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ELECTROSTATIC DEVELOPER AND TONER

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4 Claims. (Cl. 252—62.1)

This invention relates in general to xerography and in particular to a developer composition of improved performance in the art of xerography.

In xerography it is usual to reproduce a master by electrophotographic methods such as, most typically, placing an electrostatic charge on a photoconductive surface, selectively dissipating such charge by exposure to an optical image corresponding to the master to be reproduced, and developing the resulting electrostatic latent image by contact with an electroscopic material. According to one practice in xerography as disclosed in U.S. 2,618,552 to E. N. Wise, the development of the electrostatic latent image is accomplished by rolling or cascading across the image-bearing surface a developer composition of relatively large carrier particles having on their surfaces and electrostatically coated thereon fine powder particles known as toner particles. As the composition cascades or rolls across the image-bearing surface, these toner particles are electrostatically deposited on and secured to the charged portions of the image and are not deposited on the uncharged or background portions of the image. More than that, toner particles accidentally deposited on these background portions are physically removed therefrom by electrostatic action of the carrier particles passing thereacross whereby these toner particles are electrostatically secured to the rolling carrier particles and are picked up from the surface in this manner. The result is an excellent copy of the electrostatic latent image in the form of an image by the toner particles electrostatically clinging to the image surface and removable therefrom by any of various means such as adhesive transfer, electrostatic transfer, or the like. Thus the image body may be transferred to a sheet in contact with the image body by applying an electrostatic charge to the paper while in such contact. When the paper is subsequently stripped from the image-bearing surface it carries with it a substantial proportion of the image body to yield a xerographic print which thereafter may be made permanent by any desired method such as heating, solvent fixing or the like.

Problems encountered in xerography have included difficulties encountered in cleaning the image surface to prepare it for use in a subsequent xerographic cycle after the image is transferred from the image surface to the transfer member or paper. Such problems are largely due to the physical or mechanical properties of the toner particles, and co-pending application Serial No. 373,431, now U.S. 2,788,288 to J. J. Rheinfrank and W. D. Jones, discloses a novel toner composition which has improved physical and mechanical properties and obviates the difficulties above referred to. The said toner composition is particularly adapted for use with photosensitive members charged to positive polarity for sensitization, i.e., the toner particles are charged to negative polarity by mixing with carrier particles which attain a positive polarity.

However, although a toner with such triboelectric properties is suitable for xerography as most frequently practiced, there are many occasions on which it is necessary that the toner particles be charged to positive polarity, particularly where it is desired to obtain a negative by the xerographic process.

The need is therefore for a developer or toner which can be used as desired with either of two carrier components to form in one case a satisfactory developer for use in the so-called reversal process and in the other case an equally satisfactory developer for the so-called direct process.

Despite the fact that carriers of different polarities in the triboelectric series have long been known, prior attempts to provide a single universal toner have not been successful. Single or universal toners previously described have had the tendency to smear the xerographic plate after continued use, which makes them particularly unsuited for use in automatic xerographic machines. In order to obviate this difficulty a toner with a high melting point has been suggested, but that has the disadvantages attendant on high temperature fixing. An object of this invention is to provide an improved single or universal toner as an improvement of the toner described and claimed in the aforementioned application Serial No. 373,431.

While the toner described in application Serial No. 373,341 has a sufficiently low melting point, and does not smear the xerographic plate even on repeated use when used in the so-called direct process, in which a positively charged carrier and a negatively charged toner are used, it does not adhere strongly to certain of the carriers, such as cellulose acetate, used in the reversal process and hence has a tendency to rub or blow off the carrier, thus rendering it unsuitable for use in such process.

I have found that by making certain changes as described below in the composition of the toner of application Serial No. 373,431 I can produce a developer or toner which will operate satisfactorily in both the direct and reversal xerographic processes and in automatic as well as non-automatic xerographic apparatus.

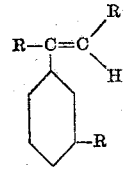
The substances I use as modifiers are of various chemical classes, but all have the property of solubility in the resin forming the main constituent of the toner and all have the property of readily giving off electrons to the carrier. Some of my modifiers are aniline dyes. In this category are such dyes as Nubian Resin Black, Spirit Nigrosine (SSB), Iosol Black, and Luxol Fast Blue. I have also used the amino acid phenyl-glycine and the synthetic resin Acryloid B–72 and have in each case obtained a novel toner satisfactorily adaptable to both the direct and reversal processes.

The toner composition comprises essentially finely divided pigmented resin particles having a particle size less than about 20 microns and preferably having an average particle size between about 5 and about 10 microns and consisting of a finely divided uniform mixture of pigment in a non-tacky low melting resin consisting substantially of a polymerized styrene or a blend of polymerized styrenes having a ball and ring melting point of about 257° F. and being characterized by extreme toughness as measured by non-smearing properties and by being an extremely hard thermoplastic resin. The polymerized styrene is present in the composition in a predominating amount, by which I mean that it is present as at least about two-thirds of the entire composition, being optionally mixed or blended with up to about 25% of polybutyl methacrylate. The pigment is present in the toner in an amount generally between about 5% and about 10%, and in any event in such a manner as will give sufficient pigmentation to the toner to form a

clearly visible image on the xerographic transfer member. In addition, there is incorporated in my toner between about ½% and about 30% of a modifier.

In the preparation of the toner composition according to the present invention the ingredients are thoroughly mixed to form a uniform dispersion of the pigment in the main body and thereafter the body is finely divided to form the desired toner or powder composition. The mixing may be done by various means, including combinations of the steps of blending, mixing, and milling and the presently preferred method includes a step of blending in a rubber mill to assure uniform and fine dispersion of the pigment in the resin.

One particular type of resin composition which has been found to be unusually well suited to the present invention is a polymerized blend of styrene and styrene homologues of the general formula



where R is selected from the group consisting of hydrogen and lower alkyl. The resins of this type are prepared in a wide range of average molecular weights from crude mixtures of styrene and styrene homologues such as those obtained from fractionation of the so-called "crude solvent" from "light oils" scrubbed out of coke oven or gas house gas. The resins are pale in color and are non-acid and unsaponifiable. They are substantially wholly hydrocarbon in composition. Polymerization does not advance significantly with age or temperature.

A particularly preferred type of resin within this class is a hard, tough resin having a ring and ball melting point of about 125° C. or 257° F. being medium-high in polymer structure. When heated to 150° C. it is quite viscous. A resin of this type, specifically designated in the following examples, is available under the name Piccolastic D–125. It, and its blends with minor amounts of up to one-third of a blended resin (wherein the predominating amount, or at least two-thirds, is the styrene-type resin thus defined) are hard and tough, highly resistant to ball milling, and melt below the char point of ordinary paper.

The following are examples of developer compositions in accordance with the present invention.

Example I

A mixture was prepared comprising 10% by weight of carbon black, 25% by weight of polybutyl methacrylate and 65% by weight of the blend of polymerized styrenes described above and having a melting point of 125° C. The mixture was melted and to 98.8 parts by weight of the mixture was added 1.2 grams of Nubian Resin Black. After preliminary mixing by agitation the composition was fed to a rubber mill and thoroughly milled to yield a uniformly dispersed composition of carbon black in the mass. The resultant mixed composition was thoroughly cooled and then finely subdivided in a pulverizer to yield a powder composition having an average particle size of about 5 microns. The particle size was moderately uniform with substantially no particles larger than 10 microns and substantially none less than one micron. The resulting powder or toner composition was found to be satisfactory in use in both the reversal process and the direct process of xerography. It was also found that there was no tendency of this novel toner to smear the xerographic plate after continued use.

Example II

A mixture of carbon black, polybutyl methacrylate and polymerized styrenes was prepared as in Example I and to 98 parts of the molten mixture was added two

parts by weight of Luxol Fast Blue. Thereafter processing was continued in the same way as in Example I. The resultant universal developer had the same satisfactory properties as that made according to Example I.

Example III

To 98 parts by weight of a molten mixture of carbon black, polybutyl methacrylate and polymerized styrenes prepared as in Example I was added 2 parts by weight of phenyl-glycine. After milling, cooling and pulverization as in Example I the resulting powder of toner composition was also found to be adapted for use in xerography by both the direct and universal processes.

Example IV

65 parts by weight of a blend of poly styrenes having a melting point of about 100° C. were blended with 10 parts of carbon black and with 25 parts of Acryloid B–72, an acrylic resin manufactured and sold by Rohm & Haas Company of Philadelphia, Pennsylvania. After melting and preliminary mixing the composition was fed to a rubber mill and thoroughly milled. The milled composition was cooled and pulverized to particles of substantially the same size as in the previous examples. Again the toner composition was found satisfactory for use in xerography by the direct and reversal processes and was found to be capable of repeated use without smearing the plate.

Example V

A toner composition was made according to the method of Example I above, but 1.2 parts by weight of phenyl-glycine was added to 98.8 parts of the mixture of polystyrenes, polybutyl methacrylate and carbon black. After milling, cooling and pulverization the toner powder was found satisfactory for use in both direct and reversal type xerography.

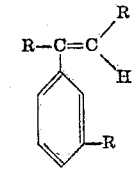
In mixing toners of the universal type having the characteristics of the present invention the final powder should contain from ½ to 2% of the aniline dyes mentioned above, the preferable range being from 1 to 1.2%. Similar results can be obtained using between about 20 and about 30% of the Acryloid resin, and about 25% being preferred. When using phenyl-glycine as the modifier the range is about the same as for the aniline dyes.

The novel developers or toners of the present invention are characterized, as are those of Serial No. 373,431 by melting points so low that the powders may be fused into masses which adhere permanently to a web such as a sheet of paper at temperatures which will not visibly affect the paper web.

While in the examples given above carbon black is used as the pigment, other pigments may be used where desired. The amount of pigment which has been found suitable has been between about 5% and about 10% by weight of the total composition.

I claim:

1. An improved xerographic toner comprising between about ½ and about 2% of a nitrogen containing aromatic compound selected from the group consisting of a nigrosine dye, Iosol Black and Luxol Fast Blue dispersed in a tough, finely-divided, pigmented thermoplastic resin consisting predominately of between about 5 and about 10% pigment in a resin body of up to 25% polybutyl methacrylate and the remainder a polymerized blend of monomers of styrene and styrene homologs of the formula



where R is selected from the group consisting of hydrogen

and lower alkyl, the polymerized blend of styrene monomers having a ring and ball melting point of about 125° C., the toner characterized by the property of fusing onto a paper surface when heated for about 5 seconds at a temperature below the char point of paper and by the property of acquiring a negative polarity when admixed with positively charged carrier particles and a positive polarity when admixed with negatively charged carrier particles.

2. A xerographic toner according to claim 1 wherein the nitrogen containing aromatic compound is a nigrosine dye.

3. A xerographic toner according to claim 1 wherein the nitrogen containing aromatic compound is Iosol Black.

4. A xerographic toner according to claim 1 wherein the nitrogen containing aromatic compound is Luxol Fast Blue.

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