ORGANIC PHOTOCOCONDUCTORS SENSITIZED BY DYES WHICH EXHIBIT SPECTRAL ABSORPTION SHIFTS ON HEATING

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Int. Cl. G03g 5/06

U.S. Cl. 96—1.6

10 Claims

ABSTRACT OF THE DISCLOSURE

Electrophotographic elements are prepared from photoconductive compositions which are spectrally sensitized with dyes which are sensitive to heat. When these elements are developed and heated, the dye undergoes a shift in the radiation absorption. Such a shift generally decreases the optical opacity of the elements, thereby permitting the image-bearing elements to be used as masters from which further reproductions can be made.

This invention relates to electrophotography and more particularly to a method for producing by an electrophotographic process an element having improved reprint properties.

The process of xerography, as disclosed by Carlson in U.S. 2,297,691, employs an electrophotographic element comprising a support material bearing a coating of a normally insulating material whose electrical resistance varies with the amount of incident actinic radiation it receives during an imagewise exposure. The element, commonly termed a photoconductive element, is first given a uniform surface charge, generally in the dark after a suitable period of dark adaptation. It is then imagewise exposed to a pattern of actinic radiation which has the effect of differentially reducing the potential of this surface charge in accordance with the relative energy contained in various parts of the radiation pattern. The differential surface charge or electrostatic latent image remaining on the electrophotographic element is then made visible by contacting the surface with a suitable electrophotographic marking material. Such marking material or toner, whether contained in an insulating liquid or on a dry carrier, can be deposited on the exposed surface to form a positive or negative developed image of the original exposure pattern. Deposited marking material can then be either permanently fixed to the surface of the sensitive element by known means such as heat, pressure, solvent vapor, or the like, or transferred to a second element to which it can similarly be fixed. Likewise, the electrostatic latent image can be transferred to a second element and developed thereon.

While photoconductor-containing electrophotographic elements have a wide range of utilities, an application in which they are finding increasing utility is the recording of data presented on cathode-ray tube screens and the like. Advantages gained through such use include attractively high photographic speeds, desirable spectral response, and short time of access to a visible recorded image.

It is frequently desirable to employ the image-bearing electrophotographic element as a master from which further prints can be generated. Such elements can be used as masters in many types of reproduction processes. Typical of these processes are the xerographic process, thermographic process, direct electrostatic process, stabilization process, gelatin transfer process, diffusion transfer process, etc. A particularly advantageous process by which such a print can be made is the diazo process. In this process, a diazonium salt-containing element is exposed through a transparent original bearing an image to activating radiation from an ultraviolet source. The exposure causes decomposition of the salt in those areas which are struck by activating radiation. Subsequently, the element is passed through an atmosphere of a suitable alkaline material, such as ammonia vapor. In the presence of the alkaline material and a dye-forming coupler, which may be either incorporated in the diazoniun-containing layer or introduced during the development step, the diazonium salt which is not decomposed by exposure is converted to an azo dye. A positive reproduction of the original is formed.

A difficulty commonly encountered in the production of copies from sensitized photoconductor-containing coated elements is that the photoconductive element possesses a relatively high optical opacity resulting from coloration imparted by the photoconductive composition. As a result the element does not transmit sufficient radiation in that portion of the electromagnetic spectrum to which the copy element is sensitive. Therefore, prints are very difficult to obtain. Also, if the image-bearing elements are to be used for direct reading, the image portions of the elements are often almost indiscernible due to the lack of contrast. There is thus seen to be a need for increasing the radiation-transmitting capability of sensitized photoconductive elements in the various regions of the electromagnetic spectrum.

It is, therefore, an object of this invention to provide novel sensitized photoconductive compositions.

It is another object of this invention to provide novel electrophotographic elements.

It is a further object of this invention to provide novel means for improving the reprint contrast of image-bearers.

It is still another object of this invention to provide a novel reversible process for improving the contrast of an image-bearing transparent electrophotographic element.

These and other objects and advantages of the invention are accomplished by decreasing the optical opacity of image-bearing electrophotographic elements comprised of a support carrying a photoconductive layer containing an organic photoconductor, an electrically insulating film-forming polymeric binder and a certain sensitizing dye or dyes for the photoconductor. The sensitizing dye employed is one which exhibits absorption shifts when subjected to heat. Thus, upon heating an electrophotographic element containing a dye sensitive to the heat, the dye causes the sensitizing dye to undergo an absorption shift. The absorption shift can be anywhere from about 20 to more than about 100 nm such that the dye actually undergoes a visible change in color. Preferably the materials become substantially decolorized upon heating. Since the color of the electrophotographic element is attributable almost entirely to the sensitizing dye, the entire element undergoes an absorption shift similar to the shift which occurs in the dye upon heating.

There are several advantages resulting from the use of the novel electrophotographic elements of this invention. Image-bearing elements which have a high coloration in order to impart appropriate sensitivity are made easily viewable according to the present invention by causing a shift in the radiation absorption of the element. Generally, such a shift greatly reduces the optical opacity apparent in the background areas such that the image on the element can easily be discerned when using projection techniques. Additionally, the elements of the present invention can be used as masters from which further reproductions can be generated by xerographic techniques, for example; whereas, elements which do not utilize heat sensitive dyes according to this invention are generally...
not usable as masters because of the high optical opacity of the element.

The dyes useful in accordance with the present invention are those dyes which spectrally sensitize organic photoconductors and which can be decolorized by the application of heat. Particularly useful dyes include those compounds having the formula:

\[(\text{I}) \quad \text{Ar} = \text{NE}-\text{CH} = \text{CH}-\text{CH} = \text{CH}-\text{CH} = \text{NE}-\text{Ar}\]

wherein \(\text{Ar}\) designates an aryl radical such as phenyl, naphthyl, etc., including substituted aryl radicals such as tolyl, chloronaphthyl, etc., and \(\text{Z}^-\) is an acid anion such as a halide radical, an alkyl sulfate radical, an alkyl sulfonate radical, an aryl sulfonate radical, perchlorate, etc. Other useful dyes include those compounds having the formula:

\[(\text{II}) \quad \text{R}_1\text{R}_2\text{N} - \text{Ar} - \text{NE}-\text{CH} = \text{CH}-\text{CH} = \text{CH}-\text{CH} = \text{NE} - (\text{Ar}) - \text{N}\text{R}_3\text{R}_4\]

wherein \(\text{Ar}\) is a divalent aromatic radical, such as a phenylene, a benzophenylene, a naphthophenylene, a dibenzophenylene, a biphenylene, a terphenylene, a tetraphenylene, etc., \(\text{R}_1\), \(\text{R}_2\), \(\text{R}_3\), and \(\text{R}_4\) are hydrogen atoms or alkyl or aralkyl or aromatic hydrocarbon radicals, hereinafter referred to as hydrocarbyl radicals, having from 1 to 8 carbon atoms which may optionally be substituted by neutral groups such as hydroxyl, carbalkoxy, carboxamido, alkylthio, arythio, cyano, etc., and \(\text{Z}^-\) is an acid radical such as a halide radical, an alkyl sulfate, an alkyl sulfonate radical, the perchlorate radical, etc., and \(n\) represents an integer of 1 to 10.

The aromatic radical may be unsubstituted or substituted by one or more radicals and, if containing more than one ring, partially hydrogenated such as in the case of diarylihydroxanthrene or contain oxygen instead of hydrogen on one ring such as in the case of anthraquinone.

The radicals, which may comprise substituents on the aromatic ring, include radicals having the formulas: \(-\text{R}_5\), \(-\text{OR}_6\), \(-\text{NR}_7\text{R}_8\), \(-\text{NR}_7\text{R}_8\), and \(-\text{COR}_{10}\) where \(\text{R}_5\), \(\text{R}_6\), \(\text{R}_7\), \(\text{R}_8\), and \(\text{R}_{10}\) are hydrogen or hydrocarbyl radicals of one to eight carbon atoms. Typical hydrocarbyl radicals, which can be present in the compounds of the present invention are methyl, ethyl, isopropyl, cyclohexyl, phenyl, benzyl, tolyl, and xylyl radicals which may optionally be substituted with neutral groups such as those indicated above. Typical radicals having the formula \(-\text{OR}_6\) hereinafter referred to as hydrocarboxy radicals, which may be substituents on the aromatic radical, are methoxy, ethoxy, propoxy, phenoxy, benzoxy, and toluyloxy radicals.

Typical amino substituents on the aromatic radical are amino, methylamino, diethylamino, anilino, and diphenylamino radicals. Typical substituents having the formula \(-\text{SR}_9\) hereinafter referred to as hydrocarbylthio radicals are methythio, ethylthio, n-propylthio, cyclohexylthio, and benzylthio radicals. Typical radicals having the formula \(-\text{COR}_{10}\) hereinafter referred to as hydrocarboxy radicals are acetyl, propionyl, hexanoyl, benzoyl, and toluyloyl radicals. The term aromatic radicals as used herein is intended to cover both substituted and unsubstituted aromatic radicals. Dyes of this type and their preparation are described in further detail in Faber U.S. Pat. No. 3,369,904, entitled Photographic Sensitizing Dyes. Useful dyes are typically present in an amount between about 0.005 to about 10% by weight of the photoconductive composition with preferred materials being present in amounts between about 0.25 to about 5% by weight.

A wide variety of organic photoconductors are useful in the present invention. Preferred materials are those organic photoconductors containing a basic radical such as an amino or a nitro radical. A suitable class of photoconductors includes certain amino substituted polyarylalkanes such as those having the formula:

\[
\begin{align*}
\text{D} & \quad \text{J} - \text{O} - \text{E} \\
\text{G} & \quad \text{a}
\end{align*}
\]

wherein each of \(\text{D}, \text{E}\) and \(\text{G}\) is an aryl group and \(\text{J}\) is a hydrogen atom, an alkyl group or an aryl group, at least one of \(\text{D}, \text{E}\) and \(\text{G}\) containing an amino substituent. The aryl groups attached to the central carbon atom are preferably phenyl groups, although naphthyl groups can also be used. Such aryl groups can contain such substituents as aryl hydroxylxy typically having 1 to 8 carbon atoms, hydroxy, halogen, etc., in the ortho, meta or para positions, ortho-substituted phenyl being preferred. The aryl groups can also be joined together or cyclized to form a fluorenone moiety, for example. The amino substituent can be represented by the formula

\[
\begin{align*}
\text{L} & \quad \text{N} \\
\text{L} & \quad \text{a}
\end{align*}
\]

wherein each \(L\) can be an aryl group typically having 1 to 8 carbon atoms, a hydrogen atom, an aryl group, or together the necessary atoms to form a heterocyclic amino group typically having 5 to 6 atoms in the ring such as morpholino, pyridyl, pyrrol, etc. At least one of \(D, E\) and \(G\) is preferably \(p\)-diethylaminophenyl group. When \(J\) is an aryl group, such as alkyl group more generally has 1 to 7 carbon atoms.

Representative useful polyarylalkane photoconductors include the compounds listed in Table 1.

<table>
<thead>
<tr>
<th>Compound number</th>
<th>Name of compound</th>
</tr>
</thead>
</table>
| 1               | 4,4' - benzylidene-bis\((N,N\text{-diethyl}-
|                 | toluidene)\). |
| 2               | 4,4'' - dianimo-4-dimethylamino-2,2' -dimethyltriphenylmethane. |
| 3               | 4,4'' - bis(dimethylamino) - 2,6-dichloro - 2,2' - dimethyltriphenylmethane. |
| 4               | 4,4'' - bis(dimethylamino) - 2,2' - dimethyl diphenylnaphthalene. |
| 5               | 2,2' - dimethyl-4,4,4'' - tris\((dimethylamino)\)triphenylmethane. |
| 6               | 4,4'' - bis\((dimethylamino)\) - 4-dimethylamino - 2,2' - dimethyltriphenylmethane. |
| 7               | 4,4'' - bis\((dimethylamino)\) - 2-chloro - 2,2' - dimethyl-4-dimethylamino-triphenylmethane. |
| 8               | 4,4'' - bis\((diethylamino)\) - 4-dimethylamino - 2,2',2'' - trimethyltriphenylmethane. |
| 9               | 4,4'' - bis\((dimethylamino)\) - 2-chloro - 2,2',2'' - dimethyltriphenylmethane. |
| 10              | 4,4'' - bis\((dimethylamino)\) - 2,2' - dimethyl - 4 - methoxytriphenylmethane. |
| 11              | bis\((4 - diethylamino)\) - 1,1,1-triphenylethane. |
| 12              | bis\((4 - dimethylamino)\) - tetrphenylmethane. |
| 13              | 4,4'' - bis\((benzylamino)\) - 2,2' - dimethyltriphenylmethane. |
| 14              | 4,4'' - bis\((diethylamino)\) - 2,2' - dioxytriphenylmethane. |
| 15              | 4,4'' - bis\((dimethylamino)\) - 1,1,1-triphenylethane. |
| 16              | 1,4\((N,N\text{-dimethylamino})\) - 1,1,1-diphenylethane. |
| 17              | 4,4'' - bis\((diethylamino)\) - tetrphenylmethane. |
| 18              | 4,4'' - bis\((diethylamino)\) - tetrphenylmethane. |

TABLE 1
Another class of photoconductors useful in this invention are the 4-diarylamino-substituted chalcones. Typical compounds of this type are low molecular weight non-polymeric ketones having the general formula:

\[
\text{R}_1 \text{O} \rightarrow \text{CH} = \text{CH} - \text{R}_2
\]

wherein \( \text{R}_1 \) and \( \text{R}_2 \) are each phenyl radicals including substituted phenyl radicals and particularly when \( \text{R}_2 \) is a phenyl radical having the formula:

\[
\text{R} \equiv \text{CH} - \text{CH} = \text{CH} \equiv \text{R}_3
\]

where \( \text{R}_3 \) and \( \text{R}_4 \) are each aryl radicals, aliphatic residues of 1 to 12 carbon atoms such as alkyl radicals preferably having 1 to 4 carbon atoms or hydrogen. Particularly advantageous results are obtained when \( \text{R}_2 \) is a phenyl radical including substituted phenyl radicals and where \( \text{R}_3 \) is diphenylaminophenyl, dimethylaminophenyl or phenyl.

Other organic photoconductors useful would include trinitrofluorenone and tetranitrofluorenone as well as the various organic amino photoconductors such as the arylamines which have an amino substituent. The photoconductors used are typically present in an amount between about 10 to about 60% by weight of the photoconductive composition.

The compositions of this invention are typically coated onto a conductive support to form an electrophotographic element. Suitable supports would include paper (at a relative humidity above 20 percent) including paper made more conductive by various coating and/or sizing techniques or carrying a conducting layer such as a conducting metal foil, a layer containing a semiconductor dispersed in a resin, a conducting layer containing the sodium salt of a carboxyester lactone of maleic anhydride and a vinyl acetate polymer such as disclosed in U.S. Patents 3,007,901 and 3,262,806, a thin film of vacuum deposited nickel, aluminum, silver, chromium, etc., a conducting layer as described in U.S. Pat. 3,245,833, such as cuprous iodide, and like kinds of conducting materials. Such conducting materials can be coated in any well known manner such as doctor-blade coating, swirling, dipping, coating, spraying, and the like. Especially preferred supports are transparent and include all of photographic film bases such as poly-ethylene terephthalate), polystyrene, polycarbonate, cellulose acetate, etc., bearing the above conducting layers, for example. The conducting layer can be overcoated with a thin layer of insulating material selected from its adhesive and electrical properties before application of a photoconducting layer. Where desired, however, the photoconducting layer can be coated directly on the conducting layer when conditions permit.

The photoconductive compositions of the present invention can be employed in photoconductive elements useful in any of the well-known electrophotographic processes which require photoconductive layers. One such process is the xerographic process. In a process of this type, an electrophotographic element held in the dark is given a blanket electrostatic charge by placing it under the layer by virtue of the substantial dark insulating property of the layer, i.e., the low conductivity of the layer in the dark. The electrostatic charge formed on the surface of the photoconductive layer is then selectively dissipated from the surface of the layer by image-wise exposure to light by means of a conventional exposure operation such as, for example, by contact-printing technique, or by lens projection of an image, and the like, to thereby form a latent electrostatic image in the photoconductive layer. Exposing the surface in this manner forms a pattern of electrostatic charge by virtue of the fact that light energy striking the photoconductor causes the electrostatic charge in the light struck areas to be conducted away from the surface in proportion to the intensity of the illumination in a particular area.

The charge pattern produced by exposure is then developed, i.e., either the charged or uncharged areas rendered visible, by treatment with a medium comprising electrostatically responsive toner particles. The developing electrostatically responsive particles can be in various forms such as small particles of pigment or other form of small particles comprised of a colorant in a resinous binder. The developer materials can be applied by cascade development as described in U.S. Pat. No. 2,618,551. A method of applying such dry toners to a latent electrostatic image especially where solid area development is desired is by the use of a magnetic brush. Methods of forming and using a magnetic brush toner applicator are described in the following U.S. Patents: 2,786,439; 2,786,440; 3,785,441; 2,811,465; 2,874,063; 2,984,163; 3,040,704; 3,117,884; and Reissue 25,779. Liquid development of the latent electrostatic image can also be used. In liquid development the developing particles are carried to the image-bearing surface in an electrically insulating liquid carrier. Methods of development of this type are widely known and have been described in the potenti literature, for example, U.S. Pat. 2,907,674 and in Australian Pat. 212,315.

In dry developing processes, the most widely used method of obtaining a permanent record is achieved by selecting a developing particle which has as one of its components a thermoplastic resin. Heating the powder image then causes the resin to melt or fuse into or on the element. The powder is, therefore, caused to adhere permanently to the surface of the photoconductive layer. In the case of the present photoconductive compositions, the heat applied to fuse the developed image can be utilized to cause decolorization. Decolorization can generally be accomplished by heating on a hot plate, in an oven, etc., at a temperature of about 100 to 200°C. for a period of about 15 to 60 seconds. The time and temperature will, of course, vary with different materials.

After images have been formed and the element decolorized as described above, it may be desirable to add on more information. The present materials can be converted back to the colored, panchromatically sensitive state by treating with an acid such as a relatively dilute hydrochloric acid solution. This can be swabbed onto the photoconductive layer or the element can be immersed in a solution. After such treatment the composition reverts to the original color and sensitivity. The element is now ready for charging, exposing, developing and heating as before. The exact mechanism of the thermal decolorization in the present invention is not entirely understood. However, it is believed that upon heating the basic photoconductor extracts a proton from the dye salt to cause decolorization. Such a reaction could occur as follows:

\[
\text{NH} - \text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{NH}^+ + R - \text{N} - (\text{CH}_2)_n \rightarrow \text{NH} - \text{CH} = \text{CH} - \text{CH} = \text{CH} = \text{N}^+ + R - \text{N} - (\text{CH}_2)_n
\]

\[
\text{NH} - \text{CH} = \text{CH} - \text{CH} = \text{CH} - \text{NH}^+ + \text{Cl}^- \rightarrow \text{NH} - \text{CH} = \text{CH} - \text{CH} = \text{CH} = \text{N}^+ + \text{Cl}^- + \text{H}^+
\]

wherein \( R \) in this instance represents the remainder of an amino-substituted triphenylmethane photoconductor nu-
EXAMPLE 1

A coating dope is prepared by mixing 25 ml of a solution containing 6% by weight of poly(4,4'-isopropylidendiphenylcarbonate) as the binder, 4% by weight of 4,4'-diethylamino-2,2'-dimethylthiophenylmethane photoc conductor and 90% by weight of methylene chloride (solvent) are added 15 mg. of pentadiene diatene hydrochloride dissolved in 1 ml. of methylene chloride. The resulting coating dope is coated at 0.006 inch wet thickness on a polystyrene coated paper support and dried to form a photoconductive element. The element is then dark adapted and subjected to a corona discharge and is then exposed for one second at 1 mm. in a Bausch and Lomb spectrograph. The resultant electrostatic latent image is cascade developed using a toner material comprised of carbon black in a styrene resin. A good wedge spectrogram results which indicates spectral sensitivity from 400 to 600 nm. with a broad peak at 540 nm. The original photoconductive element is bright orange in color; however, when the toned image is heated on a hot plate at about 120° C. to fuse the toner image, the photoconductive coating becomes decolorized. The resultant developed image after fusing step is completely devoid of any objectionable color. Similar results are obtained using 4-diethylaminotetraphenylmethane as the photoconductor. Likewise similar results are obtained using 1-(p-aminooanilino)-5-(p-aminophenyl imino)-1,3-pentadiene hydrochloride, 1-(p-dimethylamin oanilino)-5-(p-dimethylaminophenylimino)-1,3-pentadi ene hydrochloride, or 1-(3-amino-4-toluidino)-5-(3-amino 4-tolylimino)-1,3-pentadiene hydrochloride as the dye.

EXAMPLE 2

A photoconductive composition is prepared by mixing into methylene chloride the following materials: 25% by weight of bis-(4-diethylamino)tetrphenylmethane photo conductor, 12% by weight of the dye pentadiene diatene hydrochloride with the remainder being poly(vinyl-m bromo benzoate) binder. The resulting coating dope is coated onto a clay-coated paper support which has been treated with a conductivity agent. The resultant electrophotographic element No. 2 is then electrosotically charged under a corona source until the surface potential, as measured by an electrometer probe, reaches about 600 volts. The charged surface is then exposed to light from a 3000 K. tungsten source modulated by a stepped density gray scale. The exposure causes reduction of the surface potential of the element under each step of the gray scale from its initial value of Vp, to some lower potential Vf, the exact value of which depends upon the amount of exposure received by the area. The actual positive or negative speed of the photoconductive composition can then be expressed in terms of the reciprocal of the exposure required to reduce the surface potential to any fixed arbitrarily selected value. Unless otherwise stated, the actual positive or negative speed is the numerical expression of 10 divided by the exposure in meter-candle-seconds required to reduce the 600-volt surface potential to a value of 500 volts (100-volt shoulder speed) or to a value of 100 volts (100-volt toe speed). The above procedure is again repeated using in place of the photoconductor above 25% by weight of 4,4'-diethylamino-2,2'-dimethylthiophenyilmethane as the photoconductor to form Element No. 3. The results of the speed measurements on Element No. 2 above and Element No. 3 are shown in Table following:

TABLE 3

<table>
<thead>
<tr>
<th>Element No.</th>
<th>Positive, shoulder/toe</th>
<th>Negative, shoulder/toe</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4/30/34</td>
<td>280/12</td>
</tr>
<tr>
<td>5</td>
<td>4/30/34</td>
<td>280/10</td>
</tr>
</tbody>
</table>

EXAMPLE 3

Elements 4 and 5 are prepared using coating dopes similar to those of Elements 2 and 3, respectively, of the preceding example. In place of the clay-coated paper support, a transparent support is used which is formed of a transparent poly(ethylene terephthalate) film base having coated thereon a conductive layer of the sodium salt of butyl ester lactone made from vinyl acetate-maleic anhydride copolymer as in Example 1 of U.S. Pat. No. 3,260,706. The Elements 4 and 5 are then tested for positive and negative 100-volt shoulder and toe speeds as in Example 2. The results of these measurements are shown below in Table 3. The stability of these elements is examined. No change in color or spectral sensitization occurs when the elements are stored for over one year in the dark at room temperature.

TABLE 4

<table>
<thead>
<tr>
<th>Element No.</th>
<th>Positive, shoulder/toe</th>
<th>Negative, shoulder/toe</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4/30/34</td>
<td>280/12</td>
</tr>
<tr>
<td>5</td>
<td>4/30/34</td>
<td>280/10</td>
</tr>
</tbody>
</table>

EXAMPLE 4

A coating dope comprised of methylene chloride mixed with a solids composition comprised of 25% by weight of trinitrotoluene, 1% by weight of the dye pentadiene diatene dihydrochloride and the remainder poly(ethylene glycol-co-bis(hydroxyphenyl)propane terephthalate) as the binder. This material is coated on a conductive support as in the preceding example and tested as above for electrophotographic speed and found to have a negative 100-volt shoulder speed of 160.

EXAMPLE 5

All of the electrophotographic elements in Examples 2 through 4 are relatively photoschromically sensitized; however, they exhibit a coloration which is not always desirable. When these elements are heated on a hot plate or in an oven at about 120° C. for about 30 seconds, the elements all decolorize. Before heating the above elements, they are charged, image-wise exposed and developed with the toner material of Example 1 to form a visible image. During the step of fusing the developed image, the non-image areas are decolorized. If after formation of the visible image and after heating to fuse the toner and decolorize the element, it is desired to add on additional information, the element is treated with hydrochloric acid and it reverts to the original color. The element is then again charged, exposed and developed as before. As previously, the element decolorizes upon heating which results in a visible toned image having good contrast.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that various substitutions, modifications, and equivalents can be made within the spirit and scope of the invention.

We claim:

1. A photoconductive composition comprising an organic photoconductor; a film-forming polymeric binder; and a sensitizing amount of a sensitizing dye for said photoconductor which dye exhibits spectral absorption...
8,627,527 shifts upon heating, said dye selected from the group consisting of compounds having the formulas:

(I) \[ R_1-NH-CH=CH-CH=CH=N\{H-R_1 \}

(Z) \[ R_2N-\{Ar\}_l-NH-CH=CH-CH=CH

wherein \( R_1, R_2, R_3 \), and \( R_4 \) are radicals selected from the group consisting of hydrogen and hydrocarbyl radicals of one to eight carbon atoms, \( Ar \) is a divalent aromatic radical, \( Z^- \) is an acid radical, \( n \) is an integer of from 1 to 10, and \( R_3 \) is an aryl radical.

2. An electrophotographic element comprising a support having coated thereon a photoconductive composition comprising an organic photoconductor containing a moiety selected from the group consisting of an amino radical and a nitro radical; a film-forming polymeric binder; and a sensitizing amount of a sensitizing dye for said photoconductor which dye exhibits spectral absorption shifts upon heating, said dye selected from the group consisting of compounds having the formulas:

(I) \[ R_1-NH-CH=CH-CH=CH=N\{H-R_1 \}

(Z) \[ R_2N-\{Ar\}_l-NH-CH=CH-CH=CH

wherein \( R_1, R_2, R_3 \), and \( R_4 \) are radicals selected from the group consisting of hydrogen and hydrocarbyl radicals of one to eight carbon atoms, \( Ar \) is a divalent aromatic radical, \( Z^- \) is an acid radical, \( n \) is an integer of from 1 to 10, and \( R_3 \) is an aryl radical.

3. An electrophotographic element as described in claim 2 wherein said support is a conductive support.

4. An electrophotographic element as described in claim 3 wherein the sensitizing dye is pentafluor dihydrazine hydroiodide.

5. An electrophotographic element as described in claim 3 wherein the organic photoconductor is an amino-substituted polyaryllkane.

6. An electrostatic process for producing an image comprising the steps of (a) providing an electrophotographic element comprising a conductive support having coated thereon a photoconductive composition comprising: (i) an organic photoconductor, (ii) a film-forming polymeric binder, (iii) a sensitizing dye for said photoconductor which dye exhibits spectral shifts upon heating, said dye selected from the group consisting of compounds having the formula:

(I) \[ R_1-NH-CH=CH-CH=CH=N\{H-R_1 \}

(Z) \[ R_2N-\{Ar\}_l-NH-CH=CH-CH=CH

wherein \( R_1, R_2, R_3 \), and \( R_4 \) are radicals selected from the group consisting of hydrogen and hydrocarbyl radicals of one to eight carbon atoms, \( Ar \) is a divalent aromatic radical, \( Z^- \) is an acid radical, \( n \) is an integer of from 1 to 10, and \( R_3 \) is an aryl radical.

7. The method as described in claim 6 wherein said decolorized developed element is treated with a dilute acid solution thereby causing said non-image areas to revert to the original color, and repeating steps (b) through (e) inclusive.

8. An electrophotographic element comprising a transparent conductive support having coated thereon a photoconductive composition comprising from about 10 to about 60% by weight of said composition of an organic photoconductor, (b) a film-forming polymeric binder and (c) from about 0.005 to about 10% by weight of said composition of a sensitizing dye selected from the group of compounds having the formula:

\[ Ar-NH-CH=CH-CH=CH=N\{H-Ar \}

wherein \( Ar \) is an aryl radical and \( Z^- \) is an acid anion.

9. An electrophotographic element comprising a transparent conductive support having coated thereon a photoconductive composition comprising (a) from about 10 to about 60% by weight of said composition of an organic photoconductor, (b) a film-forming polymeric binder and (c) from about 0.005 to about 5% by weight of said composition of pentadine dihydrazine hydrochloride sensitizer.

10. An element as described in claim 9 wherein said photoconductor is selected from the group consisting of 4,4'-diethyl amino-2,2'-dimethyltriphenylmethane, 4-diethylamino tetr phenylmethane, bis(4'-diethylamino) tetraphenylmethane and trinitrofluorenone.

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GEORGE F. LESMES, Primary Examiner
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U.S. Cl. X.R.
96—1; 260—566
UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,627,527  Dated December 14, 1971
Inventor(s)  Paul B. Gilman and Ronald G. Raleigh

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 9, line 48, after "spectral" insert --absorption--.

Signed and sealed this 30th day of May 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.  ROBERT GOTTSCHALK
Attesting Officer  Commissioner of Patents