United States Patent Office 3,806,458 Patented Apr. 23, 1974

3,806,458

ELECTROPHOTOGRAPHIC MIXTURE COMPRISING TONER PARTICLES AND COATED CARRIER PARTICLES

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No Drawing. Filed Sept. 28, 1972, Ser. No. 293,082
Int. Cl. G03g 9/32
U.S. Cl. 252—62.1 1 Claim

ABSTRACT OF THE DISCLOSURE

A developer mixture for developing electrostatic images made up of relatively large carrier particles having toner particles electrostatically bonded to them, the carrier particles are small metal particles coated with an acrylic resin having a glass transition temperature at least 50° C. and below 100° C., with a cellulose acetate butyrate resin containing 10–35% by weight acetate, 10–40% by weight butyrate and containing less than 60% by weight acetate plus butyrate, or with mixtures of such acrylic resins and such cellulose acetate-butyrate resins.

BACKGROUND OF THE INVENTION

The essential steps in the operating cycle of a xerographic reproducing machine include imposing a uniform electrostatic charge on a photoconductive surface, exposing the surface to a light pattern which selectively dissipates the charge on the radiated areas of the surface, cascading a developer composition consisting of carrier particles coated with finely divided toner particles electrostatically bonded to the carrier particles over the photoconductive surface to deposit toner particles on the still charged areas of the photoconductive surface, electrostatically transferring the toner particles to an image surface and fusing the toner particles on that surface, cleaning the photoconductive surface to remove residual toner particles; the cycle is then repeated.

The carrier particles coated with electrostatically bonded toner particles constitute the electrophotographic developer. The carrier particles are large relative to the toner particles, 200–600 micron mean diameter for example is a satisfactory carrier particle size range. Toner particles are usually in the 10–50 micron mean diameter range.

The triboelectric properties of carrier and toner are such that the toner is electrostatically bonded to the carrier but the strength of the bond is such that when toner coated carrier contacts the charged areas of the photoconductive surface the toner particles are attracted away from the carrier particles and adhere to the photoconductive surface.

In the past both coated and uncoated carrier particles have been used. The carrier particles must be highly resistant to chipping, flaking, fragmentation, toner impaction and deterioration of the coating in order to permit very long machine runs without the need to shut down and replace the entire developer charge.

SUMMARY OF THE INVENTION

The present invention provides a developer mixture for developing electrostatic images comprising relatively large carrier particles having relatively small toner particles electrostatically bonded to them, the carrier particles of the developer mixture being small metal particles coated with an acrylic resin having a glass transition temperature at least 50° C. and below 100° C., with a cellulose acetate butyrate resin containing 10–35% by weight acetate, 10–40% by weight butyrate and containing less than 60% by weight acetate plus butyrate, or

with mixtures of such acrylic resins and such cellulose acetate butyrate resins. The toner particles of said mixture are preferably small particles of a resin produced by co-polymerizing 2 parts by weight of n-butyl methacrylate, 1.8–2.2 parts by weight styrene and 0.8–1.2 parts by weight methyl methacrylate, said resin having finely divided carbon black or other colorant dispersed in it in amount sufficient to give the dispersion a colorant content in the range 2–20% by weight. When carbon black is employed, it is used in amount sufficient to give the toner composition a carbon black content in the range 10–20% by weight. While the above described toner composition is preferred it is found that the carrier particles of this invention will handle commercial toners efficiently and effectively.

DETAILED DESCRIPTION OF THE INVENTION

The following examples provide a detailed description of the preparation and effectiveness of the electrophotographic developers of this invention.

EXAMPLE 1

Sixty-seven grams of a copolymer of 70 parts by weight methyl methacrylate and 30 parts by weight ethyl acrylate having a glass transition temperature 60° C. and 11.8 grams of a cellulose acetate butyrate having an acetyl content 13.5% and a butyryl content 37% were dissolved in 750 cc. of methyl ethyl ketone. Eight and three-tenths grams of a red monazo dye were dissolved in this solution. The solution was heated to 60° C. Thirty pounds of 450 micron steel shot were heated to 70° C. and placed in a vibrating tub. The solution was poured over the shot. The tub was vibrated and the shot was stirred in an air stream until the methyl ethyl ketone had evaporated. The shot was then spread on trays and held at 80° C. for 18 hours to cure the resin coating. After curing the shot was separated by screening; a portion which passes through a 30 mesh screen is well suited for use in either the 2400 or 3600 models of Xerox copiers.

The carrier particles were then placed in a twin-shell blender and a quantity of toner sufficient to give the carrier-toner mixture a toner content of 0.48% was added and the mixture was blended to distribute the toner evenly on the carrier surface. The toner coated carrier particles were then transferred to the developer housing of a Xerox 3600 copier. The copier was run until 500,000 copies of a sample text had been made; this required a minimum of 140 hours machine operation. Toner was added during the run to maintain developer quality.

At the end of the run 31% of the coating had been worn away from the carrier surface and there had been very little residual toner build up on the carrier particles.

The toner used in the example was prepared by co-polymerizing 2 parts by weight of n-butyl methacrylate, 2 parts styrene and 1 part methyl methacrylate and dispersing carbon black in the co-polymer in amount sufficient to give the toner a carbon black content of 15% by weight. The co-polymer was jet pulverized to produce particles having average diameter about 15 microns. Preparation of the toner is fully described in copending application Ser. No. 194,696, filed Nov. 1, 1971.

EXAMPLE 2

The procedure of Example 1 was followed. The quantities of material used in making the carrier particles were

(1) 450 micron steel shot—30 lbs.
(2) 78.8 g. of a copolymer of 40 parts methyl methacrylate and 60 parts n-butyl methacrylate having a glass transition temperature 50° C. and 8.3 g. of a red monazo dye, Solvent Red 7 dissolved in 750 cc. of methyl ethyl ketone.

After curing, the carrier was coated with toner. The toner coating amounted to 0.37% by weight of the coated carrier.

The toner coated carrier was charged to the developer housing of a Xerox 2400 model copier. Five-hundred thousand copies of a text were run off. This required a minimum of 200 hours of machine operation. At the end of the run 41% of the carrier coating had been worn off.

EXAMPLE 3

Seventy-eight and eight-tenths of a cellulose acetate butyrate having an acetyl content of 29.5% and a butyryl content of 17% were dissolved in 750 cc. of methyl ethyl ketone. Eight and three-tenths grams of the red dye Intraplast Red B a monazo dye were dissolved in the solution. Thirty pounds of 450 micron steel shot were coated with this solution following the procedure of Example 1.

The cured carrier particles were coated with toner as in Example 1 and the coated particles were charged to a developer housing and circulated to simulate a run of 500,000 copies. After this circulation copies were made and quality was excellent. During circulation 22% of the coating was worn from the carrier particles.

The carrier particles produced in Examples 1, 2 and 3 were examined under a microscope. The coating was smooth and uniform. The red dye facilitated examination.

In the runs of Examples 1–3 copy was very clean. Optical density measurement of copy background after 500,000 in Examples 1 and 2 and after 502,000 in Example 3 were 0.005 or lower. Copy quality was measured with the Welch Densichron. During testing, copy line density was maintained at 0.9–1.0. Line density was measured on a Kidder Optical Character Tester Model 081.

Resins suitable for coating the carrier particles are available commercially. Suitable acrylic resins are Acryloid B–44 and Acryloid B–66 manufactured by Rohm and Haas. Suitable cellulose acetate butyrate resins are the Half Second Butyrate and EAB–171–2 types manufactured by Eastman.

While steel shot is the preferred carrier particle base, other metal particles having densities in the range 6–9 such as copper, cobalt, chromium and nickel can be used.

We claim:

1. A developer mixture for developing electrostatic images comprising relatively large carrier particles having relatively small toner particles electrostatically bonded to them, the carrier particles of said developer mixture being small metal particles coated with a mixture of a copolymer of methylmethacrylate and ethylacrylate having a glass transition temperature at least 50° C. and below 100° C., and a cellulose acetate butyrate resin containing 10–35% by weight acetate, 10–40% by weight butyrate and containing less than 60% by weight acetate plus butyrate, and the toner particles of said mixture being small particles of a resin produced by co-polymerizing 2 parts by weight of n-butyl methacrylate, 1.8–2.2 parts by weight styrene and 0.8–1.2 parts by weight methylmethacrylate, said resin having finely divided carbon black dispersed in it in amount sufficient to give the dispersion a carbon black content in the range 10–20% by weight.

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U.S. Cl. X.R.

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