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DEVELOPER COMPOSITION FOR ELECTROPHOTOGRAPHIC IMAGES

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This invention relates to reproduction of colour by electrophotography and particularly to the manufacture and use of electrophotographic toners with enhanced overprinting characteristics in which such overprinting characteristics are controlled by the incorporation in the toner of a relatively highly conjugated drying oil.

It is known that electrophotographic images can be produced in any desired colour by one skilled in the art and toner formulations capable of producing images of various colours are known. It is also known to produce such images in a multiplicity of colours by the use of repetition exposure and development procedures on the same electrophotographic sheet.

According to the methods known heretofore, colour printing by xerographic methods usually involves the use of a photosensitive material on a relatively conducting backing or supporting layer such as a paper or metal sheet or film, the photosensitive film comprising a particulate photoconductor such as zinc oxide or the like in a resin binder, such coating resin being sufficiently hardened or polymerised so that its electrical properties are not affected by environmental changes during production of the print.

Such a sheet is first sensitised by subjecting it to a corona discharge from a series of wires or points held at a relatively high D.C. potential above the base upon which the sheet is placed, the polarity being such as to impart a negative potential to the photolayer in case such photolayer is composed of zinc oxide which is not capable of supporting a positive electrostatic charge. The sheet is then subjected to a light pattern corresponding to the requirements of the first colour to be applied and after this exposure the sheet is developed in a dish or bath or by means of some other device containing the liquid toner dispersion of the appropriate colour. It is preferable to dry the sheet after this development step as this allows the first deposited image to become sufficiently adherent to the photosurface to enable it to remain in position during subsequent handling.

Subsequent colours are deposited in turn by repetition of the charge exposure develop and dry cycle, the exposure step in each instance imposing the correct light pattern corresponding with the particular colour being reproduced at that time. Provided the successive images are placed in register with each other using a balanced set of compatible overprinting toners the resultant image will be substantially similar to that which would be produced by a mechanical printing device using the same separations and inks corresponding to the toners used.

One of the problems in overprinting xerographically is that the developers tend to affect the charging characteristics and bleeding away of the charge on the photoconductor surface and therefore while the first colour can be put down in accordance with the characteristics of the photoconductor surface itself, this colour can then modify the charge which different areas can take when preparing the photoconductor for the application of the second colour, the position being intensified when an attempt is made to charge through the first two colours in preparation for the application of a third colour.

To obtain complete overprinting the image areas must contain an insulating component either within the image

forming pigment structure or as a layer over the image, such components being capable of supporting an electrostatic charge where the surface is to be recharged for a subsequent colour step and also being capable of being discharged by exposure at a substantially similar rate to that of the previously undeveloped areas of the photo sheet.

In prior art processes of overprinting by electrophotographic methods it was customary to incorporate insulating resins into the developers or toners such resins being capable of supporting an electrostatic charge when co-deposited with conductive pigments on image areas. The disadvantage of this process is that the quantity of such insulating resin required to be present for charge-holding purposes is substantially higher than would usually be present in an ink of similar hue being employed for instance in lithography which consequently prevents intense colour deposition or changes the colour value of the system. This large quantity of insulating resin is apparently required because such resin is essentially fully or partially soluble in the liquid developer vehicle and consequently such resin may be dissolved and separated from the pigment particles thus causing the image deposit to be of sufficient conductivity to inhibit subsequent charging operations. Various prior art processes have included a step involving the introduction of such insulating resin in the form of a film over the image forming pigment and it has also been proposed to incorporate other substances capable of being retained on the pigment surface when such pigment is suspended in an insulating liquid such substances being of waxy nature and possessing the desired insulating properties. A disadvantage of the incorporation of such waxy materials is that colour values of pigments are changed considerably by their incorporation and consequently colour values of electrophotographic images produced with such toners are not necessarily true in value to those which would be produced by lithography.

In accordance with the persent invention there are provided a method of and means for producing developers or toners suitable for dispersion in appropriate liquid vehicles such toners being capable of developing an electrostatic image in any desired colour and such developed image containing sufficient insulating matter so as to be capable of supporting an electrostatic charge upon subsequent and repeated subjecting to a corona discharge.

We have now found that overprinting can be attained by the use of toner vehicles which contain a drying oil of the maximum degree of molecular conjugation with an available double bond linkage of the particular type that occurs for instance in the dehydration of castor oil.

Such conjugated molecules also occur in certain natural drying oils such as tung oil, oiticica oil, menhaden oil, and the like. Toners of suitable overprinting characteristics can be produced using such oils as the sole grinding and dispersing medium for the pigment, or such oils can be used for the preparation of varnishes which are subsequently used in the formulation of toners.

The reason for obtaining enhancement in overprinting using conjugated oils in accordance with this invention is not clearly understood but it is believed that the manner in which the pigment is wetted by the conjugated oil and the manner in which the pigment combined with such conjugated oil is deposited as image onto the photoconductive surface allows such image areas to be rechargeable without masking or affecting substantially the photo characteristics of the underlying photoconductor. Such behaviour of the conjugated oils could be ascribed, in some instance, to the characteristic orientation of molecular groups occasioned by the double bond and/or such double bonds may take part themselves in the accept-

ance of an electrosatic charge in the form of negative gaseous ions.

The following examples will serve further to illustrate the principles of this invention:

Example 1

	Grams
Microlith blue 4GT (a resinated phthalocyanine blue pigment by Ciba Limited)	25
Dehydrated castor oil	140

These components are milled together in a bar mill or triple roll mill and the resultant paste dispersed in solvent X55 (a substantially aliphatic hydrocarbon solvent by the Shell Company), n-heptane, n-hexane or trichlorotrifluoroethane.

0.1 to 2.0 grams of this paste may be dispersed in 100 milliliters of the solvent.

Example 2

	Grams
Microlith blue 4GT	25
Tung oil (heat bodied)	140

This toner is prepared and dispersed as in Example 1.

Example 3

The oil of Examples 1 and 2 is replaced with the alkyd resin Rhodene L21/100 (a dehydrated castor oil alkyd resin, oil length 65 percent, manufactured by Polymer Corporation).

Example 4

A varnish is prepared as follows:

	Grams
Dehydrated castor oil	100
Staybelite resin (a hydrogenated rosin by Hercules Co.)	20

These components are heat blended at a temperature of 460° F. and the resultant varnish allowed to cool and then milled with 25 grams microlith blue 4GT. The resultant paste can be dispersed as in Example 1.

Example 5

The Staybelite resin varnish of Example 4 is replaced with an equal quantity of a varnish containing 20 percent calcium resinate in tung oil such varnish having been heat-blended at a temperature of 410° F.

Example 6

The Microlith blue pigment of Examples 4 and 5 is replaced with 50 grams red pigment Fastel pink B Supra, an organic red pigment by I.C.I.

Example 7

The blue pigment of Examples 4 and 5 is replaced with an equal weight of permanent yellow FRR, a transparent yellow pigment by Hoechst.

What I claim is:

1. The method of preparing a toner for the overprinting of colour images by electrostatic means comprising milling together a pigment and a conjugated drying oil to form a paste, and dispersing the paste so formed with an insulating hydrocarbon carrier liquid with which the paste is miscible, said carrier liquid having a volume resistivity in excess of 10^{10} ohm centimeters and a dielectric constant less than three, approximately 0.1 to 2.0 grams of the paste being dispersed in 100 milliliters of the carrier liquid, the conjugated drying oil being selected from the group consisting of dehydrated castor oil, tung oil, oiticica oil, and menhaden oil.

2. The method of preparing a toner according to claim 1 in which the conjugated drying oil is combined with the pigment in the approximate proportion by weight of one part of pigment to six parts of the oil.

3. A toner for the overprinting of colour images by electrostatic means consisting essentially of a conjugated drying oil and a pigment suspended in an insulating hydrocarbon carrier liquid having a volume resistivity of at least 10^{10} ohm centimeter and a dielectric constant less than three, said conjugated drying oil being selected from the group consisting of dehydrated castor oil, tung oil, oiticica oil, and menhaden oil, approximately 0.1 to 2.0 grams of said drying oil and pigment being present in 100 milliliters of the carrier liquid.

4. A toner according to claim 3 wherein the drying oil is combined with the pigment in the approximate proportion by weight of one part of pigment to six parts of the oil.

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