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(54) **Toner for electropotography and production method therefor**

(57) A toner which can solve problems in durability of the printed matter (smear resistance), in that the toner image is easily broken, and moreover, the printed matter is stained by re-attaching a broken portion to itself or optional portions of near particles thereof, in the case in which external force such as scratching, etc., is applied to printed matter in which images were recorded by an electrophotographic device adopting a flash fixing method which is a non-contacting fixing method. The toner for electrophotography includes at least binder resin, wax and hydrophobic fine particles having a diameter of 1 μm or less, wherein wax domains in the toner particle are dispersed at 0.5 μm or less or the binder resin and the wax are compatibilized, and the hydrophobic fine particles are dispersed in the toner particle. A production method of the toner for electrophotography produces the toner for electrophotography by a melt-kneading and crushing method, wherein wax and binder resin in which hydrophobic fine particles are previously dispersed, are melt-kneaded.

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a toner for electrophotography and to a production method therefor which can be suitably used in flash fixing which is non-contacting fixing in electrophotography.

Description of Related Art

[0002] Electrophotography is widely used as one means of an image formation method in copying machines, printers, facsimiles, and the like. A general image formation method using electrophotography included a developing process for forming an electrostatic latent image on a photoconductive insulator (photoreceptor) uniformly charged using corona discharge, charging rollers and charging brushes, etc., by irradiating a laser beam, LED light, etc., and forming a toner image by electrostatically adhering toner for electrophotography (hereinafter, description of only toner indicates also the same means) to this electrostatic latent image; a transferring process for transferring the toner image on a material to be printed; and a fixing process for fixing the transferred toner image on the material to be printed by melting and cooling.

[0003] The fixing means in the above fixing process is divided roughly into a contacting fixing method in which a fixing member contacts with the toner image, and a non-contacting fixing method in which the fixing member does not contact with the toner image.

[0004] As the contacting fixing method, in the case in which the material to be printed is sheet shape material such as paper, etc., heat roll fixing for melting and fixing the toner while pressing the toner by a heating roller, can be generally used.

[0005] Since the above heat roll fixing has a simple mechanism in which a heating roller including a temperature-controllable heating element is combined on part of a sheet feeder, apparatus thereof is easily miniaturized at low cost. In addition, it also has an advantage in that a toner fixed surface can be smooth and printing density can be increased. In contrast, the heat roll fixing has the following problems: resolution is reduced since the toner image is pressed by contacting with the heating roller; when sheet feeding speed and heating roller temperature deviate from a permissible range of the toner, confusion or stain on the fixing image such as offset is generated by adhering to the material to be printed after the fixing failure toner is generated and is adhered to the heating roller; since heat of the heating roller is successively transferred to fed sheets in continuous printing, time for heating and retaining the heating roller at a constant temperature is required and thereby speedup of printing is inhibited; record paper after fixing is easily curled by a high-temperature; and a seal post card in which adhesive is attached to a fixing surface of paper, etc., is difficult to fix. Furthermore, in the case of the heat roll fixing, it was necessary to construct so as to prevent viscosity of resin from changing at a constant fixing temperature range in order to avoid the problem of offset.

[0006] On the other hand, as the above non-contacting method, flash fixing for melting and fixing the toner by irradiating light such as by flash of light, etc., can be mentioned, and it is suitable for high-speed printer having a high resolution since the problems of the contacting fixing method in the fixing process can be avoided, or the like, and the printer has already been marketed. In addition, the flash fixing has an advantage in that it can fix even if material to be printed is not a sheet shape but is a three-dimensional shape, or the like. Furthermore, it also has an advantage in that it can use various resins since there is no problem of the offset with the above heat roll fixing.

[0007] In the above flash fixing, a principle in which energy of light irradiated on the surface of the toner is converted into thermal energy and the toner is melted by the thermal energy is utilized.

[0008] The flash fixing has the following problems because of this fixing principle.

(a) In an image portion in which a toner amount is less (for example, a halftone portion, a letter portion, etc.), since a quantity of heat generated in energy conversion of the light is low and temperature difference between the portion and a portion in which there is no toner is large, the temperature is difficult to increase and the toner cannot be sufficiently melted, and therefore, the fixing strength is insufficient.
(b) The surface of the toner image is easily increased based on an adhered amount of the toner, since the toner image is not pressed to the material to be printed.
(c) The surface of the fixing image is difficult to be smoothed, and the sliding friction of the surface is easily increased.
(d) Melting of the toner may easily be incomplete, since the flash of light does not reach directly on the toner of the inside of the raised image.

[0009] In particular, (e) in the color toner in which an addition amount of light absorbent such as infrared absorbent, etc., is limited in order to retain color tone, the above problems of the flash fixing become more remarkable.

[0010] Furthermore, when the printed matter of which the toner image is fixed is handled in daily use, as described in the above problems (a) to (e), if the fixing strength is insufficient; the surface of the toner image is raised; the sliding friction of the surface is increased by deteriorating smoothness of the image surface; or the melting of the toner of the inside of the image is incomplete, in the case in which external forces such as scratching, etc., is applied to the printed matter, there are problems in durability of the printed matter, in that the toner image is easily broken, and moreover, the printed matter may be stained by re-attaching a broken portion to itself or optional portions of nearby particles thereof. In the following, overall durability of the printed matter to scratching external force will be represented as smear resistance.

[0011] As a conventional art which the above problems of the flash fixing can solve, for example, Japanese Unexamined Patent Application Publication No. 2001-22127 discloses a technique in which melting temperature of toner is decreased by including a specific ester wax in the toner, and thereby, fixing strength can be sufficiently obtained, even if thermal energy is low.

[0012] Japanese Unexamined Patent Application Publication No. 2002-99111 discloses a technique in which conversion efficiency of light energy of a flash of light to thermal energy is increased by containing one or more infrared absorbents having a specific absorption wavelength in the toner so as to promote melting of resin, and thereby, fixing strength is obtained.

[0013] Japanese Unexamined Patent Application Publication No. 2004-170957 discloses a technique in which binder resin is rapidly melted by including a wax having a melting point of similar temperature to glass transition temperature (Tg) of the binder resin which constitutes toner, so as to increase melting rate, and thereby, fixing strength can be sufficiently obtained, even if irradiation time is short.

[0014] Japanese Unexamined Patent Application Publication No. 2009-151201 discloses a technique in which conversion efficiency of light energy of a flash of light to thermal energy is increased by intervening infrared absorbent on the surface of the toner or at an interface of wax so as to promote melting of resin or the wax, and thereby, fixing strength can be sufficiently obtained.

[0015] Japanese Unexamined Patent Application Publication No. 2009-175319 discloses a technique in which raising of an image surface is decreased by introducing a surface smoothing process after the non-contact fixing and sliding friction is reduced by smoothing the image surface, and thereby the above smear resistance can be improved.

[0016] In all cases of the addition of the ester wax, the addition of the infrared absorbent, the adjustment of temperature characteristic by adding the wax, and the surface localization of the infrared absorbent, as proposed above, the problem in that the fixing strength in the flash fixing is insufficient, is solved to some degree; however, the problem in the smear resistance, which is the other weak point in the non-contacting fixing method, is not sufficiently solved. In particular, in a halftone region in which an adhered amount of the toner is low, or a letter portion in which an edge effect is easily exhibited, the shortage of the smear resistance is remarkable.

[0017] In addition, the smear resistance is improved by introducing the surface smoothing process; however, since this is a solution method which adds a printing process, existing printers cannot be used and enlargement of the apparatus and complication of the process are caused, and therefore, this method is not always preferable.

SUMMARY OF THE INVENTION

[0018] An ultimate object of the present invention is to provide a toner for electrophotograhy in which images having no problem in the above smear resistance can be formed on printed matter in which images are recorded by an electrophotographic device adopting a flash fixing method which is a non-contacting fixing method. Accordingly, problems of the present invention are to individually improve the reasons which cause problems in the smear resistance in the conventional toner, that is, the following improvements.

(a) The fixing strength is not insufficient even in an image portion in which a toner amount is less such as a halftone portion, a letter portion, etc.
(b) The surface of the toner image is difficult to raise, even if an adhered amount of the toner is great.
(c) The sliding friction on the surface of the fixed image is suppressed.
(d) The toner of the inside of the toner image, in which a flash of light does not reach directly, is not incompletely melted.
(e) The above problems (a) to (d) are also solved in a color toner.

[0019] In the present invention, the above problems could be solved by technical features described in the following (1) to (10).

(1) A toner for electrophotography comprising at least binder resin, wax and hydrophobic fine particles having a diameter of 1 μm or less, wherein wax domains in a toner particle are dispersed at 0.5 μm or less or the binder resin and the wax are compatibilized, and the hydrophobic fine particles are dispersed in the toner particle.
(2) The toner for electrophotography according to the above feature (1), wherein the hydrophobic fine particle

includes one kind or more of resin substituted by fluorine.
(3) The toner for electrophotography according to the above feature (1) or (2), wherein the wax is contained at 0.1 to 50 mass % in the toner.
(4) The toner for electrophotography according to any one of the above features (1) to (3), wherein the hydrophobic fine particles are contained at 0.01 to 10 mass % in the toner.
(5) The toner for electrophotography according to any one of the above features (1) to (4), wherein diameter of the hydrophobic fine particle is 1 μm or less.
(6) The toner for electrophotography according to any one of the above features (1) to (5), wherein the hydrophobic fine particles are ethylene-based completely fluorinated resin or ethylene-based partially fluorinated resin.
(7) The toner for electrophotography according to any one of the above features (1) to (6), wherein the binder resin is styrene-(meth)acrylate copolymerized resin, resin including the cyclic olefin structure, or polyester resin.
(8) The toner for electrophotography according to any one of the above features (1) to (7) further including a component which absorbs light and converts to thermal energy.
(9) A production method of toner for electrophotography which produces the toner for electrophotography described in any one of the above features (1) to (8) by a melt-kneading and crushing method, wherein wax and binder resin in which hydrophobic fine particles are previously dispersed, are melt-kneaded.
(10) The production method of toner for electrophotography according to the above feature (9), wherein the hydrophobic fine particles are dispersed in the overall of melt-kneaded material.

[0020] According to the present invention, in the electrophotographic device which adopts a flash fixing method which is a non-contacting fixing method, the following superior effects can be obtained.

(a) The sufficient fixing strength can be obtained even in an image portion in which a toner amount is less such as a halftone portion, a letter portion, etc.
(b) The surface of the toner image is difficult to raise, even if an adhered amount of the toner is great.
(c) The sliding friction resistance on the surface of the fixed image is suppressed.
(d) The toner of the inside of the toner image, in which a flash of light does not reach directly, is not incompletely melted.
(e) The above effects (a) to (d) are also obtained in a color toner.

As a result, the toner for electrophotography and the production method thereof, having superior effects, in which the problem in the above smear resistance is not caused on printed matter on which images are recorded by an electrophotographic device adopting a flash fixing method which is a non-contacting fixing method, can be provided.

[0021] In addition to this effect, according to the production method of the toner for electrophotography of the present invention, when the toner is produced by a melt-kneading and crushing method, it is difficult to adhere the melt-kneaded material to a kneader since the hydrophobic fine particles are dispersed in the entirety of the melt-kneaded material without polarization, and therefore, (f) formability of the melt-kneaded material in producing the toner is superior. Furthermore, the melt-kneaded material is easily crushed since the surface of the hydrophobic fine particles easily exceeds the fracture threshold in crushing the melt-kneaded material, and moreover, the size of the crushed material is easily made uniform since the hydrophobic fine particles are dispersed without polarization, and therefore, effect in (g) crushability of the melt-kneaded material in producing the toner is superior, can also be obtained. As the result, a production method that can efficiently produce the toner for electrophotography of the present invention at high yield, can be provided.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] In the following, embodiments of the present invention will be explained.

[0023] The toner of the present invention can suitably include various materials usable in a general toner for electrophotography such as colorants, charge control agents, magnetic powders, etc., infrared absorbents, or the like, in addition to essential constituents such as binder resin, wax, and hydrophobic fine particles, and can further include various materials such as silica, carbon black, charge control agent, etc., by external adding, in order to control fluidity and chargeability of the toner particles.

Binder Resins

[0024] The binder resin in the present invention is not limited to specific materials and can be selected from resins that are generally used in toners, and for example, copolymers in which the following monomers are polymerized alone and are copolymerized in an optional combination. As the above monomer, styrenes such as styrene, chlorostyrene, etc.; monoolefins (α-C2 to 10 olefin is preferable, and α-C2 to 4 olefin is more preferable) such as ethylene, propylene, 1-butylene, 1-pentene, 1-hexene, 1-heptene, 1-octene, etc.; branched-chain olefins such as isobutene, isoprene, etc.;

vinylesters such as vinyl acetate, vinyl propionate, vinyl benzoate, vinyl butyrate, etc.; α-methylene aliphatic monocarboxylates such as methyl acrylate, ethyl acrylate, butyl acrylate, octyl acrylate, dodecyl acrylate, phenyl acrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate, dodecyl methacrylate, etc.; vinyl ethers such as vinyl methyl ether, vinyl ethyl ether, vinyl butyl ether, etc.; vinyl ketones such as vinyl methyl ketone, vinyl hexyl ketone, vinyl isopropenyl ketone, etc.; mono-cyclic olefins such as cyclobutene, cyclopentene, cyclohexene, cycloheptene, cyclooctene, etc.; cyclic conjugated dienes such as cyclopentadiene, cyclohexadiene, cycloheptadiene, cyclooctadiene, etc., or these derivatives; poly-cyclic olefins such as norbornene, dicyclopentadiene, tricyclodecene, tetracyclododecene, hexacycloheptadecene, etc., can be mentioned. The copolymers including the olefinic monomers are preferable, since flexibility is imparted to the toner.

[0025] In addition, as another binder resin used in the present invention, polyester resins formed by carboxylic acids such as maleic acid, fumaric acid, phthalic acid, etc., and alcohols such as bisphenol A (including EO/PO adducts), ethylene glycol, etc., can be mentioned.

[0026] Of the above resins, styrene-(meth)acrylate copolymer, resins having a cyclic olefin structure, polyester resin are preferable as binder resin used in the present invention, since toner durability is superior, even if it is stirred for a long term in a developer by continuously using an electrophotographic apparatus. Of those, polyester resin and copolymer copolymerized by α-olefin and cyclic olefin are preferable, and polyester resin and copolymer copolymerized by α-olefin such as ethylene-norbornene and polycyclic olefin are more preferable from the point view of the above toner durability.

[0027] The glass transition temperature of the alicyclic olefinic resin depends on composition ratio of cyclic olefin and acyclic unsaturated monomer, and generally is about 50 to 200 °C, and it can be properly selected based on application or forming temperature. The glass transition temperature for using the toner is preferably 50 to 80 °C, is more preferably 50 to 70 °C, and is most preferably 50 to 65 °C. When the glass transition temperature of the alicyclic olefinic resin exceeds 80°C, rigidity and shock resistance are increased, and therefore, the formability of the toner is not sufficient. In contrast, when it is under 50 °C, it is feared that the toner fuses to members with which the toner contacts in the electrophotographic apparatus, such as a photoreceptor, developing roller, etc., and thereby, image formation is inhibited.

[0028] Number-average molecular weight (Mn) of polyester resin is molecular weight distribution measured by gel permeation chromatography (GPC), and it is preferably 1,000 to 14,000 and is more preferably 1,000 to 7,000. When the number-average molecular weight is under 1,000, there is a possibility that durability of the toner is insufficient, whereas when it exceeds 14,000, it is feared that fixing strength is not sufficient.

[0029] In addition, weight-average molecular weight (Mw) is preferably 5,000 to 20,000. It is more preferably 5,000 to 15,000. When the weight-average molecular weight is under 5,000, there is a possibility that durability of the toner is insufficient, whereas when it exceeds 20,000, it is feared that the fixing strength is not sufficient.

[0030] Furthermore, it is preferable that molecule having molecular weight of under 1,000 be under 10 mass %. It is more preferably under 9 mass %. When the molecule having molecular weight of under 1,000 exceeds 10 mass %, it is feared that the image formation is inhibited by decreasing fusion resistance of the toner for the members with which the toner contacts in the electrophotographic apparatus, such as a photoreceptor, developing roller, etc.

[0031] In addition, the glass transition temperature (Tg) of the polyester resin is preferably 30 to 80 °C. It is more preferably 40 to 70 °C. When it is below 30 °C, it is feared that blocking resistance (storage property) deteriorates, whereas when it exceeds 80 °C, it is feared that low-temperature fixing deteriorates.

[0032] Furthermore, flow softening point of the polyester resin is preferably 85 to 145 °C. It is more preferably 90 to 120 °C. When it is below 85 °C, it is feared that the blocking resistance (preserving property) deteriorates, whereas when it exceeds 145 °C, it is feared that the low-temperature fixity deteriorates.

Waxes

[0033] The wax used in the toner for electrophotography of the present invention has an effect in that the toner particles are easily heat-melted and has a role as a medium in which the following hydrophobic fine particles are dispersed in the toner. Therefore, it is preferably materials which can disperse the hydrophobic fine particles therein and which can be finely dispersed or compatibilized in the binder resin.

[0034] Heat characteristics of the wax may be suitably designed depending on heat characteristics of the binder resin, and it is preferable that the wax be a compound having a relatively low softening point or low melting point, and specifically, the softening point (melting point) is preferably 50 to 170 °C and more preferably 80 to 160 °C. When the softening point is below 50 °C, blocking resistance and storage stability of the toner are insufficient, whereas when it exceeds 170 °C, the fixing temperature is increased.

[0035] As a wax used in the present invention, polyolefin waxes such as polyethylene wax, polypropylene wax, polybutene wax, modified polyethylene wax, etc.; synthetic waxes such as Fischer Tropsch wax, etc.; paraffin waxes such as natural paraffin, micro wax, synthetic paraffin, etc.; petroleum waxes such as microcrystalline wax, etc.; carnauba wax, candelilla wax, rice wax, hardening castor oil, acidic olefin wax, ester waxes made of fatty acid esters or partial saponifyed fatty acid esters such as ethyl maleate, butyl maleate, methyl stearate, butyl stearate, cetyl palmitate, ethylene

glycol montanate, etc.; amide waxes such as amide stearate, amide oleate, amide palmitate, amide laurylate, amide behenate, octadecanamide, methylenebisstearoamide, ethylenebisstearoamide, etc.; can be mentioned.

[0036] In addition, these waxes can be used alone or in combination. They may be mixed with waxes having different softening point (melting point).

[0037] In the toner of the present invention, the wax exists in a condition which is compatibilized with the binder resin in the toner particle or in a condition which is finely dispersed in the binder resin. The compatibility in the present invention indicates chemical characteristics which can be mixed in a condition having no clear interface. Specifically, in the case in which a cross section of melt-kneaded toner is observed using a microscope at 400 times magnification, it is judged as a condition in which the wax is finely dispersed when dispersed wax domains (islands of wax component dispersed in a sea of the binder resin) having a diameter of 0.5 μm or less are observed, and in contrast, it is judged as a condition in which it is compatibilized when the wax domain is not observed.

[0038] The content of the wax in the toner of the present invention may be suitably designed depending on heat characteristics of the binder resin and compatibility with the wax, and in the case in which total toner mass is set as a standard, it is preferably a range of 0.1 to 50 mass %, is more preferably a range of 1 to 20 mass %, and is most preferably 2 to 15 mass %. When the content of the wax is below 0.1 mass %, it is feared that the resin is difficult to melt and therefore, the image fixing strength is decreased. In contrast, when it exceeds 50 mass %, it is feared that the fluidity of the toner deteriorates in use under a high temperature environment and the toner is difficult to charge, or it is feared that the wax will come off the toner particle, and therefore, there is a possibility that the image formation is inhibited by fusing it to members in the electrophotographic apparatus such as photoreceptor, developing roller, etc.

Hydrophobic Fine Particles

[0039] The hydrophobic fine particle dispersed in the toner for electrophotography of the present invention is formed by micronizing hydrophobic material, and it has an effect which prevents toner particles before image formation from blocking, that is, adhering to each other and an effect which suppresses to change chargeability of the toner due to change of humidity under a toner storage environment, and moreover, in the toner image after fixing, it exerts a function in which when external force such as scratching, etc., is applied to the fixed image, damage of the fixed image is prevented by decreasing sliding friction resistance on the surface of the fixed image. Therefore, the hydrophobic fine particle is preferably material which can remove a factor in which the sliding friction resistance is increased on the surface of the particle, such as hydrogen bond, etc., and is preferably material in which it is difficult to adsorb moisture, even if humidity in the air is high. The hydrophobic fine particle may be dispersed in the toner in a condition which contacts with the binder resin, and it may be dispersed in the wax domain dispersed in the toner.

[0040] As a hydrophobic material which is a component of the hydrophobic fine particle in the present invention, for example, fine particles in which the surface thereof exhibits hydrophobicity such as a resin which is substituted fluorine, etc., can be suitably used.

[0041] As the above resin in which is substituted fluorine, ethylene completely fluorinated resin such as polytetrafluoroethylene (PTFE), etc.; ethylene partially fluorinated resin such as polychlorotrifluoroethylene (PCTFE), polyvinylidene fluoride (PVDF), polyvinylfluoride (PVF), etc.; fluorinated resin copolymer such as perfluorofluoroalkoxide (PFA), tetrafluoroethylene-hexafluoropropylene copolymer (FEP), ethylene-tetrafluoroethylene copolymer (ETFE), ethylene-chlorotrifluoroethylene copolymer (ECTFE), etc.; or the like, can be mentioned, and of those, ethylene completely fluorinated resin or ethylene partially fluorinated resin are preferable and PTFE is more preferable.

[0042] The hydrophobic fine particles used in the present invention are uniformly dispersed to the entirety, that is, the inside and the surface, of one toner particle, and the hydrophobic fine particles dispersions are equally and evenly in plural toner particles, and this condition is a superior condition. In the toner of the present invention, the hydrophobic fine particles may be dispersed in the toner in a condition in which there is contact with the binder resin, or the hydrophobic fine particle may exist in the toner particle, so that they are included in the wax domain at a smaller size than that of the wax domains in the toner particle.

[0043] Therefore, in order to disperse the hydrophobic fine particles in a preferable condition, it is necessary that the diameter of the hydrophobic fine particles in the present invention be smaller than that of the toner particles and be preferably 1 μm or less, since volume average particle size of the general toner particles diameter is about 3 to 15 μm. It is preferable that the diameter of the hydrophobic fine particles be smaller than 0.5 μm of the diameter of the wax domain, since the hydrophobic fine particles can exist in the toner particle so as to include the hydrophobic fine particles in the wax domain.

[0044] Maximum width of each particle is measured by visual observation using a ruler on a two-dimensional image (photograph, etc.) of particles observed using a microscope, and thereby, each diameter of the hydrophobic fine particles can be measured.

[0045] As a method for atomizing components of the hydrophobic fine particle, a method which independently cools and crushes the components, a method which sprays the components under a melted condition, a method which simul-

taneously atomizes the hydrophobic material and mixes the hydrophobic fine particle and the wax by crashing the hydrophobic material and the wax under a dry-blended condition, a method which sprays or crushes the hydrophobic material and the wax under a melted and mixed condition so as to form small phase separated material, a method which grows the particles by an emulsion polymerization method, etc., can be mentioned.

[0046] In the toner of the present invention, it is preferable that the content of the hydrophobic fine particle in the toner be 0.01 to 10 mass %.

[0047] When the content exceeds 10 mass %, it is feared that the image formation is inhibited by the fine particles coming off the toner and contaminating (filming) photoreceptors or electrified members (electrified rollers, electrified brushes, etc.), whereas when it is below 0.01 mass %, since the effect of the hydrophobic fine particle is decreased, it is feared that blocking or charge-controlling defect of toner will occur by lowering fluidity of the toner particles, or it is feared that smear resistance is deteriorated by increasing surface friction resistance on a toner fixed image.

[0048] Here, in the case in which the hydrophobic fine particle is previously dispersed (pre-dispersed) in the wax, using a melt-kneading and crushing method as described below, in order to suitably disperse, the content of the hydrophobic fine particles to total mixing mass including the wax and the hydrophobic fine particles in pre-dispersing is preferably below 30 mass %, is more preferably 0.1 to 20 mass %, and is most preferably 1 to 15 mass %.

[0049] In the case in which the toner for electrophotography of the present invention is produced by the melt-kneading and grinding method, it is preferable that the hydrophobic fine particle be previously dispersed (pre-dispersed) in the wax before the melt-kneading process of the binder resin previous process, since the hydrophobic fine particles can be easily dispersed in the entirety of the melt-kneaded material and can be easily dispersed in the entirety of the toner particle. In the case in which the hydrophobic fine particles are pre-dispersed in the wax when the toner of the present invention is produced by the melt-kneading and grinding method, since the hydrophobic fine particles are dispersed without polarization in the entirety of the melt-kneaded material, effects in that the formability in the toner production process is superior and crushability is also superior, can be attained.

[0050] Here, in the melt-kneaded material after passing through the melt-kneading process, the hydrophobic fine particles dispersed in the wax by the pre-dispersion may be dispersed in the melt-kneaded material under a condition separate from the wax and contact with the binder resin, or they may be dispersed in the wax domain dispersed in the melt-kneaded material.

[0051] Furthermore, in the toner coarse grain after passing through the crushing process (a prior process to a classifying process and an external adding process), the hydrophobic fine particles may be dispersed in the toner coarse grain under a condition in contact with the binder resin, or they may be dispersed in the wax domain dispersed in the toner coarse grain.

Other Optional Component

[0052] As another optional component, colorants, charge control agents, magnetic powders, additives, etc., can be added. In the following, each component will be explained.

Colorant

[0053] The colorant which can be used in the toner of the present invention is not limited to the specific material. As a pigment type colorant of a yellow colorant, compounds represented by condensed azo compounds, iso-indolinone compounds, anthraquinone compounds, azo metal complex methine compounds, and arylamide compounds, can be used.

[0054] Specifically, C. I. Pigment Yellow 3, 7, 10, 12, 13, 14, 15, 17, 23, 24, 60, 62, 73, 74, 75, 83, 93, 94, 95, 99, 100, 101, 104, 108, 109, 110, 111, 117, 122, 123, 128, 129, 138, 139, 147, 148, 150, 155, 166, 168, 169, 177, 179, 180, 181, 183, 185, 191:1, 191, 192, 193 and 199, can be suitably used.

[0055] As a dye type colorant, for example, C. I. solvent Yellow 33, 56, 79, 82, 93, 112, 162 and 163, and C. I. dispersed Yellow 42, 64, 201 and 211, can be mentioned.

[0056] As a magenta colorant, condensed azo compounds, diketo pyrrolo pyrrolic compounds, anthraquinone, quinacridone compounds, basic dye lake compounds, naphthol compounds, benz imidazolone compounds, thioindigo compounds, and perylene compounds, can be used.

[0057] Specifically, C. I. pigment red 2, 3, 5, 6, 7, 23, 48:248:3, 48:457:1, 81:1, 122, 146, 166, 169, 177, 184, 185, 202, 206, 220, 221, 238, 254 and 269, and C.

I. pigment violet 19, can be preferably used.

[0058] As a cyan colorant, copper phthalocyanine compounds and derivatives thereof, anthraquinone compound, basic dye lake compounds, etc., can be used.

[0059] Specifically, C. I. pigment blue 1, 7, 15, 15:1, 15:2, 15:3, 15:4, 60, 62 and 66, can be suitably used.

[0060] As a black colorant, carbon black such as acetylene black, run black, aniline black, etc.; magnetic particles such as graphite, nigrosin, iron black, magnetite, iron oxide manganese, iron oxide zinc, iron oxide nickel, etc.; or the like, can be used, and black colorants which tones the above yellow/magenta/cyan colorants to black, can also be used.

[0061] The content of the colorant to 100 mass parts of the binder resin is preferably 2 to 20 mass parts and is more preferably 2 to 15 mass parts, and it is preferably below 12 mass parts and is most preferably 3 to 9 mass parts, in consideration of suitable permeability of toner image on an OHP film.

Charge Control Agents

[0062] In the present invention, charge control agent can be added as necessary, and it is not limited to specified material.

[0063] In the case in which it is added, as a positive charge control agent, for example, nigrosin dyes, quarternary ammonium salt-based compounds, triphenylmethane-based compounds, imidazole-based compounds, polyamine resin, etc., can be used.

[0064] As a negative charge control agent, azo dyes containing metal such as Cr, Co, Al, Fe, Zn, etc., salicylic acid metal compounds, alkyl salicylic acid metal compounds, calixarene compounds, boron complexes, high molecule type charge control agents, etc., can be used.

[0065] The content of the charge control agent to 100 mass parts of the binder resin is preferably 0.05 to 10 mass parts.

Infrared Absorbents

[0066] In the present invention, as an infrared absorbent, components which absorb light including infrared wavelength region and convert to thermal energy, can be used. During fixing light, the irradiated light at the specific wavelength range is absorbed so as to generate heat, by containing this infrared absorbent, and the toner is efficiently melted. As an infrared absorbent, components which show the largest absorption in a wavelength range from 730 nm to 1,150 nm (preferably 820 nm to 1,080 nm), can be suitably used. As an infrared absorbent, well-known infrared absorbents can be used, and for example, indium oxide-based metal oxides, tin oxide-based metal oxides, zinc oxide-based metal oxides, cadmium stannates, specific amide compounds, lanthanoid-based compounds, cyanine compounds, melocyanine compounds, benzenethiol-based metal complexes, mercaptophenol-based metal complexes, aromatic diamine-based metal complexes, diimonium compounds, aminium compounds, nickel complex compounds, phthalocyanine-based compounds, anthraquinone compounds, naphthalocyanine-based compounds, etc., can be mentioned. Furthermore, black pigments such as carbon black, titanium black, ferrite, magnetite, zirconium carbide, etc., can also be used. These compounds may be used alone or in combination.

[0067] As a specific infrared absorbent, nickel metal complex type infrared absorbent (produced by Mitsui Chemicals, Inc., trade name: SIR-130, SIR-132), bis(dithiobenzil)nickel (produced by Midori Kagaku Co., Ltd., trade name: MIR-101), bis[1,2-bis(p-methoxyphenyl)-1,2-ethylenedithiolate]nickel (produced by Midori Kagaku Co., Ltd., trade name: MIR-102), tetra-n-butylammonium bis(cis-1,2- iphenyl-1,2-ethylenedithioate)nickel (produced by Midori Kagaku Co., Ltd., trade name: MIR-1011), tetra-n-butylammonium bis[1,2-bis(p-methoxyphenyl)-1,2-ethylenedithiolate] nickel (produced by Midori Kagaku Co., Ltd., trade name: MIR-1021), bis(4-tert-1,2-butyl-1,2-dithiophenolate)nickel-tetra-n-butylammonium (produced by Sumitomo Seika Chemicals Co., Ltd., trade name: BBDT-NI), cyanine type infrared absorbent (produced by Fujifilm Corporation, trade name: IRF-106, IRF-107), cyanine type infrared absorbent (produced by Yamamoto Chemicals Inc., trade name: YKR2900), aminium, diimonium-based infrared absorbent (produced by Nagase ChemteX Corporation, trade name: NIR-AM1, IM1), imonium compound (produced by Japan Carlit Co., Ltd., trade name: CIR-1080, CIR-1081), aminium compound (produced by Japan Carlit Co., Ltd., trade name: CIR-960, CIR-961), anthraquinone compound (produced by Nippon Kayaku Co., Ltd., trade name: IR-750), aminium-based compound (produced by Nippon Kayaku Co., Ltd., trade name: IRG-002, IRG-003, IRG-003K), polymethine-based compound (produced by Nippon Kayaku Co., Ltd., trade name: IR-820 B), diimonium-based compound (produced by Nippon Kayaku Co., Ltd., trade name: IRG-022, IRG-023), dianine compound (produced by Nippon Kayaku Co., Ltd., trade name: CY-2, CY-4, CY-9), soluble phthalocyanine (produced by Nippon Shokubai Co., Ltd., trade name: TX-305A), naphthalocyanine (produced by Yamamoto Chemicals Inc., trade name: YKR 5010, produced by Sanyo Color Works Ltd., trade name: Sample 1), inorganic material types (produced by Shin-Etsu Chemical Co., Ltd., trade name: Ytterbium UU-HP, produced by Sumitomo Metal Industries Ltd., trade name: indium tin oxide), or the like, can be mentioned. Of these, in the case in which light fixing (flash fixing) is carried out, diimonium, aminium, naphthalocyanine, and cyanine are preferable.

[0068] The content of the infrared absorbent to the toner is preferably from 0.5 mass parts to 5.0 mass parts to 100 mass parts of the toner.

External Additives

[0069] In the toner of the present invention, it is preferable that the external additive adhere to the surface thereof, from the viewpoint of fluidity.

[0070] As an external additive, various organic external additives and inorganic external additives can be used, and in particular, inorganic fine powders such as silica, titania, alumina, zinc oxide, magnesium oxide, strontium titanate, metallic soap (lithium stearate, zinc stearate, etc.), or the like, are suitable considering to improvement of fluidity and control of aggregability of the toner.

[0071] The mixing amount of the external additive varies depending on the average particle size, particle size distribution, etc., of the external additive and the toner particles to be used, and it can be properly controlled so as to obtain desirable toner fluidity. Generally, the mixing amount of the external additive to 100 mass parts of the toner particle is preferably 0.05 to 10 mass parts, and is more preferably 0.1 to 8 mass parts.

[0072] When the mixing amount is below 0.05 mass parts, the fluidity improvement effect is small and storage stability at high temperature is deteriorated, whereas when it exceeds 10 mass parts, in the photoreceptor filming is generated by some separated external additives, and failures such as of degradation of charge controlling function, etc., are caused by depositing developer in a developing tank.

[0073] In addition, in case of the inorganic fine powder, it is preferable that the external additive be hydrophobized by silane coupling agent, etc., from the viewpoint of stability under a high humidity environment, and furthermore, in the case in which the chargeability is considered, as an agent for impairing negative charge, dimethyl dichlorosilane, monoocthyl trichlorosilane, hexamethyl disilazane, silicone oil, etc., may be used, and as an agent for impairing positive charge, aminosilane, etc., may be used.

[0074] As another external additive, in order to adjust electric resistance of the toner and polishing, fine powders such as magnetite other than magnetite for improving fluidity, ferrite, electroconductive titanium, antimony oxide, tin oxide, cerium oxide, hydrotalcite compounds, acrylic beads, silicone beads, polyethylene beads, etc., may be mixed in a proper amount, and the mixing amount is preferably 0.005 to 10 mass parts to 100 mass parts of the toner.

[0075] Furthermore, as an external additive, in respect of resin fine powders such as polytetrafluoroethylene resin powder, polyvinylidene fluoride resin powder, etc., may be adhered to the toner. The additional amount of these resin fine powders to 100 parts of the toner can be suitably selected from a range of 0.01 to 8 mass parts, and it is preferably 0.1 to 5 mass parts, and is most preferably 0.1 to 4 mass parts.

[0076] It is preferable that the external additive be adhered to the toner particle in mixing by a dry blend method, and as an example of mixing apparatus, a double cone mixer, V type mixer, drum mixer, super mixer, Henschel mixer, nautar mixer, etc., can be mentioned.

[0077] Next, the suitable production method for the toner for electrostatic charge image development of the present invention will be explained.

[0078] It is preferable that the toner for electrostatic charge image development of the present invention be produced by a melt-kneading and crushing method. In the case in which the toner of the present invention is produced by a melt-kneading and crushing method, it is preferable that the kneading process, cooling process and crushing and classifying process be carried out, after pre-dispersing process which disperses the hydrophobic fine particles in the wax.

Pre-dispersing Process

[0079] In the pre-dispersing process, the wax in which the hydrophobic fine particles are dispersed is produced by dispersing the hydrophobic fine particles that are in the wax. Micronization of the hydrophobic material and mixing of the hydrophobic fine particles and the wax can be simultaneously carried out by crushing the wax and the hydrophobic material under a dry blended condition. In addition, there is a case in which the micronization of the hydrophobic material is further continued or the hydrophobic fine particles are more finely dispersed in the wax, by a method in which small phase separated material is obtained by spraying or crushing the wax in which the hydrophobic fine particles are dispersed once in a melted condition. When the pre-dispersing process is carried out, components of the toner may be properly added unless the hydrophobic fine particles are prevented from dispersing.

[0080] A dispersing device used in the pre-dispersing process is not limited to specific devices. For example, batch type hot melting kneaders (for example, pressure kneader, Banbury type mixer, etc.), uniaxial or biaxial continuous extruders (for example, KTK type biaxial extruder, produced by Kobe Steel Ltd.; TEM type biaxial extruder, produced by Toshiba Machine Co., Ltd.; biaxial extruder, produced by KCK Co., Ltd.; PCM type biaxial extruder, produced by Ikegai Corp.; biaxial extruder, produced by Kuriyama S. S.; Ko-kneader, produced by Buss Co., Ltd.), open roll type continuous extruders, or the like, can be used.

[0081] A shape of raw material which is placed into the dispersing device is not limited to a specific shape as long as the raw material appropriately mixes, and can be optionally set. For example, it is preferable that the shape of the wax placed into the kneader be a powder, coarse crushed shape or pellet shape, and a method for putting the hydrophobic

fine particles into after mixing by a rotary mixers, etc., can be used. In the case in which the batch type kneader is used, a method in which the kneader operates at about the melting point of the wax, after putting the wax thereinto, and the content of the hydrophobic particulate in the melt-kneaded material is increased by gradually adding the hydrophobic fine particles, may be adopted.

Kneading Process

[0082] In the kneading process, melt-kneaded material is obtained by melt-kneading the raw material including binder resin and the wax in which the above hydrophobic fine particles are dispersed. As a raw material, the optional components described above may be added properly. In the case in which the toner of the present invention is produced by the melt-kneading and crushing method, the hydrophobic fine particles can be dispersed well in the melt-kneaded material, without condensing, by carrying out the kneading process after the pre-dispersing process.

[0083] In the kneading process, batch type extruders (for example, pressure kneader, Banbury type mixer, etc.) or continuous hot melting kneaders can be used, and the uniaxial or biaxial continuous extruders are preferable from the viewpoint of advantages such as a continuous kneading process, etc. For example, KTK type biaxial extruder, produced by Kobe Steel Ltd.; TEM type biaxial extruder, produced by Toshiba Machine Co., Ltd.; biaxial extruder, produced by KCK Co., Ltd.; PCM type biaxial extruder, produced by Ikegai Corp.; biaxial extruder, produced by Kuriyama S. S.; Ko-kneader, produced by Buss Co., Ltd., or the like, can be preferably used. Here, open roll type continuous extruders can also be used.

Cooling Process

[0084] Subsequently, the kneaded material is cooled and is solidified by the cooling process.

Crushing and Classifying Process

[0085] Then, in the crushing and classifying process, classified toner is obtained by crushing and classifying cooled, solidified and kneaded material.

[0086] First the cooled, solidified and kneaded material is coarsely crushed by a crusher, a hammer mill, a feather mil, etc., and it is gradually pulverized up to be a desired toner particle size by a jet mill, a counter jet mill, a high-speed rotor rotary type mil, etc. Then the toner is classified by an elbow-jet classifier using an inertia classification method, a microplex classifier using a centrifugal classification method, a DS separator, dry-type air flow classifier, etc., and classified toner having volume average particle size of 3 to 18 μm is obtained.

[0087] Coarse powder classified in the classifying process may be recycled by returning to the crushing and classifying process, and fine powder may be recycled by returning to the kneading process.

[0088] Next, an external adding process that adheres the external additive to the classified toner is carried out as necessary. The classified toner and various external additives are mixed at a desired ratio, and are sintered and mixed by a high-speed mixer such as a Henschel mixer, super mixer, etc., which gives shearing force to the powder.

[0089] In this case, since cohesion easily occurs by generating heat on the inside of an external adding apparatus, it is preferable that the temperature of the external adding apparatus be controlled by cooling around a container portion of the external adding apparatus using water, or the like, and it is more preferable that material temperature on the inside of the external adding apparatus be cooled to a controlling temperature which is 10 °C lower than a glass transition temperature of the resin.

[0090] The toner of the present invention is produced by the above-mentioned method, and the volume average particle size thereof is preferably 3 μm to 15 μm and is more preferably 5 μm to 10 μm. When the volume average particle size is below 3 μm, since superfine particles having the volume average particle size of below 2 μm are increased, fogging, reduction of image concentration, generation of sunspots or filming on a photoreceptor, generation of fusion on a development sleeve or a layer thickness regulating blade, or the like, are caused. In contrast, when it exceeds 15 μm, resolution is deteriorated and a high quality image cannot be obtained.

[0091] Here, in the present invention, the volume average particle size was obtained by measuring volume distribution in an Aperture tube having diameter of 100 μm, using a Coulter counter TA-II type (produced by Coulter Inc.).

[0092] The obtained toner can be used for a one-component development system, two-component development system, and another development system. The two-component development system is used by mixing with the carrier.

[0093] As a carrier used for the two-component development system, for example, nickel, cobalt, iron oxide, ferrite, iron, glass bead, etc., can be used. These carriers may be used alone or in combination. It is preferable that the average particle size of the carrier be 20 to 150 μm. In addition, the surface of the carrier may be covered with coating such as fluorine resin, acrylic resin, silicone resin, etc.

[0094] The toner of the present invention may be a toner for black and white images and may be a toner for color

images, and it can be used as a toner for coloring as a toner for color images, in particular, a toner for full color images, in which glossiness of image is remarkably improved.

EXAMPLES

[0095] In the followings, the present invention will be explained in more detail based on Examples, and the present invention is not limited to these Examples.

Example 1

[0096] The following raw material was melt-kneaded by a biaxial kneading extruder, after it was uniformly mixed in a Henschel mixer.

· Binder Resin

[0097] Cyclic olefin resin (trade name: TOPAS TM, produced by Polyplastics Co., Ltd.), 70 mass parts
[0098] Cyclic olefin resin (trade name: TOPAS TB, produced by Polyplastics Co., Ltd.), 30 mass parts

• Colorant (also as Infrared Absorbent)

[0099] Carbon black (trade name: REGAL 330 R, produced by Cabot Corporation), 7 mass parts

• Charge Control Agent

[0100] Iron compound (trade name: T-77, produced by Hodogaya Chemical Co., Ltd.), 1.5 mass parts

• Hydrophobic Fine Particle Dispersion Wax

[0101] Pre-dispersed mixture of polyethylene wax (trade name: PE-130, produced by Hoeckst Co., Ltd.) and polytetrafluoroethylene (trade name: L-170J, produced by Asahi Glass Co., Ltd.), using a method which crushes after melt-kneading at 85:15 mass ratio in a melted phase state, 3 mass parts
[0102] Next, the kneaded mixture was cooled, was crushed by a jet mill, and was classified by an air flow type classifier, and therefore, the toner particle having volume average particle size of 9 μm was obtained. 100 mass parts of the toner particle and 0.6 mass parts of hydrophobic silica (trade name: TS-530, produced by Cabot Corporation) were uniformly mixed by a Henschel mixer, and the toner of Example 1 was obtained.

Example 2

[0103] The toner of Example 2 was obtained in the same manner as that of Example 1, except that the polyethylene wax in Example 1 was changed to carnauba wax (trade name: Carnauba wax Second type powder, produced by S. Kato & Co.).

Example 3

[0104] The following raw material was melt-kneaded by a biaxial kneading extruder, after it was uniformly mixed in a Henschel mixer.

· Binder Resin

[0105] Polyester resin (trade name: FC-916, produced by Mitsubishi Rayon Co., Ltd.), 100 mass parts

- Colorant (also as Infrared Absorbent)

[0106] Carbon black (trade name: REGAL 330 R, produced by Cabot Corporation), 7 mass parts

- Charge Control Agent

[0107] Iron compound (trade name: T-77, produced by Hodogaya Chemical Co., Ltd.), 1.5 mass parts

- Hydrophobic Fine Particle Dispersion Wax

[0108] Pre-dispersed mixture of carnauba wax (trade name: Carnauba wax Second type powder, produced by S. Kato & Co.) and polytetrafluoroethylene (trade name: L-170J, produced by Asahi Glass Co., Ltd., diameter: 2 μm), using a method which crushes after melt-kneading at 85:15 mass ratio in a melted phase state, 3 mass parts

[0109] Next, the kneaded mixture was cooled, was crushed by a jet mill, and was classified by an air flow type classifier, and therefore, the toner particle having volume average particle size of 9 μm was obtained. 100 mass parts of the toner particle and 0.6 mass parts of hydrophobic silica (trade name: TS-530, produced by Cabot Corporation) were uniformly mixed by a Henschel mixer, and the toner of Example 3 was obtained.

Example 4

[0110] The toner of Example 4 was obtained in the same manner as that of Example 3, except that the carnauba wax in Example 3 was changed to synthetic ester wax (trade name: WEP-9, produced by NOF Corporation).

Example 5

[0111] The toner of Example 5 was obtained in the same manner as that of Example 3, except that the binder resin in Example 3 was changed to styrene-acrylate resin (trade name: HIMER ST-305 the Sanyo Chemical Industries Co., Ltd.).

Example 6

[0112] The toner of Example 6 was obtained in the same manner as that of Example 1, except that the colorant (also as Infrared absorbent) and the charge control agent in Example 1 were changed to the below colorant, infrared absorbent and the charge control agent.

- Colorant

[0113] Magenta pigment (trade name: Pigment Red 122, produced by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), 4.5 mass parts

- Infrared Absorbent

[0114] Naphthalocyanine compound (trade name: YKR-5010, produced by Yamamoto Chemical Inc.), 2.0 mass parts

- Charge Control Agent

[0115] Boron complex particle (trade name: LR-147, produced by Japan Carlit Co., Ltd.), 2.0 mass parts

Comparative Example 1

[0116] The toner of Comparative Example 1 was obtained in the same manner as that of Example 1, except that 3 mass parts of the hydrophobic fine particle dispersion wax in Example 1 was changed to 3 mass parts of polyethylene wax (trade name: PE-130, produced by Hoeckst Co., Ltd.).

Comparative Example 2

[0117] The toner of Comparative Example 2 was obtained in the same manner as that of Example 2, except that 3 mass parts of the hydrophobic fine particle dispersion wax in Example 2 was changed to 3 mass parts of polyethylene wax (trade name: PE-130, produced by Hoeckst Co., Ltd.).

Comparative Example 3

[0118] The toner of Comparative Example 3 was obtained in the same manner as that of Example 1, except that the polyethylene wax and the polytetrafluoroethylene were not pre-dispersed.

Comparative Example 4

[0119] The toner of Comparative Example 4 was obtained in the same manner as that of Example 2, except that the polyethylene wax and the polytetrafluoroethylene were not pre-dispersed.

Comparative Example 5

[0120] The toner of Comparative Example 5 was obtained in the same manner as that of Example 3, except that 3 mass parts of the hydrophobic fine particle dispersion wax in Example 3 was changed to 3 mass parts of polyethylene wax (trade name: PE-130, produced by Hoeckst Co., Ltd.).

Comparative Example 6

[0121] The toner of Comparative Example 6 was obtained in the same manner as that of Example 4, except that 3 mass parts of the hydrophobic fine particle dispersion wax in Example 4 was changed to 3 mass parts of polyethylene wax (trade name: PE-130, produced by Hoeckst Co., Ltd.).

Comparative Example 7

[0122] The toner of Comparative Example 7 was obtained in the same manner as that of Example 3, except that the polyethylene wax and the polytetrafluoroethylene were not pre-dispersed.

Comparative Example 8

[0123] The toner of Comparative Example 8 was obtained in the same manner as that of Example 4, except that the polyethylene wax and the polytetrafluoroethylene were not pre-dispersed.

Comparative Example 9

[0124] The toner of Comparative Example 9 was obtained in the same manner as that of Example 3, except that the carnauba wax in Example 3 was changed to polyethylene wax (trade name: PE-130, produced by Hoeckst Co., Ltd.).

Evaluation of Melt-kneaded material

Dispersion of Wax Component

[0125] A cut cross section of the melt-kneaded material which was cooled to a room temperature was observed at 400 magnification by an optical microscope, and the dispersion of the wax component was evaluated as follows by diameter of the visually observed wax domain (islands of the wax component dispersed in the sea of the binder resin).
◎ : In the case in which the wax domain was not observed.
O : In the case in which the diameter of the wax domain was 0.5 μm or less.
X : In the case in which the diameter of the wax domain exceeded 0.5 um.

[0126] Here, in the diameter of the wax domain in the toner particle produced by a melt-kneading and crushing method, the diameter of the wax domain in the melt-kneaded material is reflected. The comparison of different components from the charge control agent in the melt-kneaded material in producing the toners of Examples and Comparative Examples is shown in Tables 1 and 2. Here, common components were omitted.

Table 1

Comparison of Different Components in Melt-kneaded Material of Examples		Examples					
		1	2	3	4	5	6
Binder Resin	Cycloolefin	100	100	–	–	–	100
	Polyester	–	–	100	100	–	–
	Styrene-Acrylate Resin	–	–	–	–	100	–
Hydrophobic Fine Particles Dispersion Wax Components	Polyethylene Wax	2.55	–	–	–	–	2.55
	Carnauba Wax	–	2.55	2.55	–	2.55	–
	Synthetic Ester Wax	–	–	–	2.55	–	–
	Polytetrafluoroethylene	0.45	0.45	0.45	0.45	0.45	0.45
	Pre-dispersion Y: Carrying out, N: Not carrying out	Y	Y	Y	Y	Y	Y
Infrared Absorbent	Carbon Black (also as Pigment)	7.0	7.0	7.0	7.0	7.0	–
	Naphthalocyanine Compound	–	–	–	–	–	2.0
Wax Dispersion Evaluation		◎	◎	○	○	○	◎

(unit: mass part)

Table 2

Comparison of Different Components in Melt-kneaded Material of Comparative Examples		Comparative Examples								
		1	2	3	4	5	6	7	8	9
Binder Resin	Cycloolefin	100	100	100	100	–	–	–	–	–
	Polyester	–	–	–	–	100	100	100	100	100
	Styrene-Acrylate Resin	–	–	–	–	–	–	–	–	–
Hydrophobic Fine Particles Dispersion Wax Components	Polyethylene Wax	2.55	–	2.55	–	–	–	–	–	2.55
	Carnauba Wax	–	2.55	–	2.55	2.55	–	2.55	–	–
	Synthetic Ester Wax	–	–	–	–	–	2.55	–	2.55	–
	Polytetrafluoroethylene	–	–	0.45	0.45	–	–	0.45	0.45	0.45
	Pre-dispersion Y:Carrying out, N:Not carrying out	–	–	N	N	–	–	N	N	Y
Infrared Absorbent	Carbon Black (also as Pigment)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
	Naphthalocyanine Compound	–	–	–	–	–	–	–	–	–
Wax Dispersion Evaluation		◎	◎	◎	◎	○	○	○	○	×

(unit: mass part)

Evaluation of Toner Image

[0127] 5 mass parts of the toner of Examples 1 to 6 and Comparative Examples 1 to 9 and 95 mass parts of silicone coated ferrite carrier having an average particle size of 80 μm were mixed, and therefore, two-component developer was produced. These two-component developers were loaded to a commercial copying machine, and the following unfixed image was drawn on a paper having a basis weight of 80 $g/_{m^2}$.

. Mat image adjusted so as to have a toner adhered amount of 6 g/m^2

· 2 dot line image in resolution of 600 dpi.

[0128] Next, the unfixed image was fixed by a fixing device using a flash of light of a xenon lamp having an energy of 2.5 J/cm^2.

Fixing Strength

[0129] A mending tape produced by Sumitomo 3M Ltd., was adhered on the mat image, and after a weight of 1 kg was slid 10 lengths over the tape, the tape was peeled off. The image concentrations before and after peeling off the tape were measured by a reflection densitometer (trade name: RD-914, produced by Gretag Macbeth GmbH) and fixation ratio was calculated as follows.

[0130] Fixation ratio = (image concentration after peeling off / image concentration before peeling off) x 100

[0131] The fixation ratio was evaluated as follows.

O: The fixing ratio was 85% or more, and there was no problem.

Δ : The fixing ratio was 70% or more, and it was not a level at which image defects occur.

X : The fixing ratio was under 70% , and it was a level at which image defects occur.

Smear Resistance

[0132] An unused paper sheet having a basis weight of 80 g/m^2 was laid over the line image, and a weight of 1 kg was slid 10 lengths over 20 cm on the paper. The smear which was transferred to the paper sheet was evaluated as follows.
O: The smear was almost not observed, and there was no problem.
Δ : The smear was slightly observed, and it was not a level at which image defects occur.
X : The smear was remarkably observed, and it was a level at which image defects occur.

[0133] The toner image evaluation results of each toner of Examples 1 to 6 and Comparative Examples 1 to 9 are shown in Table 3.

Table 3

	Fixing Strength	Smear Resistance
Example 1	O	O
Example 2	O	O
Example 3	O	O
Example 4	O	O
Example 5	O	O
Example 6	O	O
Comparative Example 1	O	×
Comparative Example 2	O	×
Comparative Example 3	O	×
Comparative Example 4	O	×
Comparative Example 5	O	×
Comparative Example 6	O	×
Comparative Example 7	O	×
Comparative Example 8	O	×
Comparative Example 9	Δ	×

[0134] Examples 1 to 5 (black toner) and Example 6 (color toner) were produced by selecting tetrafluoroethylene as a hydrophobic fine particle, as shown in Table 1, by pre-dispersing with the wax and by melt-kneading, and the wax was dispersed well in the melt-kneaded material. The reason for this was the superior compatibility between the binder resin and the wax. Then, in the case of all the toners including the color toner, as shown in Table 2, the fixing strength was high and the smear resistance was superior.

[0135] In contrast, in Comparative Examples 1, 2, 5 and 6 which did not add the hydrophobic fine particle, and Comparative Examples 3, 4, 7 and 8 which did not carry the pre-dispersion process with the wax but the hydrophobic fine particles were added, as shown in Table 2, there were problems in the smear resistance on all the toners, in spite of the superior dispersion of the wax in the melt-kneaded material, and there was no toner corresponding to "the smear was slightly observed, and it was not a level in which image defects occur" (reference symbol: Δ).

[0136] The reason for the superior smear resistance of the toners of Examples 1 to 4 to that of the toners of Comparative Examples 1 to 8 was to impair a special effect caused by dispersing the hydrophobic fine particles in the entirety of the toner, and by having sufficient hydrophobic fine particles on the surface of the toner fixed image.

[0137] In Comparative Example 9, as shown in Table 1, polyester as a binder resin, polyethylene wax as wax, tetrafluoroethylene as hydrophobic fine particle were selected and the melt-kneading process was carried out after the pre-dispersing process with the wax; however, the wax was not dispersed in the melt-kneaded material. Additionally, as shown in Table 2, although in this toner, the fixing strength was kept at a constant level; however, the smear resistance was completely inferior and was a level at which image defects occur.

[0138] In this Comparative Example 9, in toner production using the melt-kneading and crushing method, when wax in which there is little compatibility with binder resin as shown in a combination of polyester and polyethylene, was selected, it is difficult to disperse the wax in the toner in the following melt-kneading process, even if the hydrophobic fine particles were pre-dispersed in the wax, and as a result, it is also difficult to disperse the hydrophobic fine particles,

and therefore, the effect against the smear resistance could not be impaired.

[0139] Here, in the above Examples 1 to 5 and Comparative Examples 1 to 9, the carbon black served both as a colorant and an infrared absorbent (component which absorbs light and converts to thermal energy).

Claims

1. A toner for electrophotography comprising at least binder resin, wax and hydrophobic fine particles having a diameter of 1 μm or less, wherein wax domains in a toner particle are dispersed at 0.5 μm or less or the binder resin and the wax are compatibilized, and the hydrophobic fine particles are dispersed in the toner particle.

2. The toner for electrophotography according to claim 1, wherein the hydrophobic fine particle includes one kind or more of resin substituted by fluorine.

3. The toner for electrophotography according to claim 1 or 2, wherein the wax is contained at 0.1 to 50 mass % in the toner.

4. The toner for electrophotography according to any one of claims 1 to 3, wherein the hydrophobic fine particles are contained at 0.01 to 10 mass % in the toner.

5. The toner for electrophotography according to any one of claims 1 to 4, wherein diameter of the hydrophobic fine particle is 1 μm or less.

6. The toner for electrophotography according to any one of claims 1 to 5, wherein the hydrophobic fine particles are ethylene-based completely fluorinated resin or ethylene-based partially fluorinated resin.

7. The toner for electrophotography according to any one of claims 1 to 6, wherein the binder resin is styrene-(meth) acrylate copolymerized resin, resin including the cyclic olefin structure, or polyester resin.

8. The toner for electrophotography according to any one of claims 1 to 7 further comprising component which absorbs light and converts to thermal energy.

9. A production method of toner for electrophotography which produces the toner for electrophotography according to any one of claims 1 to 8 by a melt-kneading and crushing method, wherein wax and binder resin in which hydrophobic fine particles are previously dispersed, are melt-kneaded.

10. The production method of toner for electrophotography according to claim 9, wherein the hydrophobic fine particles are dispersed in the overall of melt-kneaded material.

REFERENCES CITED IN THE DESCRIPTION

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