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(54) **TONER AND IMAGE FORMING APPARATUS**

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(57) **ABSTRACT**

A toner comprises toner particles and an external additive adhering to surfaces of the toner particles, wherein the toner particle includes a crystalline polyester resin and a wax, the external additive includes organic/inorganic composite fine particles and an associated silica having two or more primary particles being associated with each other, and the toner has a softening point of 110° C. or lower.

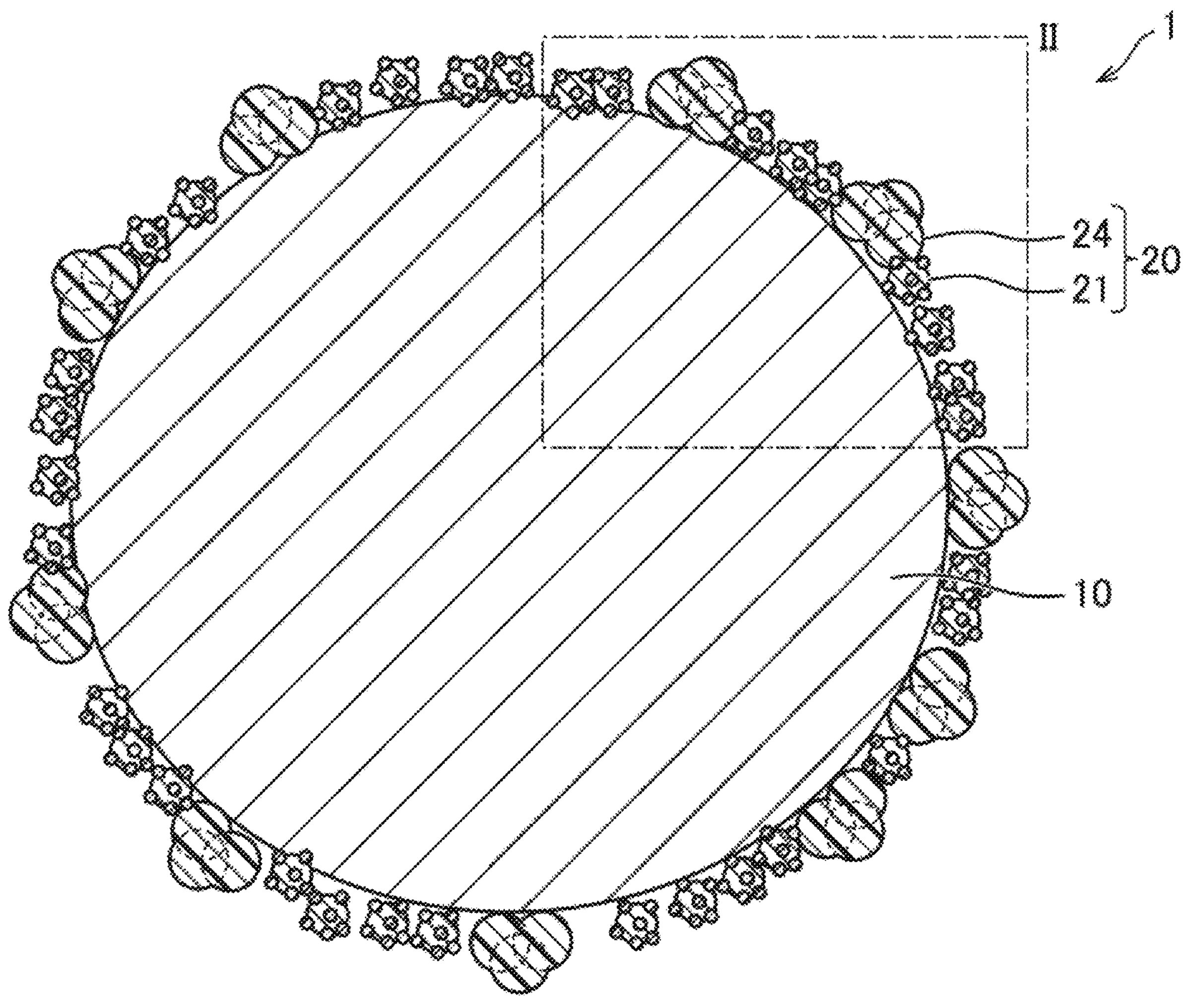


FIG. 1

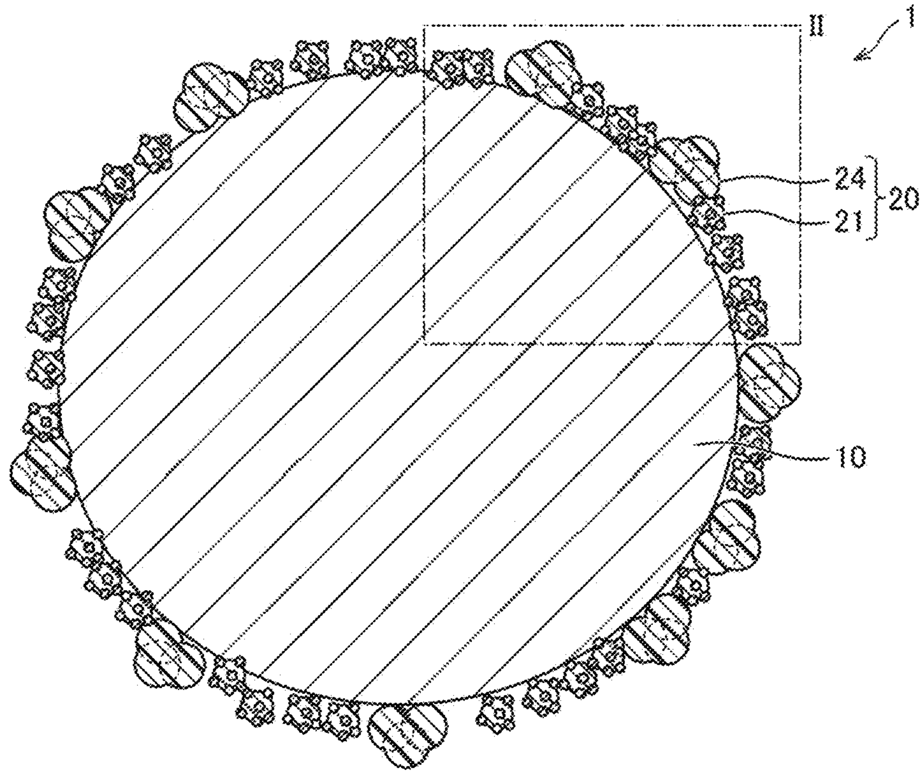


FIG. 2

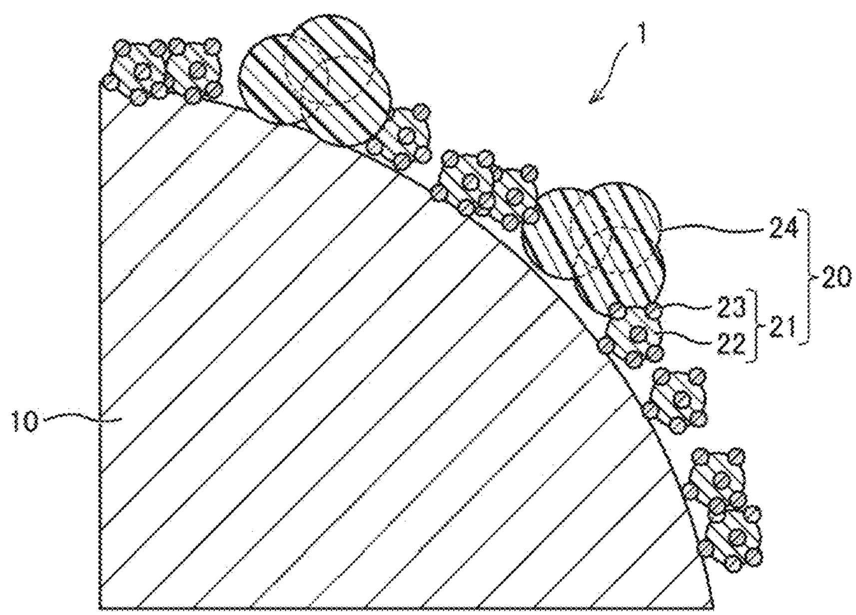


FIG. 3

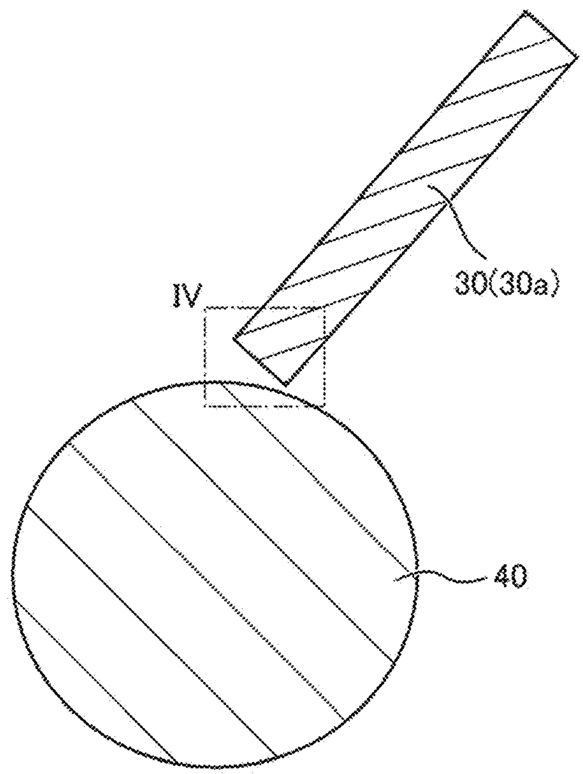


FIG. 4

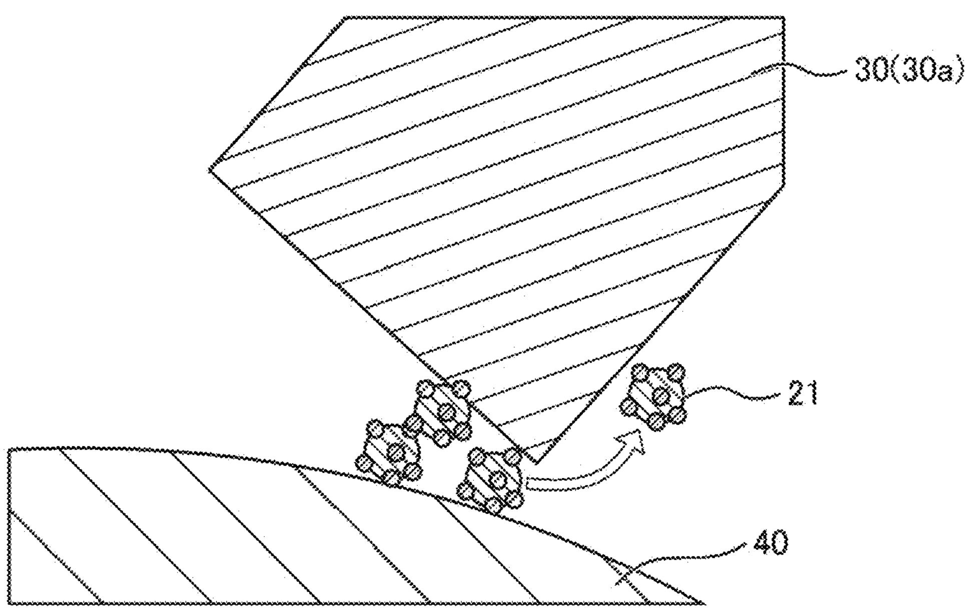


FIG. 5

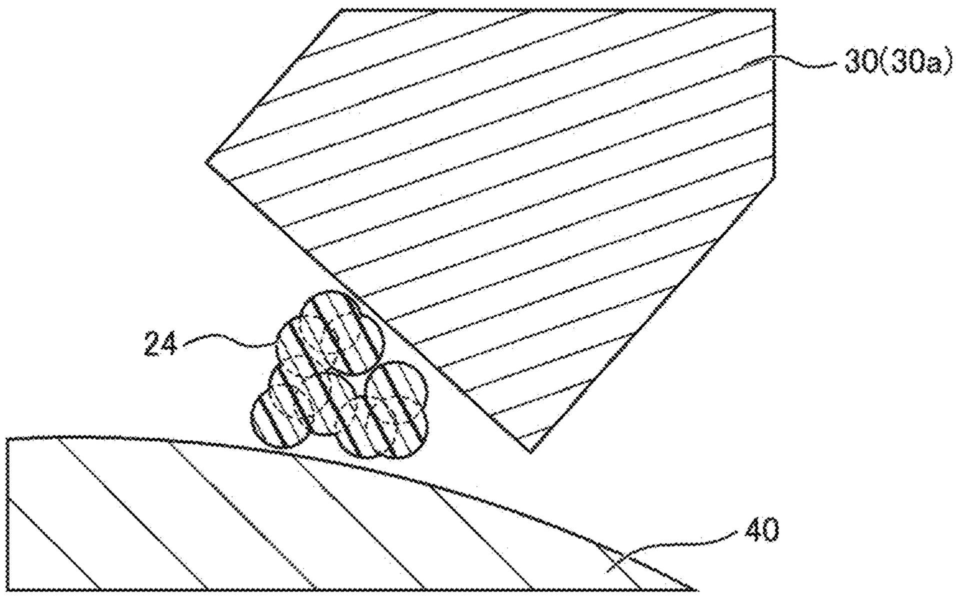


FIG. 6

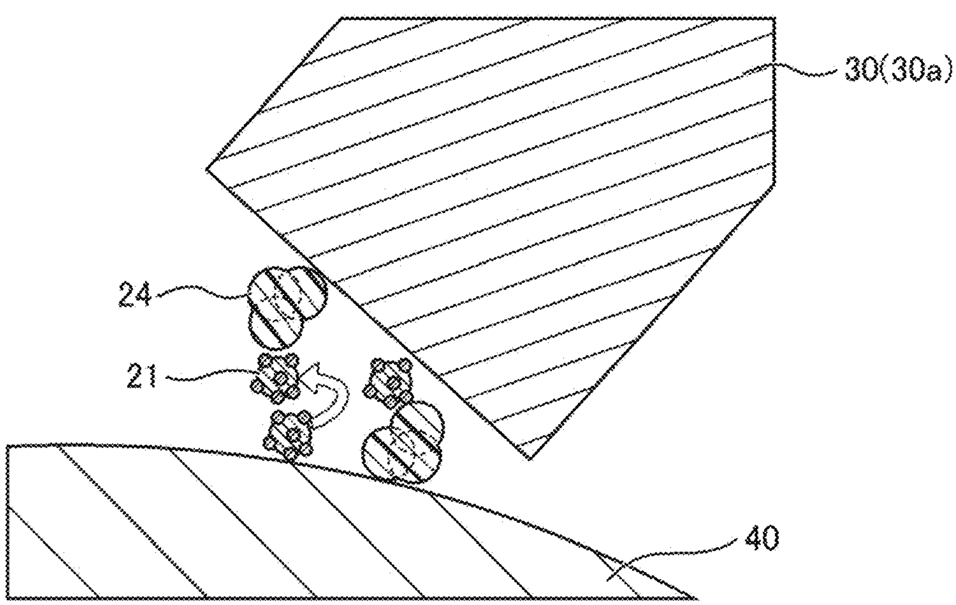
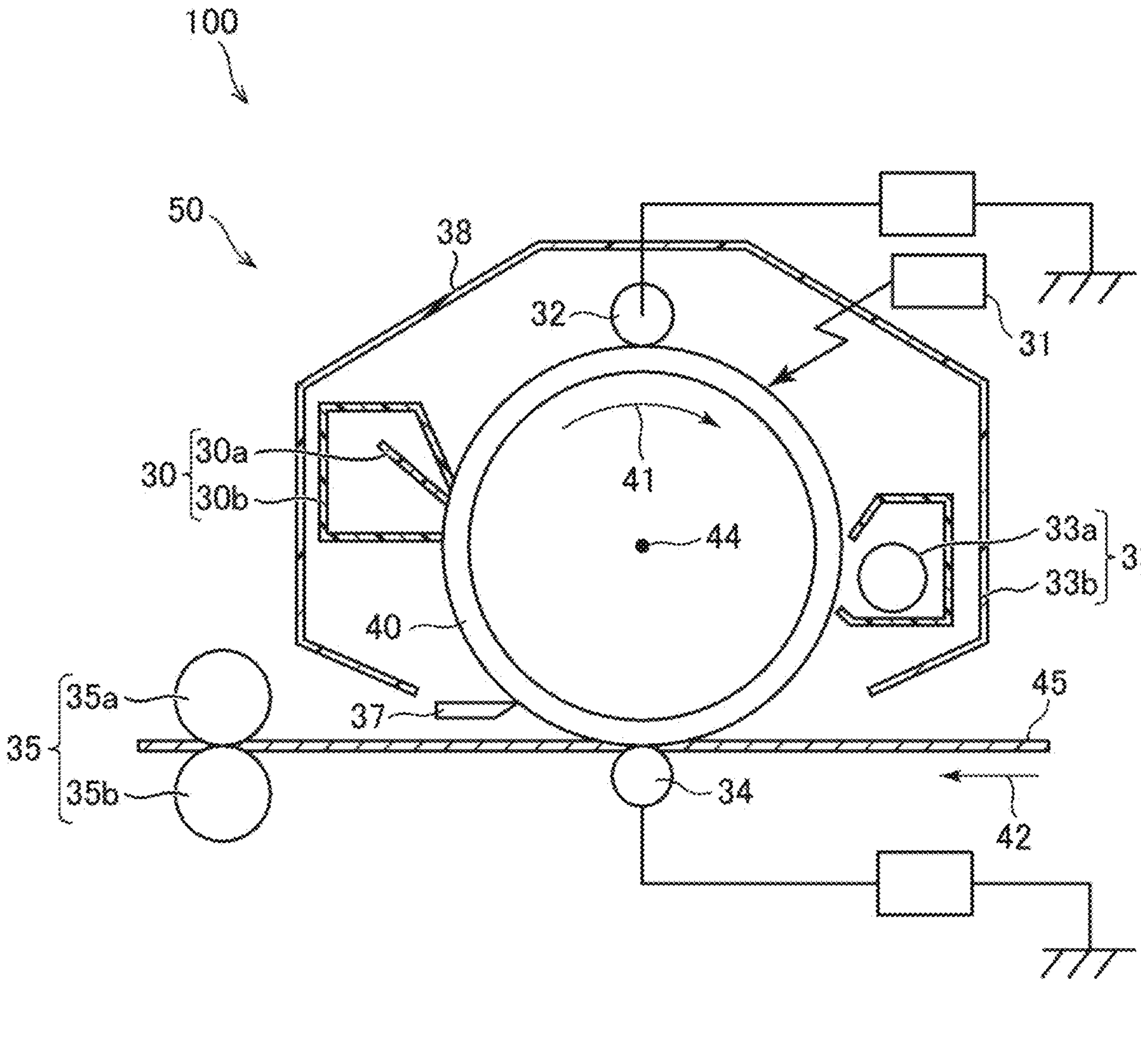


FIG. 7



TONER AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from Japanese Application JP2024-018223, the content of which is hereby incorporated by reference into this application.

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0002] The present disclosure relates to a toner and an image forming apparatus.

2. Description of the Related Art

[0003] Conventionally, there has been known a toner.

[0004] For example, there is known a method for producing associated silica, where hydrophobic spherical silica fine particles having an average primary particle diameter of 0.01 to 200 nm are reacted in a humidified atmosphere at a temperature of 100 to 500° C. to obtain two or more primary particles having an average particle diameter in a range of 5 to 500 nm associated with each other, and there is known a toner having such an associated silica externally added to a surface of the toner particles.

[0005] There is also known a toner including toner particles and organic/inorganic composite fine particles on surfaces of the toner particles, where the organic/inorganic composite fine particles include resin fine particles and inorganic fine particles embedded in surfaces of the resin fine particles, a part of the inorganic fine particles is exposed on the surface of the organic/inorganic composite fine particles, the organic/inorganic composite fine particles satisfy a predetermined relationship, and the organic/inorganic composite particles are externally added to the surfaces of the toner particles.

SUMMARY OF THE DISCLOSURE

[0006] However, in the above toner, when external additives adhering to a surface of a photoreceptor is cleaned with a cleaning blade, the organic/inorganic composite particles may slip through the cleaning blade, or a filming may occur.

[0007] Therefore, in view of the above problems, the present disclosure provides a toner and an image forming apparatus by which it is possible to reduce a slip-through from a cleaning blade and reduce a filming without impairing a low-temperature fixability.

[0008] One aspect of the present disclosure is a toner including toner particles and an external additive adhering to a surface of the toner particles, in which each toner particle includes a crystalline polyester resin and a wax, the external additive includes organic/inorganic composite fine particles and an associated silica, and a softening point of the toner is 110° C. or lower.

[0009] An image forming apparatus according to another aspect of the present disclosure includes the toner, an electrophotographic photoreceptor, and an image former.

[0010] As described above, according to the present disclosure, it is possible to provide a toner and an image forming apparatus by which it is possible to reduce a slip-through from a cleaning blade and reduce a filming without impairing a low-temperature fixability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a schematic cross-sectional view of a toner according to the present disclosure.

[0012] FIG. **2** is an enlarged view of a part II in FIG. **1**.

[0013] FIG. **3** is a diagram illustrating how an external additive adhering to a surface of a photoreceptor is cleaned by a cleaning blade.

[0014] FIG. **4** is a diagram illustrating how the external additive adhering to the surface of the photoreceptor is cleaned by the cleaning blade, and illustrates a case in which the external additive includes only organic/inorganic composite fine particles.

[0015] FIG. **5** is a diagram illustrating how the external additive adhering to the surface of the photoreceptor is cleaned by the cleaning blade, and illustrates a case in which the external additive includes only an associated silica.

[0016] FIG. **6** is a diagram illustrating how the external additive adhering to the surface of the photoreceptor is cleaned by the cleaning blade, and illustrates a case in which the external additive includes organic/inorganic composite fine particles and an associated silica.

[0017] FIG. **7** is a schematic side view illustrating a configuration of main components of an image forming apparatus according to the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0018] A preferred embodiment of the present disclosure will be described in detail with reference to the drawings, below. Note that the present embodiment described below does not unduly limit the content of the present disclosure described in the claims, and not all of the configurations described in the present embodiment are necessarily essential as a solution to the present disclosure.

Toner

[0019] FIG. **1** is a schematic cross-sectional view of a toner **1** according to the present disclosure. FIG. **2** is an enlarged view of a part II in FIG. **1**. As illustrated in FIG. **1** and FIG. **2**, the toner **1** according to the present disclosure includes toner particles **10** and an external additive **20** adhering to the surface of each toner particle **10**. A softening point of the toner **1** is 110° C. or lower. First, a method for producing the toner **1** will be described.

[0020] The method for producing the toner **1** includes producing toner particles in which each toner particle **10** (toner core) is produced.

[0021] In the producing toner particles, each toner particle **10** serving as a core of the toner **1** is produced. As described above, each toner particle **10** is a particle including a binder resin, a release agent, and a colorant, and a method for producing the toner particle **10** includes, for example, a dry method such as a pulverization method, and a wet method such as a suspension polymerization method, an emulsion aggregation method, a dispersion polymerization method, a solution suspension method, and a melt emulsification method. Each toner particle **10** is added with a crystalline polyester resin and a wax. Therefore, each toner particle **10** includes a crystalline polyester resin and a wax. A method for producing each toner particle **10** by a pulverization method will be described below.

[0022] If each toner particle **10** is produced by a pulverization method, a toner composition including a binder resin, a release agent, and optionally a colorant and a charge control agent is dry-mixed in a mixer and then melt-kneaded in a kneader. The kneaded product obtained by melt-kneading is cooled and solidified, and the solidified product is pulverized by a pulverizer. Thereafter, a particle size is adjusted by classification or the like as necessary to obtain each toner particle **10**.

[0023] Examples of the mixer include a Henschel type mixer such as Henschel Mixer (product name, manufactured by Mitsui Mining Co., Ltd.), Super Mixer (product name, manufactured by Kawata Co., Ltd.), and Mechano Mill (product name, manufactured by Okada Seiko Co., Ltd.), Ongmill (product name, manufactured by Hosokawa Micron Corporation), Hybridization System (product name, manufactured by Nara Machinery Works, Ltd.), and Cosmo System (product name, manufactured by Kawasaki Heavy Industries, Ltd.).

[0024] An example of the kneader includes a general kneader such as a twin-screw extruder, a three-roll mill, or a lab blast mill. More specifically, examples of the kneader include a single- or twin-screw extruder such as TEM-100B (product name, manufactured by Toshiba Machine Co., Ltd.), PCM-65/87, and PCM-30 (all of which are product names, manufactured by Ikegai Corporation), and an open-roll type kneader such as Kneadex (product name, manufactured by Mitsui Mining Co., Ltd.). In particular, the open-roll type kneader is preferred.

[0025] Examples of a crusher include a jet crusher using a supersonic jet stream to crush a material, and an impact crusher introducing a solidified material into a space formed between a rotor rotating at high speed and a stator (liner) to crush the material.

[0026] An example of a classifier includes a cyclone-type wind classifier (rotary type wind classifier).

[0027] The toner **1** of the present disclosure produced as described above is mixed with the external additive **20** functioning to improve a powder fluidity, a frictional electrification property, a heat resistance, a long-term storage property, a cleaning property, and to control a surface wear property of a photoreceptor **40**, and the external additive **20** adheres to the surface of each toner particle **10**.

[0028] An example of the external additive **20** includes inorganic fine particles such as silica, titanium oxide, or alumina having an average particle diameter of 7 to 200 nm, and each inorganic fine particle imparted with hydrophobicity by surface treatment in which a silane coupling agent, a titanium coupling agent, or silicone oil are applied to a surface of each inorganic fine particle is preferable because it is possible to reduce a decrease in electrical resistance and charge amount under a high humidity condition.

[0029] An amount of the external additive **20** to be added externally is preferably 0.2 to 3 parts by weight relative to each toner particle **10**. If the amount is less than 0.2% by weight, it may be difficult to improve a fluidity, whereas if the amount exceeds 3% by weight, a fixing property may decrease. More preferably, the external additive **20** is added externally in an amount of 1.0 to 1.2 parts by weight relative to each toner particle **10**. If the amount of the external additive **20** is less than 1.0 part by weight relative to each toner particle **10**, a spacer effect may not be expected. On the other hand, if the amount of the external additive **20** is more than 1.2 parts by weight relative to each toner particle **10**, the external additive **20** detached from the toner particle **10** may cause a filming.

[0030] For the method for adding the external additive **20**, a method of mixing each toner particle **10** and the external additive **20** with an air flow mixer such as a Henschel mixer is generally used.

[0031] The toner **1** to which the external additive **20** is externally added as described above may be directly used as a one-component developer, or may be used by mixing the toner **1** with a carrier as a two-component developer. If used as the one-component developer, the toner is used alone without any carriers. If used as the one-component developer, the toner is transported by using a cleaning blade **30***a* and a fur brush to frictionally charge the toner with a developing sleeve and adhering the toner to such a sleeve, to form an image.

[0032] The external additive **20** contains organic/inorganic composite fine particles **21** and an associated silica **24**.

[0033] As illustrated in FIG. **2**, each organic/inorganic composite fine particle **21** contains a polymer **22** and the above-mentioned inorganic fine particle (inorganic material **23**). The organic/inorganic composite fine particle **21** added as an external additive in the toner **1** according to the present disclosure includes a structure in which the inorganic fine particle (inorganic material **23**) is embedded in the polymer **22** so that a plurality of protrusions derived from the inorganic fine particle are present on a surface of the resin particle. Examples of such organic/inorganic composite fine particles **21** include a metal oxide-polymer composite particle in which a metal oxide is covalently bonded to a polymer, as described in Japanese Patent Application Publication No. 2013-92748, and a specific example thereof includes ATLAS (product name) manufactured by Cabot Corporation. Each organic/inorganic composite fine particle may be used after being partially or entirely modified by a surface treatment, and for example, each organic/inorganic composite fine particle surface-treated with a hydrophobizing agent as described in Japanese Patent Application Publication No. 2013-92748 is suitable as an external additive.

[0034] As described above, the inorganic material **23** may include metal oxide particles.

[0035] Each metal oxide particle is covalently bonded to the polymer **22**, a surface of the metal oxide is modified with a first hydrophobizing agent, a moisture content of the metal oxide-polymer composite particle is from 0 wt % to about 10 wt %, as measured after equilibration at 50% relative humidity and 25° C. at about 1 atmosphere, and a density of the metal oxide-polymer composite particle is from about 30% to about 90% of a density of the metal oxide as measured by helium pycnometry.

[0036] A moisture content of each metal oxide-polymer composite particle may be from 0 wt % to about 5 wt %, as measured after equilibration at 50% relative humidity and 25° C. at about 1 atmosphere. A toner composition may contain from about 0.5 to about 7 wt % of the metal oxide-polymer composite particle. The metal oxide-polymer composite particle is from about 50 nm to about 500 nm in diameter. At least a portion of the metal oxide particle may be exposed at a surface of the metal oxide-polymer composite particle.

[0037] The polymer **22** may include the polymer **22** or a copolymer of a first hydrophobizing agent. The metal oxide particle may include a precipitated or colloidal metal oxide particle. A surface of the metal oxide particle may be modified with a second hydrophobizing agent. The second hydrophobizing agent may be selected from a silazane compound, a siloxane compound, a silane compound, and a silicone fluid having a number average molecular weight of at most 10,000. The first hydrophobizing agent has a formula Si [H3-x(OR1)x]R2Q, where x is 1, 2 or 3, R1 is methyl or ethyl, R2 is an alkyl linker having a general formula CnH2n (n is 1 to 10), and Q is a substituted or unsubstituted vinyl, acrylate, or methacrylate group.

[0038] The metal oxide-polymer composite particle may be treated with a third hydrophobizing agent. The third hydrophobizing agent may be an alkylhalosilane or a silicone fluid having a number average molecular weight greater than 10,000. The polymer **22** may be selected from acrylates and methacrylates, olefins, vinyl esters, acrylonitriles, copolymers, and mixtures thereof. The metal oxide-polymer composite particle may have an aspect ratio of from about 0.8 to about 1.2. From about 5% to about 95% of a length of the metal oxide particle may be exposed at a surface of the metal oxide-polymer composite particle.

[0039] The associated silica **24** used in the present disclosure is not a secondary particle (aggregate) in which primary particles are loosely attached to one another to be collected, but is a secondary particle in which the primary particles are firmly attached and are not easily disintegrated. Thus, the associated silica **24** means a particle in which two or more primary particles are associated to form a chain, a fiber, or other irregular forms. Examples of such a form include a particle in which two primary particles are associated, a particle in which three or more primary particles are associated in a chain, a particle in which three primary particles are associated at three points, a particle in which four primary particles are associated in a planar or tetrapod-shaped configuration, similarly, a particle in which five or more particles are associated, and a particle in which such associate-type silica groups are combined to each other. Here, the "primary particle" refers to the smallest unit of particles forming a powder. Such particles (associated silica **24**) are more advantageous in terms of a shape and an area of an adhesive surface to a toner surface or the like than a particle in an ordinary form in which the primary particles are collected to form a sphere or aggregated to form a lump. It is noted that the "primary particle" mentioned here indicates the smallest unit of particles forming a powder.

[0040] Examples of such a form include a particle in which two primary particles are associated, a particle in which three or more primary particles are associated in a chain, a particle in which three primary particles are associated at three points, a particle in which four primary particles are associated in a planar or tetrapod-shaped configuration, similarly, a particle in which five or more particles are associated, and a particle in which such associate-type silica groups are combined to each other.

[0041] Here, the "primary particle" refers to the smallest unit of particles forming a powder. The associated-type silica particle has a larger contact (adhesion) area to a surface of a toner base particle than a silica particle in an ordinary form, and therefore, such a particle is difficult to detach from a toner surface. Further, the associated-type silica particle has an irregular shape, and thus, such a particle is less likely to form an aggregate, and therefore, it is possible to suppress an occurrence of a filming while ensuring a sufficient spacer effect.

[0042] An average particle diameter of the primary particle of the associated silica **24** used in the present disclosure is preferably 10 nm or more and 200 nm or less. When the average particle diameter of the primary particle of the associated silica is within a range of 10 nm or more and 200 nm or less, it is possible to prevent an aggregation of the toner **1** and to improve a transferability of the toner **1**, which are functions required for the external additive **20**.

[0043] A shape of the primary particle forming the associate-type silica may be any of spherical, egg-like, cubic, and rod-like, but for use as an external additive, the spherical shape is preferred. Further, particle diameters of the primary particle may be different from each other.

[0044] The associate-type silica may be produced by a method described in Japanese Patent Application Publication No. 2012-025596, and a commercially available product such as that used in Examples may also be used.

[0045] A softening point of the toner **1** according to the present disclosure is 110° C. or lower. The softening point is preferably 90° C. or higher and 110° C. or lower, more preferably 100° C. or higher and 110° C. or lower, and even more preferably 105° C. or higher and 110° C. or lower. If the softening point is less than the lower limit, the external additive **20** is likely to be embedded in the surface of the toner particle **10**, and as a result, a dispersibility deteriorates and a dispersibility of the silica particle also deteriorates. Consequently, an amount of film loss on a photosensitive drum may increase and an environmentally charging performance may deteriorate.

[0046] Next, a mechanism by which a slip-through and a filming occur will be described. FIG. **3** is a diagram illustrating how the external additive **20** adhering to the surface of the photoreceptor **40** is cleaned by the cleaning blade **30*a***. A case where the external additive **20** is only the organic/inorganic composite fine particle **21**, a case where the external additive **20** is only the associated silica **24**, and a case where the external additive **20** includes both the organic/inorganic composite fine particle **21** and the associated silica **24** will be described below.

[0047] FIG. **4** is a diagram illustrating how the external additive **20** adhering to the surface of the photoreceptor **40** is cleaned by the cleaning blade **30*a***, and illustrates a case in which the external additive **20** includes only the organic/inorganic composite fine particle **21**. FIG. **5** is a diagram illustrating how the external additive **20** adhering to the surface of the photoreceptor **40** is cleaned by the cleaning blade **30*a***, and illustrates a case in which the external additive **20** includes only the associated silica **24**. FIG. **6** is a diagram illustrating how the external additive **20** adhering to the surface of the photoreceptor **40** is cleaned by the cleaning blade **30*a***, and illustrates a case in which the external additive **20** includes the organic/inorganic composite fine particle **21** and the associated silica **24**.

[0048] If the external additive **20** includes only the organic/inorganic composite fine particle **21**, as illustrated in FIG. **4**, the organic/inorganic composite fine particle **21** has the inorganic material **23** on a surface of the polymer **22** and has a structure with a plurality of convex portions, and thus, the external additive **20** slips through the cleaning blade **30*a***, that is, a so-called slip-through phenomenon occurs.

[0049] On the other hand, if the external additive **20** includes only the associated silica **24**, as illustrated in FIG. **5**, the associated silica **24** tends to aggregate in particles and has an irregular shape, resulting in being prone to remaining on the cleaning blade **30*a***. Consequently, the external additive **20** aggregates, resulting in what is known as "filming".

[0050] Therefore, if the external additive **20** includes the organic/inorganic composite fine particles **21** and the associated silica **24** as in the toner **1** according to the present disclosure, as illustrated in FIG. **6**, when the toner **1** according to the present disclosure includes the associated silica **24** likely to remain in the external additive to a certain extent, it is possible to hold back the organic/inorganic composite fine particles **21**, and as a result, it is possible to reduce a slip-through and a filming.

[0051] However, if an amount of the associated silica **24** in the toner **1** is too small, it is not possible to hold back the organic/inorganic composite fine particles **21**, and thus, a slip-through may easily occur. On the other hand, if the amount of the associated silica **24** in the toner **1** is too large, the associated silica **24** may aggregate, which may cause a filming.

[0052] Therefore, it is preferable that the organic/inorganic composite fine particles **21** are contained in the external additive **20** in an amount of 75 to 90 wt %. If a content of the organic/inorganic composite fine particles **21** is less than 75 wt % relative to the external additive **20**, a filming may easily occur as described above. On the other hand, if the content of the organic/inorganic composite fine particles **21** is greater than 90 wt % relative to the external additive **20**, a slip-through of the external additive **20** may easily occur.

[0053] A particle diameter of the organic/inorganic composite fine particles **21** is preferably 70 to 200 nm. If the particle diameter of the organic/inorganic composite fine particles **21** is less than 70 nm, a spacer effect is reduced and the external additive **20** may often slip through the cleaning blade **30***a*. On the other hand, if the particle diameter of the organic/inorganic composite fine particles **21** is larger than 200 nm, an amount of the particles detached from the toner **1** may often increase. Therefore, if the particle diameter is set within the above range, it is possible to provide a spacer effect to the toner **1** because the organic/inorganic composite fine particles **21** are the external additives **20** having a large particle diameter. In addition, because of a shape having a plurality of convex portions, firm adherence to the surfaces of the toner particles **10** is possible and an uneven distribution to a concave portion of the toner particles **10** is unlikely to occur.

[0054] A degree of association of the associated silica **24** is preferably 2.0 to 3.0. It is possible to further reduce a filming. If the degree of association of the associated silica **24** is less than 2.0, a shape of the associated silica **24** approaches that of a spherical silica and the associated silica **24** tends to be unevenly distributed in the concave portion on the surface of the toner particles **10**, which may weaken the spacer effect. On the other hand, if the degree of association of the associated silica **24** is greater than 3.0, aggregates are likely to be formed by the cleaning blade **30***a*, which may worsen a filming. Therefore, when the above range is maintained, the associated silica **24** has an irregular and therefore tends to adhere firmly to the surface of the toner particles **10**. However, to exhibit the effect resulting from the irregular shape, a certain degree of association is necessary, and if the degree of association is too high, the particles detach from the cleaning blade **30***a* with difficulty.

[0055] A particle diameter of the associated silica **24** is preferably 100 to 300 nm. If the particle diameter of the associated silica **24** is less than 100 nm, the spacer effect may not be expected. On the other hand, if the particle diameter of the associated silica **24** is greater than 300 nm, aggregates are likely to be formed by the cleaning blade **30***a*, which may worsen the filming. Therefore, when the above range is maintained, it is possible to prevent formation of aggregates on the cleaning blade **30***a* and improve the filming.

[0056] A particle diameter of the organic/inorganic composite fine particles **21** is preferably smaller than the particle diameter of the associated silica **24**. Thus, it is possible to further prevent the slip-through of the organic/inorganic composite fine particles **21**.

[0057] It is also preferable that a bulk density of the toner **1** is 0.38 or more. Thus, the toner **1** has a good fluidity and is transferred to conform to an unevenness of a paper surface, resulting in high image quality.

[0058] It is preferable that an adhesion strength of the external additive **20** to the toner particles **10** is 70% or less. If the adhesion strength of the external additive **20** to the toner particles **10** is greater than 70%, the spacer effect may decrease, and the external additive **20** may be deeply embedded in the surface of the toner particles **10**, causing a fluidity of the toner **1** to deteriorate.

[0059] As described above, according to the toner **1** of the present disclosure, when both the organic/inorganic composite fine particles **21** and the associated silica **24** are externally added, a low-temperature fixing property is not impaired, and the associated silica **24** suppresses the organic/inorganic composite fine particles **21** from slipping through the cleaning blade **30***a*, it is possible to solve the problem. It is possible to ensure the fluidity of the toner **1**, and thus, it is possible to transfer the toner **1** in accordance with the unevenness of the paper surface, as a result of which it is possible to achieve a high image quality.

Image Forming Apparatus

[0060] FIG. **7** is a schematic side view illustrating a configuration of main components of an image forming apparatus **100** according to the present disclosure. The image forming apparatus **100** according to the present disclosure includes the above-described toner **1**, the photoreceptor **40** (hereinafter also referred to as the electrophotographic photoreceptor **40**), and an image former **50**. An example of the image forming apparatus **100** includes a laser printer.

[0061] The toner **1** described above is used.

[0062] The image former **50** charges the electrophotographic photoreceptor **40** with a charging roller **32** to form an image through exposure, transfer, and fixation. The image former **50** will be described, below.

[0063] As illustrated in FIG. **7**, the image former **50** includes a housing **38**, the charger **32** that charges the electrophotographic photoreceptor **40**, an exposer **31** that exposes the charged photoreceptor **40** to form an electrostatic latent image, a developer **33** that develops the electrostatic latent image formed by the exposure to form a toner image (to form a visible image), a transferer **34** that transfers the toner image formed by the development onto a recording medium **45**, a fixer **35** that fixes the transferred toner image onto the recording medium **45** to form an image, a cleaner **30** that removes and collects the external additive **20** remaining on the electrophotographic photoreceptor **40**, and a charge remover (not illustrated) that discharges a surface charge remaining on the electrophotographic photoreceptor **40**.

[0064] The electrophotographic photoreceptor **40** is rotatably supported by a main body of the image forming apparatus **100**, and is driven to rotate about a rotation axis **44** in a direction of an arrow **41** by a driver (not illustrated). The driver is configured to include, for example, an electric motor and a speed reduction gear, and drives the electrophotographic photoreceptor **40** to be rotated at a predetermined peripheral speed by transmitting a driving force to a conductive support body configuring a core body of the electrophotographic photoreceptor **40**. The charger (charging machine) **32**, the exposer **31**, the developer (developing machine) **33**, the transferrer (transfer charger) **34**, and the cleaner (cleaning machine) **30** are arranged in this order along an outer circumferential surface of the electrophotographic photoreceptor **40** from an upstream side to a downstream side in a rotation direction of the electrophotographic photoreceptor **40** as indicated by the arrow **41**.

[0065] The charger **32** is a roller charger that uniformly charges an outer circumferential surface of the electrophotographic photoreceptor **40** to a predetermined potential. The exposer **31** includes a semiconductor laser as a light source, and irradiates the surface of the electrophotographic photoreceptor **40** between the charger **32** and the developer **33** with a laser beam output from the light source to expose the charged outer peripheral surface of the electrophotographic photoreceptor **40** according to image information. The surface is repeatedly scanned with the light in a main scanning direction, that is, a direction in which the rotation axis **44** of the electrophotographic photoreceptor **40** extends, and such light beams are focused to form an electrostatic latent image on the surface of the electrophotographic photoreceptor **40** in sequence. That is, an amount of charge on the electrophotographic photoreceptor **40** that is uniformly charged by the charger **32** differs depending on whether the electrophotographic photoreceptor **40** is irradiated with the laser beam, and as a result, the electrostatic latent image is formed.

[0066] The developer **33** includes a developing roller **33*a*** being a developer that develops the electrostatic latent image formed on the surface of the electrophotographic photoreceptor **40** by exposure with a developing agent (toner **1**), the developing roller **33*a*** being provided facing the electrophotographic photoreceptor **40** and supplying the toner **1** to the outer circumferential surface of the electrophotographic photoreceptor **40**, and a casing **33*b*** that rotatably supports the developing roller **33*a*** about a rotation axis parallel to the rotation axis **44** of the electrophotographic photoreceptor **40** and that houses the developing agent including the toner **1** into an internal space therein.

[0067] The transferrer **34** is a transfer charger that transfers the toner image being a visible image formed on the outer circumferential surface of the electrophotographic photoreceptor **40** by development, onto a transfer paper being the recording medium **45** supplied between the electrophotographic photoreceptor **40** and the transfer charger **34** from a direction of the arrow **42** by a transporter not illustrated. The transferrer **34** is, for example, a contact-type transfer charger that includes the charger **32** and transfers the toner image onto the transfer paper by applying a charge of the opposite polarity to that of the toner **1** to the transfer paper.

[0068] As described above, the cleaner **30** removes the toner **1** and the external additive **20** remaining on the outer circumferential surface of the electrophotographic photoreceptor **40**. It is noted that the cleaner **30** removes the toner **1** and the external additive **20** after a transfer operation by the transfer charger **34**. The cleaner **30** is a cleaning machine that includes the cleaning blade **30*a*** that peels off the toner **1** and the external additives **20** remaining on the outer circumferential surface of the electrophotographic photoreceptor **40**, and a collection casing **30*b*** that houses the above-mentioned toner peeled off by the cleaning blade **30*a***. The cleaner **30** is provided together with a charge removing lamp (not illustrated).

[0069] In the cleaner **30**, the toner according to the present disclosure reduces the slip-through from the cleaning blade **30*a*** and reduces the filming.

[0070] The image forming apparatus **100** includes a fixing machine being the fixer **35** that fixes a transferred image, on a downstream side of a transport path of the transfer paper **45** passing between the electrophotographic photoreceptor **40** and the transfer charger **34**. The fixer **35** includes a heating roller **35*a*** including a heater (not illustrated), and a pressure roller **35*b*** arranged to face the heating roller **35*a*** and pressed against the heating roller **35*a*** to form a contactor. Reference numeral **37** denotes a segmenter **37** that segments the transfer paper **45** from the electrophotographic photoreceptor **40**, and reference numeral **38** denotes a casing that houses therein the above-mentioned components of the image forming apparatus **100**.

[0071] An image forming operation by the image forming apparatus **100** is performed as follows. First, when the electrophotographic photoreceptor **40** is driven to rotate in a direction of an arrow **41** by a driver, by the charger **32** provided upstream in the rotation direction of the electrophotographic photoreceptor **40** from an image forming point of the light by the exposer **31**, the surface of the electrophotographic photoreceptor **40** is uniformly charged to a predetermined positive potential.

[0072] Next, the exposer **31** irradiates the surface of the electrophotographic photoreceptor **40** with the light according to the image information. In the electrophotographic photoreceptor **40**, a surface charge of a portion irradiated with the light is removed by the exposure, and a difference occurs in surface potential between the surface potential of the portion irradiated with the light and the surface potential of a portion not irradiated with the light, and as a result, an electrostatic latent image is formed. From the developer **33** provided downstream in the rotation direction of the electrophotographic photoreceptor **40** from the image forming point of light by the exposer **31**, the toner **1** is supplied to the surface of the electrophotographic photoreceptor **40** formed thereon with the electrostatic latent image, and a toner image is formed.

[0073] In synchronization with the exposure of the electrophotographic photoreceptor **40**, the transfer paper **45** is supplied between the electrophotographic photoreceptor **40** and the transfer charger **34**. The transfer charger **34** applies a charge of the opposite polarity to that of the toner **1** to the supplied transfer paper **45**, and the toner image formed on the surface of the electrophotographic photoreceptor **40** is transferred onto the transfer paper. The transfer paper **45** onto which the toner image is transferred is transported by the transporter to the fixer **35**, and is heated and pressurized in passing through a contact area between the heating roller **35*a*** and the pressure roller **35*b*** of the fixer **35**, so that the toner image is fixed onto the transfer paper **45** to form a robust image. The transfer paper **45** on which the image is formed in such a manner is discharged to outside of the image forming apparatus **100** by the transporter.

[0074] On the other hand, the toner **1** remaining on the surface of the electrophotographic photoreceptor **40** even after the transfer of the toner image by the transfer charger **34** is peeled off from the surface of the electrophotographic photoreceptor **40** and collected by the cleaner **30**. The charge on the surface of the electrophotographic photoreceptor **40** from which the toner **1** is removed in such a manner is removed by light from a charge removing lamp, and the electrostatic latent image on the surface of the electrophotographic photoreceptor **40** disappears. Thereafter, the electrophotographic photoreceptor **40** is further driven to rotate and the series of operations starting from charging are repeated, and as a result, images are continuously formed.

[0075] A process cartridge includes the electrophotographic photoreceptor **40** according to the present disclosure, and at least one of the charger **32** that charges the electrophotographic photoreceptor **40**, the developer **33** that develops the electrostatic latent image formed by the exposure to form a toner image, and the cleaner **30** that removes the toner **1** remaining on the electrophotographic photoreceptor **40**.

[0076] For example, the process cartridge is configured by integrating the electrophotographic photoreceptor **40** of the present disclosure, a charging device, a developing device, and a cleaning device with a supporting member. When such a process cartridge is incorporated into the image forming apparatus **100**, the image forming apparatus **100** includes each of the components of the process cartridge. When the process cartridge is detachable and attachable from and to the image forming apparatus **100**, it is easy to replace the process cartridge when the process cartridge is worn out.

[0077] As described above, according to the image forming apparatus **100** of the present disclosure, it is possible to reduce a slip-through from the blade and reduce a filming without impairing a low-temperature fixing property.

EXAMPLE

[0078] The toner according to the present disclosure will be specifically described below with reference to examples and comparative examples, but the present disclosure is not limited to the examples described here.

Example 1

[0079] According to the above-mentioned particle production process, toner particles (toner cores) were obtained.

[0080] Next, 1.0 part by mass of silica particles "R976S" (manufactured by Nippon Aerosil Co., Ltd., particle diameter: 7 nm) was added to 100 parts by mass of the obtained toner particles, an airflow mixer (Henschel mixer, manufactured by Mitsui Mining Co., Ltd. (now Nippon Coke & Engineering Co., Ltd.), model: FM20C) with the tip speed of the mixing blade set to 40 m/s, was used, and the following ingredients were premixed for five minutes (mixing).

- **[0081]** Colorant: 7% by mass of C.I. Pigment Blue 15:3 (DIC Corporation)
- **[0082]** Release agent: 5% by mass of monoester wax (manufactured by NOF Corporation, product name: WEP-3)
- **[0083]** Charge control agent: 1% by mass of salicylic acid compound (Orient Chemical Industry Co., Ltd., product name: Bontron E-84)

[0084] Next, an open roll type continuous kneader (manufactured by Mitsui Mining Co., Ltd. (now Nippon Coke & Engineering Co., Ltd.), model: MOS320-1800) was used to melt and knead the materials to obtain a molten and kneaded product (kneading). Open roll setting conditions were as follows: a heating roll supply side temperature was set to 130° C., a discharge side temperature was set to 100° C., a cooling roll supply side temperature was set to 40° C., and a discharge side temperature was set to 25° C. A heating roll and a cooling roll used were rolls having a diameter of 320 mm and an effective length of 1,550 mm, and a gap between the rolls on both a supply side and a discharge side was set to 0.3 mm. A rotation speed of the heating roll was set to 75 rpm, a rotation speed of the cooling roll to 65 rpm, and a supply amount of the toner raw material was set to 5.0 kg/h.

[0085] The obtained molten and kneaded product was cooled with a cooling belt and then coarsely pulverized by using a speed mill including a φ2 mm screen to obtain a coarsely pulverized product. The obtained coarsely pulverized product was finely pulverized by using a jet pulverizer (manufactured by Nippon Pneumatic Mfg. Co., Ltd., model: IDS-2) to obtain a finely pulverized product (finely pulverizing).

[0086] Next, the obtained finely pulverized product was classified by using an elbow jet classifier (manufactured by Nittetsu Mining Co., Ltd., model: EJ-LABO) to obtain toner particles (classifying).

[0087] External addition conditions are as follows.

[0088] 100 parts by mass of the obtained toner particles were added with 1.0 parts by mass of silica particles "R976S" (manufactured by Nippon Aerosil Co., Ltd., particle diameter: 7 nm), and stirred for four minutes in an airflow mixer (Henschel mixer, manufactured by Mitsui Mining Co., Ltd. (now Nippon Coke & Engineering Co., Ltd.), model: FM20C) with the tip speed of the mixing blade set to 40 m/s. Then, an external additive A and an external additive B were prepared. The external additive A is an organic/inorganic composite fine particle and the external additive B is an associated silica.

[0089] Thereafter, 0.9 parts by mass of the external additive A and 0.2 parts by mass of the external additive B were added to the toner particles, and the mixture was stirred for two minutes with the tip speed of the air flow mixer set to 40 m/see to adhere the external additives to obtain a toner according to Example 1.

[0090] Details of the toner obtained in Example 1 are shown in Table 1.

Example 2

[0091] The particle diameter of the external additive A was changed to 150 nm, and thus, a toner according to Example 2 was obtained. The other conditions were similar to those in Example 1.

Example 3

[0092] The particle diameter of the external additive A was changed to 300 nm, and thus, a toner according to Example 3 was obtained. The other conditions were similar to those in Example 1.

Example 4

[0093] The particle diameter of the external additive A was changed to 50 nm, and thus, a toner according to Example 4 was obtained. The other conditions were similar to those in Example 1.

Example 5

[0094] The degree of association of the external additive B was adjusted to be 2.8, and thus, a toner according to Example 5 was obtained. The other conditions were similar to those in Example 1.

Example 6

[0095] The degree of association of the external additive B was adjusted to be 5, and thus, a toner according to Example 6 was obtained. The other conditions were similar to those in Example 1.

Example 7

[0096] The particle diameter of the external additive B was changed to 220 nm, and thus, a toner according to Example 7 was obtained. The other conditions were similar to those in Example 1.

Example 8

[0097] The particle diameter of the external additive B was changed to 330 nm, and thus, a toner according to Example 8 was obtained. The other conditions were similar to those in Example 1.

Example 9

[0098] The particle diameter of the external additive B was changed to 70 nm, and thus, a toner according to Example 9 was obtained. The other conditions were similar to those in Example 1.

Example 10

[0099] The amounts of the external additive A and the external additive B were changed to 0.3 parts by weight and 0.1 parts by weight respectively, and thus, a toner according to Example 10 was obtained. The other conditions were similar to those in Example 1.

Example 11

[0100] The amounts of the external additive A and the external additive B were changed to 1.8 parts by weight and 0.4 parts by weight, respectively, and thus, a toner according to Example 11 was obtained. The other conditions were similar to those in Example 1.

Example 12

[0101] The amounts of the external additive A and the external additive B were changed to 0.6 parts by weight and 0.5 parts by weight, respectively. A toner according to Example 12 was obtained so that a weight ratio of the external additive A to the external additive B was 6:5. The other conditions were similar to those in Example 1.

Example 13

[0102] The amounts of the external additive A and the external additive B were changed to 1.0 parts by weight and 0.1 parts by weight, respectively. A toner according to Example 13 was obtained so that a weight ratio of the external additive A to the external additive B was 10:1. The other conditions were similar to those in Example 1.

Example 14

[0103] The bulk density of the toner was adjusted to 0.36, and thus, a toner according to Example 14 was obtained. The other conditions were similar to those in Example 1. At this time, an adhesion strength of the external additive to the toner particles was 75%.

Comparative Example 1

[0104] In Comparative Example 1, the external additive A including the organic/inorganic composite fine particles was not added to the toner particles, and only the external additive B was added to obtain a toner according to Comparative Example 1. After the external additives were added, the mixture was stirred for four minutes. The other conditions were similar to those in Example 1.

Comparative Example 2

[0105] In Comparative Example 2, the external additive B including the organic/inorganic composite fine particles was not added to the toner particles, and only the external additive A was added to obtain a toner according to Comparative Example 2. The other conditions were similar to those in Example 1.

Comparative Example 3

[0106] In Comparative Example 3, the external additive B including the organic/inorganic composite fine particles was not added to the toner particles, and only the external additive A was added so that the amount was 0.9 parts by weight relative to the toner particle. In addition, a spherical silica of 110 nm was added so that the amount was 0.2 parts by weight relative to the toner particles. In such a manner, a toner according to Comparative Example 3 was obtained. The other conditions were similar to those in Example 1. It is noted that the spherical silica was added to obtain a spacer effect.

Comparative Example 4

[0107] In Comparative Example 4, the external additive A including the organic/inorganic composite fine particles was not added to the toner particles, and only the external additive B was added so that the amount was 0.2 parts by weight relative to the toner particle. In addition, a spherical silica of 110 nm was added so that the amount was 0.9 parts by weight relative to the toner particles. In such a manner, a toner according to Comparative Example 4 was obtained. The other conditions were similar to those in Example 1.

Comparative Example 5

[0108] In Comparative Example 5, in the mixing, a blending ratio was changed to 87% by mass of an amorphous polyester resin and 0% by mass of a crystalline polyester resin to obtain toner particles having a softening point different from the above. The other conditions were similar to in Example 1, and a toner according to Comparative Example 5 was obtained.

[0109] A low temperature offset is evaluated as follows.

[0110] The prepared developing agent and toner were filled into a commercially available copying machine (product name: MX-5111FN, manufactured by Sharp Corporation), a test document of A4 size having a rectangular solid image of 20 mm in height and 50 mm in width was copied, and whether a low-temperature offset occurred on a recording medium (product name: PPC sheet SF-4AM3, manufactured by Sharp Corporation) was examined. At this time, an amount of toner adhering to a solid image area was set to 0.5 mg/cm^2 and a fixing roller temperature was set to 135° C.

[0111] It is noted that the low-temperature offset means a phenomenon that occurs when the toner does not fix to a recording sheet during fixing and the toner adheres again to the recording sheet after the fixing roller makes one revolution with the toner being adhering to the fixing roller. Also, a filming resistance was evaluated according to the following criteria.

[0112] Good: No toner re-adhesion to the recording sheet is observed

[0113] Bad: Toner re-adhesion to the recording sheet is clearly observed

[0114] The filming was evaluated as follows.

[0115] The prepared developer and toner were filled into the developing device and the toner cartridge of a color multifunction machine (manufactured by Sharp Corporation, model: MX-5100FN), respectively. Next, a continuous print test using 50,000 A4 sheets was performed in an environment of a temperature of 25° C. and a humidity of 5% so that a square solid image (ID=1.45 to 1.50) with a side length of 10 mm was formed at three positions, that is, a center and both ends in an axial direction of the developing roller.

[0116] Thereafter, a solid image (ID: 1.6 to 1.8) and halftone (HT) image (ID: 0.5 to 0.7) were output onto an A3 sheet, and the resulting images were visually observed to evaluate the filming resistance according to the following criteria.

[0117] Excellent: There are no image defects (white streaks, and the like) in both the solid and HT images, and no streaks are observed on a photoreceptor surface

[0118] Good: There are no image defects (white streaks, and the like) in both the solid and HT images, but some streaks are observed on the photoreceptor surface

[0119] Available: There are no image defects (white streaks, and the like) in the solid image, but slight image defects (white streaks, and the like) are observed in the HT image, and streaks are partially observed on the photoreceptor surface

[0120] Bad: There are defects (white streaks, and the like) in both the solid image and the HT image, and streaks are observed all over the photoreceptor surface.

[0121] A method for measuring a softening point of the toner particles is as follows.

[0122] A flow characteristic evaluation device (product name: Flow Tester CFT-100C, manufactured by Shimadzu Corporation) was used to heat 1 g of a sample at a temperature increase rate of 6° C. per minute, and a load of 20 kgf/cm^2 (9.8×105 Pa) was applied, and a temperature at which the sample started to flow out of a die (nozzle diameter: 1 mm, length: 1 mm) was determined as a softening temperature. The softening points of the toners according to Examples 1 to 14 and Comparative Examples 1 to 4 were 110° C., and the softening point of the toner according to Comparative Example 5 was 125° C.

[0123] A transferability was evaluated as follows.

[0124] A test copying machine modified from a digital copying machine (manufactured by Sharp Corporation, model: MX-5100FN) was used, a secondary transfer current was changed from −45 μA to −55 μA, and images were output under the following conditions.

[0125] ID on the sheet was then measured, and ID differences between the four corners and the center of the square were determined as density unevenness and a median, respectively.

[0126] NN environment (temperature: 25° C., humidity: 50%)

[0127] Sheet (manufactured by Sharp Corporation, PPC sheet, model: SF-4AM3)

[0128] Amount of toner adhering to transfer belt (black 0.45 to 0.5 mg/cm^2)

[0129] Solid image (center of sheet surface, square of 50 mm in height and 50 mm in width)

[0130] Excellent: (ID: 1.40 or more and density unevenness less than 0.05)

[0131] Good: (ID: 1.40 or more and density unevenness 0.05 or more)

[0132] Available: (ID: less than 1.40 and density unevenness less than 0.05)

[0133] Bad: (ID: less than 1.40 and density unevenness 0.05 or more)

[0134] A method for measuring a fluidity of the toner is as follows.

[0135] A weight of 30 ml of the toner was measured in 180 seconds by using a bulk density measuring device (manufactured by Ito Seisakusho Co., Ltd., JIS-K-5101), and a bulk density of the toner was taken as a flowability value.

[0136] An adhesion strength of the external additive to the toner particles is as follows.

[0137] An adhesion strength of each external additive to the toner particles (toner base particles) was measured according to the following procedures (1) to (7). It is noted that a silica in the expression "adhesion strength of silica" refers to a silica added as an external additive to the toner (not a part of the fine powder), rather than a silica added to a core of the fine powder.

[0138] (1) 2.0 g of a toner is added to 40 ml of an aqueous solution of Triton (polyoxyethylene octylphenyl ether) having a concentration of 0.2% by mass, and the mixture is stirred for one minute.

[0139] (2) The aqueous solution is irradiated with ultrasonic waves using an ultrasonic homogenizer (manufactured by Nippon Seiki Seisakusho Co., Ltd., model: US-300T) (output: 40 μA, four minutes).

[0140] (3) The aqueous solution irradiated with the ultrasonic waves is left to stand for three hours, and the toner and liberated external additives are separated.

[0141] (4) After a supernatant is removed, approximately 50 ml of pure water is added to a precipitate and stirred for five minutes.

[0142] (5) The mixture is subjected to suction filtration by using a membrane filter having a pore diameter of 1 μm (manufactured by Advantec Co., Ltd.).

[0143] (6) A toner remaining on the filter is vacuum-dried overnight.

[0144] (7) A fluorescent X-ray analyzer (manufactured by Rigaku Corporation, model: ZSX Primus II) is used to analyze a strength of an element (Si) in the external additive of 1 g of the toner before and after the series of processing (1) to (6) above, and an adhesion strength of the external additive to the toner particles is calculated according to the following formula.

$$\text{Silica adhesion strength (\%)}=\{(\text{Si strength after treatment})/(\text{Si strength before treatment})\}\times 100$$

[0145] Conditions and results of Examples 1 to 11 and Comparative Examples 1 to 4 are shown in Table 1.

TABLE 1

Example	Toner softening point	External additive A Particle diameter	External additive A Parts by mass (Part)	External additive B Degree of association	External additive B Particle diameter	External additive B Parts by mass (Part)	Spherical Silica Particle diameter	Spherical Silica Parts by mass (Part)	Weight ratio (A:B)
Example 1	110° C.	85 nm	0.9	2.4	150 nm	0.2	—	—	9:2
Example 2		150 nm	0.9	2.4	150 nm	0.2	—	—	9:2
Example 3		300 nm	0.9	2.4	150 nm	0.2	—	—	9:2
Example 4		50 nm	0.9	2.4	150 nm	0.2	—	—	9:2
Example 5		85 nm	0.9	2.8	150 nm	0.2	—	—	9:2
Example 6		85 nm	0.9	5	150 nm	0.2	—	—	9:2
Example 7		85 nm	0.9	2.4	220 nm	0.2	—	—	9:2
Example 8		85 nm	0.9	2.4	330 nm	0.2	—	—	9:2
Example 9		85 nm	0.9	2.4	70 nm	0.2	—	—	9:2
Example 10		85 nm	0.3	2.4	150 nm	0.1	—	—	9:2
Example 11		85 nm	1.8	2.4	150 nm	0.4	—	—	9:2
Example 12		85 nm	0.6	2.4	150 nm	0.5	—	—	6:5
Example 13		85 nm	1	2.4	150 nm	0.1	—	—	10:1
Example 14		85 nm	0.9	2.4	150 nm	0.2	—	—	9:2
Comparative Example 1	110° C.	—	—	2.4	150 nm	1.1	—	—	—
Comparative Example 2		85 nm	1.1	—	—	—	—	—	—
Comparative Example 3		85 nm	0.9	—	—	—	110 nm	0.2	9:2
Comparative Example 4		—	—	2.4	150 nm	0.2	110 nm	0.9	9:2
Comparative Example 5	125° C.	85 nm	0.9	2.4	150 nm	0.2	—	—	9:2

Example	Bulk density	Adhesion strength Si	Evaluation Low temperature offset	Evaluation Filming	Evaluation Transferability	Remarks
Example 1	0.41	68%	Good	Excellent	Excellent	Good
Example 2	0.40	67%	Good	Excellent	Excellent	Particle diameter relation + larger particle diameter of organic/inorganic composite fine particles
Example 3	0.39	67%	Good	Good	Excellent	Particle diameter relation + large particle diameter of organic/inorganic composite fine particles
Example 4	0.42	61%	Good	Good	Available	Small particle diameter of organic/inorganic composite fine particles
Example 5	0.38	69%	Good	Good	Excellent	Higher degree of association
Example 6	0.38	59%	Good	Available	Excellent	High degree of association
Example 7	0.38	62%	Good	Good	Excellent	Larger particle diameter of associated silica
Example 8	0.38	58%	Good	Available	Excellent	Large particle diameter of associated silica
Example 9	0.39	60%	Good	Available	Available	Small particle diameter of associated silica
Example 10	0.38	69%	Good	Excellent	Available	Small parts by mass
Example 11	0.43	65%	Good	Available	Excellent	Large parts by mass
Example 12	0.39	69%	Good	Available	Excellent	Ratio (55%:45%)
Example 13	0.42	69%	Good	Available	Excellent	Ratio (91%:9%)
Example 14	0.36	75%	Good	Excellent	Available	Low AD + High adhesion strength

TABLE 1-continued

Comparative Example 1	0.38	68%	Good	Bad	Available	No organic/inorganic composite fine particles
Comparative Example 2	0.39	69%	Good	Bad	Available	No associated silica
Comparative Example 3	0.39	63%	Good	Bad	Good	Spherical Silica
Comparative Example 4	0.41	62%	Good	Bad	Good	Spherical Silica
Comparative Example 5	0.41	67%	BAD	Excellent	Excellent	High toner core softening point

[0146] In all the Examples, excellent filming and transfer properties were obtained. Furthermore, there were differences in superiority among the Examples.

[0147] In Example 1, the particle diameter of the external additive A was relatively large, that is, 85 nm, and therefore, the result was that the filming and the transferability were most excellent. In Example 2, the particle diameter of the external additive A was larger than that in Example 1, and therefore, the filming was deteriorated. In Example 3, the particle diameter of the external additive A was smaller than that of Example 1, and therefore, the transferability was worsened and the slip-through was deteriorated. In Example 4, a degree of association of the external additive B was larger than that in Example 1, and therefore, the filming was deteriorated.

[0148] In Example 5, the particle diameter of the external additive B was smaller than that in Example 1, and therefore, the filming was deteriorated. In Example 6, the particle diameter of the external additive B was larger than that of Example 1, and therefore, the filming and the transferability were deteriorated and the slip-through was deteriorated. In Example 7, the parts by weight of the external additive A and the external additive B were smaller than those in Example 1, and therefore, the transferability was deteriorated.

[0149] In Example 8, the parts by weight of the external additive A and the external additive B were larger than those in Example 1, and therefore, the filming was deteriorated. In Example 9, a ratio of the external additive A was smaller than that in Example 1, and therefore, the filming was deteriorated.

[0150] In Example 10, the ratio of the external additive A was larger than that in Example 1, and therefore, the slip-through was deteriorated. In Example 11, the bulk density was smaller than that in Example 1, and therefore, the transferability was deteriorated.

[0151] In all the Comparative Examples in which the external additive A or B was not included, the result was that the filming and the transferability were poor. It is noted that in Comparative Example 1 in which only the associated silica was included in the external additive, the filming occurred. In Comparative Example 2 in which only the organic/inorganic composite fine particles were included in the external additive, the slip-through occurred.

[0152] In Comparative Examples 3 and 4 in which the spherical silica was added, the transferability was slightly improved, but not to the same extent as in the Examples.

[0153] As described above, in the toner and the image forming apparatus according to the present disclosure, it is possible to reduce the slip-through from the blade and reduce the filming.

[0154] It is noted that although each embodiment and each example of the present disclosure have been described in detail above, and it will be readily apparent to those skilled in the art that many modifications are possible without substantially departing from the novel points and effects of the present disclosure. Accordingly, all such modifications are intended to be included within the scope of this disclosure.

[0155] For example, a term described at least once in the specification or drawings together with a different term having a broader or similar meaning may be replaced by that different term anywhere in the specification or drawings. Furthermore, the configurations and operations of the toner and the image forming apparatus are not limited to those described in the embodiments and examples of the present disclosure, and various modifications are possible.

[0156] While there have been described what are at present considered to be certain embodiments of the disclosure, it will be understood that various modifications may be made thereto, and it is intended that the appended claims cover all such modifications as fall within the true spirit and scope of the disclosure.

What is claimed is:

1. A toner, comprising: toner particles and an external additive adhering to surfaces of the toner particles, wherein

the toner particle includes a crystalline polyester resin and a wax,

the external additive includes organic/inorganic composite fine particles and an associated silica having two or more primary particles being associated with each other, and

the toner has a softening point of 110° C. or lower.

2. The toner according to claim **1**, wherein the organic/inorganic composite fine particles have a particle diameter of 70 to 200 nm.

3. The toner according to claim **1**, wherein a degree of association of the associated silica is 2.0 to 3.0.

4. The toner according to claim **1**, wherein a particle diameter of the associated silica is 100 to 300 nm.

5. The toner according to claim **1**, wherein 1.0 to 1.2 parts by weight of the external additive is added externally to the toner particle.

6. The toner according to claim **1**, wherein the organic/inorganic composite fine particles are included in an amount of 75 to 90 wt % relative to the external additive.

7. The toner according to claim **1**, wherein a particle diameter of the organic/inorganic composite fine particles is smaller than a particle diameter of the associated silica.

8. The toner according to claim **1**, wherein a bulk density of the toner is 0.38 or more.

9. The toner according to claim **1**, wherein an adhesion strength of the external additive to the toner particle is 70% or less.

10. An image forming apparatus, comprising:
the toner according to claim **1**;
an electrophotographic photoreceptor; and
an image former.

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