Binder resin>

[0215]

Polyester resin 1 (RN-306SF, manufactured by Kao Corporation, low acid value resin, acid value: 8 mgKOH/g)
Polyester resin 2 (RN-290, manufactured by Kao Corporation, high acid value resin, acid value: 27 mgKOH/g)

<Release agent>

[0216] Ester wax (WEP-5, manufactured by Nippon Oil & Fats Co., Ltd.)

<Charge control agent>

[0217] Zinc salicylate (E-304, manufactured by ORIENT CHEMICAL INDUSTRIES CO., LTD.)

<Phosphorescent pigment>

[0218]

GGL-300FF (manufactured by Nemoto & Co., Ltd., number average particle diameter: from 2.5 μm to 3.0 μm, metal aluminate, composition: $SrAl_2O_4$; Eu, Dy, green or yellow green phosphorescent pigment)
Classified product of GGL-300FF (number average particle diameter: 0.4 μm)

<Fluorescent pigment>

[0219] D-1165 (manufactured by Nemoto & Co., Ltd., number average particle diameter: from 2.0 μm to 2.5 μm, green fluorescent pigment)

<Preparation of Two-Component Developer>

[Preparation of Carrier]

[0220] A mixture of the following carrier raw materials was dispersed in a homomixer for 20 minutes to prepare a coating layer forming liquid. The coating layer forming liquid was applied on Mn ferrite particles having a mass average particle diameter of 40 μm as the core material using a fluidized bed coating apparatus so as to have an average film thickness of 0.20 μm at the core material surface by controlling the temperature in a fluidized tank to 70°C, and then dried. The resulting carrier was baked in an electric furnace at 180°C for two hours to obtain a carrier A.

(Raw Materials for Carriers)

[0221]

Silicone resin (organo straight silicone): 100 parts by mass
Toluene: 100 parts by mass
γ-(2-Aminoethyl)aminopropyltrimethoxysilane: 5 parts by mass
Carbon black: 10 parts by mass

[Preparation of Two-Component Developer]

[0222] The toner prepared in each of Examples 1 to 7 and Comparative Examples 1 to 5 and the carrier A were uniformly mixed with a TURBULA mixer (manufactured by Willy A. Bachofen (WAB) AG) at 48 rpm for 5 minutes to charge, thereby preparing a two-component developer, respectively. The mixing ratio of the toner and the carrier A was adjusted to the toner concentration (7% by mass) of the initial developer of an evaluator and the developer was obtained.

[0223] "Scratches on photoconductor" and "phosphorescence" were evaluated using the developer containing the toner prepared in each of Examples 1 to 7 and Comparative Examples 1 to 5. The evaluation result is illustrated in Table 2.

<Scratches on photoconductor>

[0224] Development was performed with a remodeled apparatus of a printer (imagio MF7070, manufactured by Ricoh Co., Ltd.) using the obtained two-component developers. White solid images and black solid images were continuously fed on A4 size paper (brand: RICOH MyPaper, manufactured by Ricoh Co., Ltd.) in 40% print mode, A4 size horizontal, under the MM environment (temperature: 23°C, humidity: 50% RH) for 5,000 sheets/day, both initially and after 100K sheets (100,000 sheets) runs.

[0225] After continuous paper feeding, the photoconductor surface was observed with an optical microscope to check for scratches on the photoconductor that lead or are likely to lead to image defects that are present. Based on the observation results, judgment was made according to the following criteria. The ranks A and B are considered to be practically used.

[Evaluation criteria]

[0226]

A: The surface of the photoconductor is very good.
B: Fewer than three scratches or white or black deposits of less than 10 mm in length and less than 0.5 mm in width are observed, and no scratches or white or black deposits of 10 mm or more in length or 0.5 mm or more in width are observed.
C: Three or more scratches or white or black deposits of less than 10 mm in length and less than 0.5 mm in width are observed, or scratches or white or black deposits of 10 mm or more in length or 0.5 mm or more in width are observed.

<Phosphorescence>

[0227] Development was performed with a remodeled apparatus of a printer (imagioMF7070, manufactured by Ricoh Co., Ltd.) using the obtained two-component developers. A solid image with adhered amount of 1.2 mg/cm^2 was formed in a A4 size paper under a moderate-temperature and moderate-humidity (MM) environment (temperature: 23°C, humidity: 50% RH), left under a fluorescent light of 2,000 lux for 5 minutes, and then phosphorescence was visually evaluated in a dark room based on the following evaluation criteria.

[Evaluation criteria]

[0228]

A: Fluorescence can be visually recognized both after 30 seconds and after 10 minutes, and fluorescence can be recognized even after 10 seconds of lighting the fluorescent lamp.
B: Fluorescence can be visually recognized both after 30 seconds and after 10 minutes, and although the coloring is fading, fluorescence can still be recognized after 10 seconds of lighting the fluorescent lamp, and there is no problem in actual use.
C: Either one or both of the fluorescence after 30 seconds and 10 minutes cannot be visually recognized, or the fluorescence is faint but the difference between the edge and the white paper part cannot be clearly recognized after 10 seconds of lighting the fluorescent lamp.

Table 2

	Evaluation result	
	Scratches on photoconductor	Phosphorescence
EXAMPLE 1	A	A
EXAMPLE 2	A	A
EXAMPLE 3	A	A
EXAMPLE 4	A	A
EXAMPLE 5	A	B

(continued)

	Evaluation result	
	Scratches on photoconductor	Phosphorescence
EXAMPLE 6	A	A
EXAMPLE 7	B	A
COMPARATIVE EXAMPLE 1	C	B
COMPARATIVE EXAMPLE 2	A	C
COMPARATIVE EXAMPLE 3	C	A
COMPARATIVE EXAMPLE 4	A	C
COMPARATIVE EXAMPLE 5	C	None

[0229] As described above, although some embodiments are described, it should be noted that the above embodiments are presented as examples, and the disclosure is not limited by the above embodiments. The above embodiments may be implemented in various other forms, and various combinations, omissions, substitutions, changes, etc. may be made without departing from the scope of the disclosure. These embodiments and variations thereof are included in the scope of the disclosure, as well as in the gist of the disclosure and its equivalents described in the claims.

[0230] Aspects of the present disclosure are as follows, for example.

First Aspect

[0231] A toner contains a phosphorescent pigment that contains Al element and Sr element. The toner has an acid value of 10 mgKOH/g or more. The toner shows an Al intensity of from 180 kcps to 600 kcps when irradiated with fluorescent X-rays. A ratio (G/F) of an Al intensity measured when P80 to P85 particles (G) in a number-based particle size distribution of the toner are irradiated with fluorescent X-rays to an Al intensity measured when P20 to P25 particles (F) in the number-based particle size distribution of the toner are irradiated with fluorescent X-rays is from 1.05 to 1.25. A content of the phosphorescent pigment is 45% by mass or less.

Second Aspect

[0232] In the toner according to the first aspect, the phosphorescent pigment is a metal aluminate.

Third Aspect

[0233] In the toner according to the second aspect, the metal aluminate is $SrAl_2O_4$ or $Sr_4Al_{14}O_{25}$.

Fourth Aspect

[0234] In the toner according to any one of the first to third aspects, the content of the phosphorescent pigment is from 20% by mass to 45% by mass.

Fifth Aspect

[0235] In the toner according to any one of the first to fourth aspects, the toner has an acid value of from 12 mgKOH/g to 30 mgKOH/g.

Sixth Aspect

[0236] A toner storage container storing the toner according to any one of the first to fifth aspects.

Seventh Aspect

[0237] An image forming apparatus includes: the toner storage container according to the sixth aspect; an electrostatic latent image bearer; an electrostatic latent image forming device to form an electrostatic latent image on the electrostatic

latent image bearer; a developing device to develop the electrostatic latent image with the toner to form a toner image; a transfer device to transfer the toner image onto a recording medium; and a fixing device to fix the transferred toner image on the recording medium.

Eighth Aspect

[0238] An image forming method includes: forming an electrostatic latent image on an electrostatic latent image bearer; developing the electrostatic latent image with the toner according to any one of the first to fifth aspects to form a toner image; transferring the toner image onto a recording medium; and fixing the transferred toner image on the recording medium.

[0239] The toner according to any one of the first to fifth aspects, the toner storage container according to the sixth aspect, the image forming apparatus according to the seventh aspect, and the image forming method according to the eighth aspect can solve various conventional problems and achieve the object of the present disclosure.

[0240] Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

Claims

1. A toner comprising:

a phosphorescent pigment that contains Al element and Sr element,
wherein the toner has an acid value of 10 mgKOH/g or more,
the toner shows an Al intensity of from 180 kilo counts per second (kcps) to 600 kcps when irradiated with fluorescent X-rays,
a ratio (G/F) of an Al intensity measured when P80 to P85 particles (G) in a number-based particle size distribution of the toner are irradiated with fluorescent X-rays to an Al intensity measured when P20 to P25 particles (F) in the number-based particle size distribution of the toner is from 1.05 to 1.25, and
a content of the phosphorescent pigment is 45% by mass or less.

2. The toner according to claim 1,
wherein the phosphorescent pigment is a metal aluminate.

3. The toner according to claim 2,
wherein the metal aluminate is $SrAl_2O_4$ or $Sr_4Al_{14}O_{25}$.

4. The toner according to any one of claims 1 to 3,
wherein the content of the phosphorescent pigment is from 20% by mass to 45% by mass.

5. The toner according to any one of claims 1 to 4,
wherein the toner has an acid value of from 12 mgKOH/g to 30 mgKOH/g.

6. A toner storage container (100Y, 100C, 100M, 100K) storing the toner according to any one of claims 1 to 5.

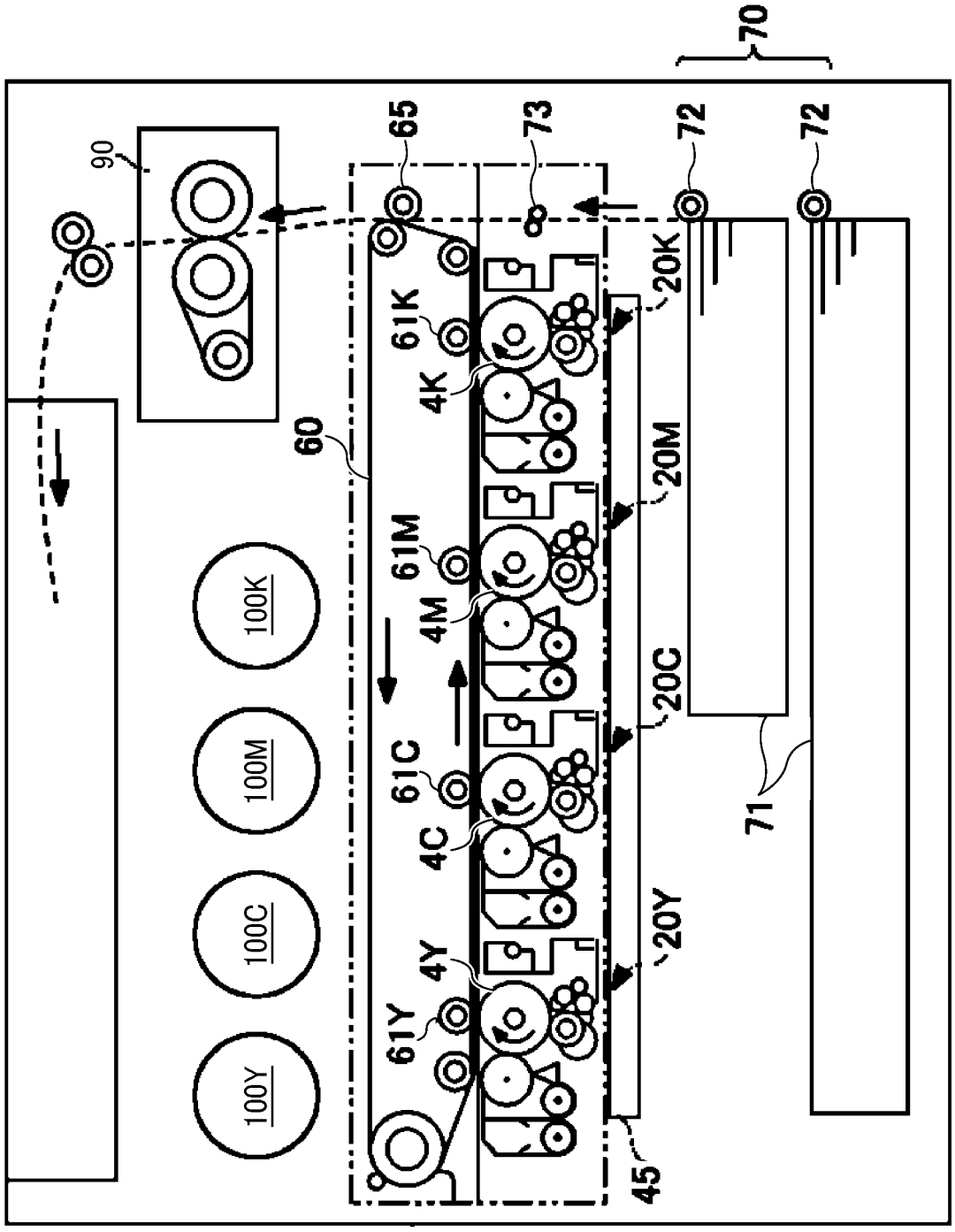
7. An image forming apparatus comprising:

the toner storage container (100Y, 100C, 100M, 100K) according to claim 6;
an electrostatic latent image bearer (4Y, 4C, 4M, 4K; 4; 5, 11, 17, 23, 29);
an electrostatic latent image forming device (45; 40; 6, 12, 18, 24, 30) to form an electrostatic latent image on the electrostatic latent image bearer (5, 11, 17, 23, 29);
a developing device (50; 8, 14, 20, 26, 32) to develop the electrostatic latent image with the toner to form a toner image;
a transfer device (61Y, 61C, 61M, 61K, 60, 65; 10, 16, 22, 28, 34, 40, 41) to transfer the toner image onto a recording medium; and
a fixing device (90; 43) to fix the transferred toner image on the recording medium.

8. An image forming method comprising:

forming an electrostatic latent image on an electrostatic latent image bearer;
developing the electrostatic latent image with the toner according to any one of claims 1 to 5 to form a toner image;
transferring the toner image onto a recording medium; and
fixing the transferred toner image on the recording medium.

FIG. 1


70
65
73
72
72
90
20K
61K
4K
60
20M
61M
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20C
61C
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61Y
100Y
45

FIG. 2

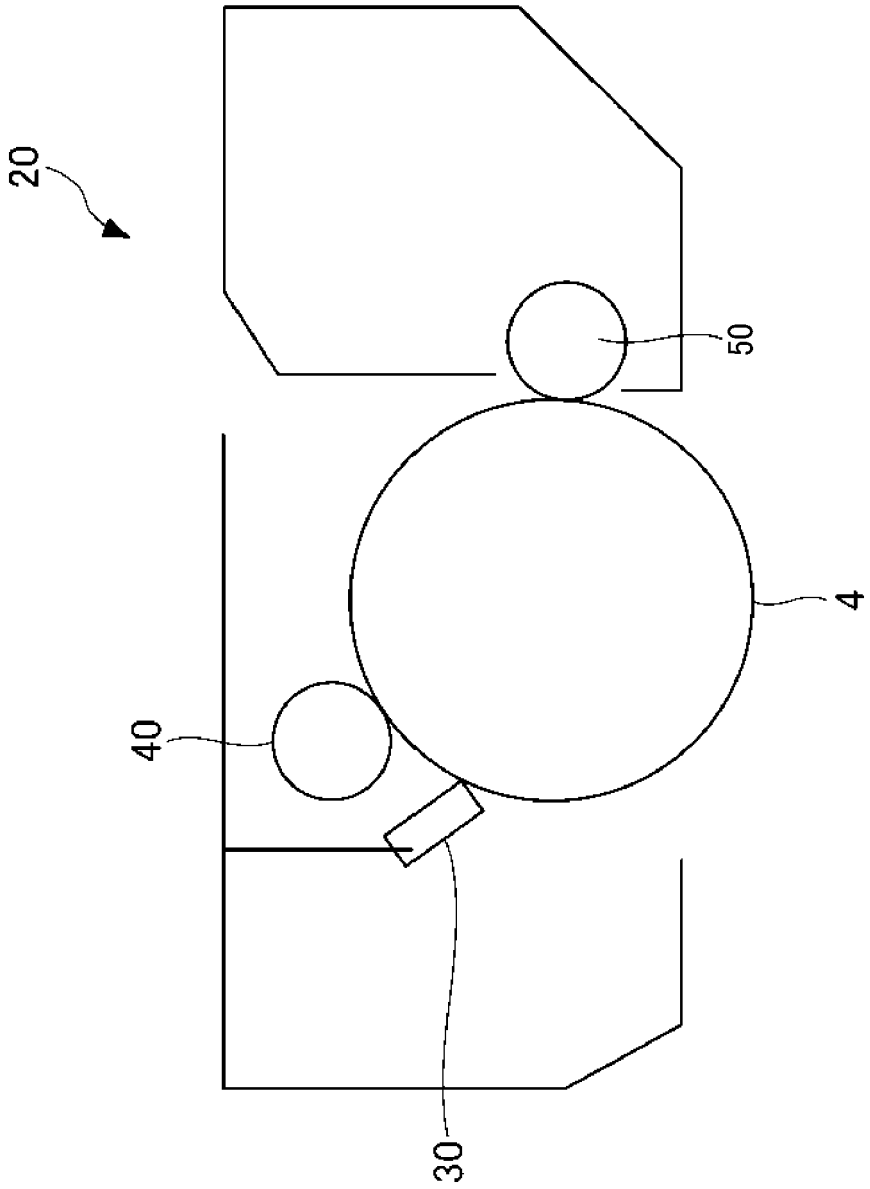
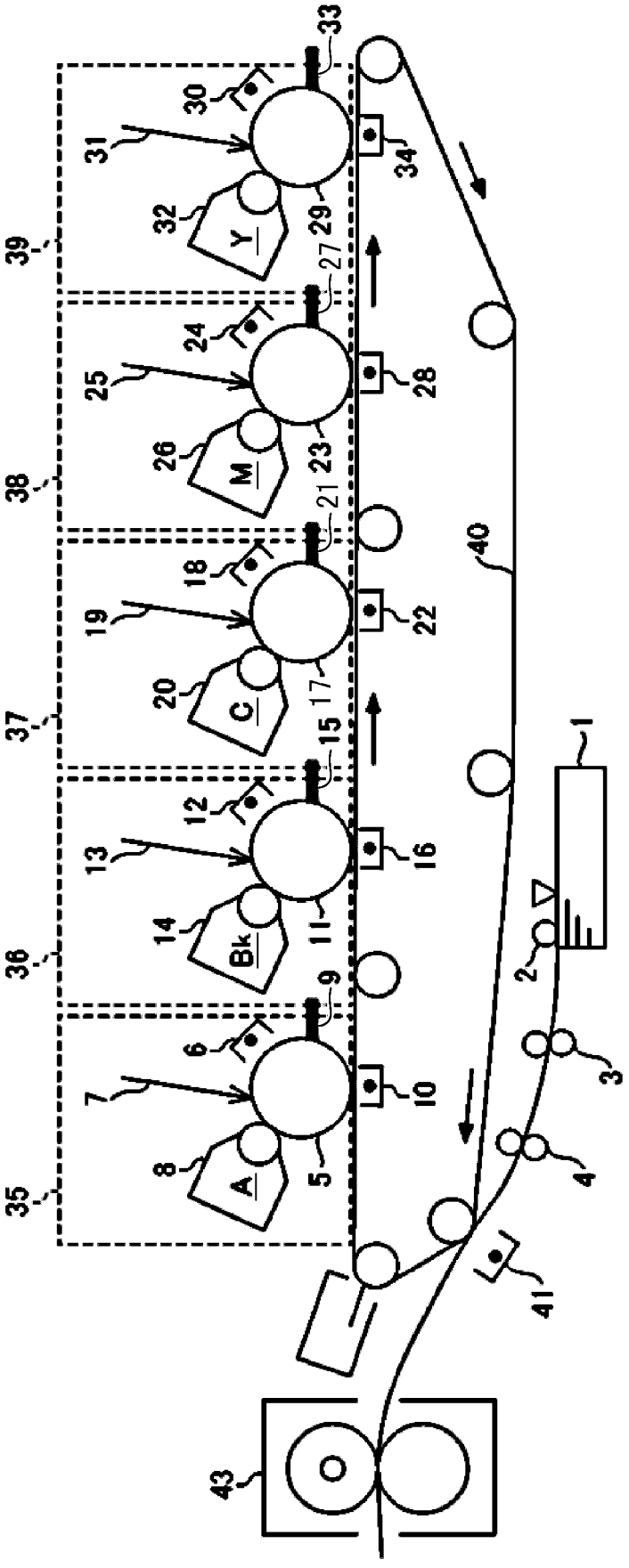


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 24 16 1859

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2003/054277 A1 (FUJIKURA YUKIHIRO [JP]) 20 March 2003 (2003-03-20) * paragraphs [0027], [0037], [0039], [0041], [0056] * * paragraphs [0078] - [0085]; example 1 * * paragraphs [0086], [0090], [0099], [0104]; examples 2,3,7,8 *	1-8	INV. G03G9/087 G03G9/09 G03G9/08
A	US 2013/280648 A1 (GILSON CARRIE A [US] ET AL) 24 October 2013 (2013-10-24) * claims 1,2,4,6; examples I-IV *	1-8	
A	US 2022/100112 A1 (KNOWLES ALEXANDER [US] ET AL) 31 March 2022 (2022-03-31) * paragraphs [0008], [0011], [0012], [0035], [0037]; claims 1,7,8,9,11,20 *	1-8	
			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
The Hague	26 July 2024	Vogt, Carola

CATEGORY OF CITED DOCUMENTS

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26-07-2024

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