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3,552,958

ELECTROPHOTOGRAPHIC COMPOSITION AND ELEMENT

Edward J. Seus, Penfield, and George A. Reynolds,
Rochester, N.Y., assignors to Eastman Kodak Com-
pany, Rochester, N.Y., a corporation of New Jersey
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11 Claims

ABSTRACT OF THE DISCLOSURE

Aryl and heterocyclic-substituted cyclopropenyl salts are sensitizers for organic photoconductors.

This invention relates to the novel use of a class of organic compounds as sensitizers in electrophotographic elements.

The process of xerography, as disclosed by Carlson in U.S. Patent No. 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 after a suitable period of dark adaptation. The element is then exposed to a pattern of actinic radiation which has the effect of differentially reducing the potential of the 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 electroscopic 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 in accordance with either the charge pattern or in the absence of charge pattern as desired. The 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 and the like or transferred to a second element to which it may similarly be fixed. Likewise, the electrostatic latent image can be transferred to a second element and developed there.

Various photoconductive insulating materials have been employed in the manufacture of electrophotographic elements. For example, vapors of selenium and vapors of selenium alloys deposited on a suitable support and particles of photoconductive zinc oxide held in a resinous, film-forming binder have found wide application in present-day document copying applications.

Since the introduction of electrophotography, a great many organic compounds have been formed to possess some degree of photoconductivity. Many organic compounds have revealed a useful level of photoconduction and have been incorporated into photoconductive compositions. Optically clear organic photoconductor-containing elements having desirable electrophotographic properties can be especially useful in electrophotography. Such electrophotographic elements may be exposed through a transparent base, if desired, thereby providing unusual flexibility in equipment design. Such compositions when coated as a film or layer on a suitable support also yield an element which is reusable; that is, it can be used to form subsequent images after residual toner from prior images has been removed by transfer and/or cleaning.

Although some of the organic photoconductor materials referred to above are inherently light sensitive, their de-

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gree of sensitivity is usually low so that it is often necessary to add materials to increase their speed.

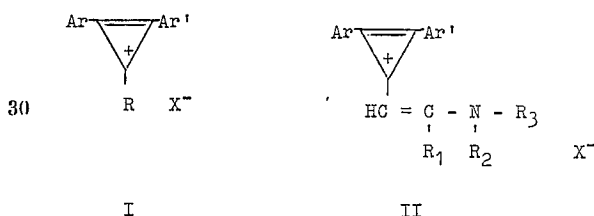
Increasing the electrophotographic speed has several advantages in that it reduces exposure time, allows projection printing through various optical systems, etc. By increasing the speed through the use of sensitizers, photoconductors which would otherwise have been unsatisfactory are useful in processes where higher speeds are required. However, a major disadvantage of many prior sensitized organic photoconductor systems has been the highly colored nature of such systems.

It is, therefore, an object of this invention to provide a novel class of sensitizers for use in combination with organic photoconductors.

Another object of this invention is to provide novel sensitized photoconductive elements.

A further object of this invention is to provide novel photoconductive compositions which are colorless or only slightly colored.

These and other objects are accomplished by the use of cyclopropenyl salts containing aryl and/or heterocyclic radical substituents as sensitizers in organic photoconductor-containing compositions. Typical sensitizers of the present invention include those having the following structural formulas:



wherein:

X is an anionic function including such anions as perchlorate, fluoroborate, sulfonate, periodate and halide such as chloride, bromide, iodide, etc.:

R is an aralkenyl radical having from 2 to 4 carbon atoms in the alkenyl moiety such as phenylethenyl, diethylaminophenylethenyl, phenylpropenyl, phenylbutenyl, etc., or an aryl radical including substituted aryl radicals having such substituents as (a) alkyl radicals of one to three carbon atoms such as methyl, ethyl, isopropyl, etc., (b) dialkylamino radicals of from two to six carbon atoms, such as dimethylamino, methylethylamino, diethylamino, dipropylamino, etc., (c) diarylamino radicals, or (d) aralkenyl radicals having two to four carbon atoms in the alkenyl moiety such as phenylethenyl, diethylaminophenylethenyl, phenylpropenyl, phenylbutenyl, etc.;

Ar and Ar' can each be an aryl radical including substituted aryl such as phenyl, chlorophenyl, tolyl, naphthyl, etc., or a heterocyclic radical having at least one hetero atom such as nitrogen, oxygen or sulfur and being mono- or polycyclic such as 2-thienyl, 2- or 4-pyridyl, pyrrol, furyl, benzothienyl, 2- or 4-quinolyl, indolyl, benzofuryl, etc., and including the corresponding substituted radicals having such substituents as alkyl radicals of from one to four carbon atoms such as methyl, ethyl, isopropyl, butyl, etc.;

R₁, when taken alone, can be a hydrogen atom or an alkyl radical of from one to four carbon atoms such as methyl, ethyl, isopropyl, butyl, etc., or, when taken together with R₂, represents the atoms necessary to form a heterocyclic ring of up to six atoms including substituted heterocyclic rings having for example alkyl substituents of from one to four carbon atoms such as methyl, ethyl, isopropyl, butyl, etc., or having a fused aromatic ring attached thereto;

R₂, when taken alone, can be a hydrogen atom or an alkyl radical of from one to six carbon atoms such as

methyl, ethyl, isopropyl, tertbutyl, pentyl, hexyl, etc., or, when taken together with R₁, represents the atoms necessary to form a heterocyclic ring of up to six atoms as described above; and

R₃ represents an alkyl radical of from one to six carbon atoms such as methyl, ethyl, isopropyl, n-butyl, pentyl, hexyl, cyclohexyl, etc.

The sensitizers of the present invention can be prepared in accordance with the methods reported in the literature. Breslow and Yuan reported in J. Am. Chem. Soc. 80, 5991 (1958) early synthesis of cyclopropenyl salts. Similarly Fohlisch and Burgle have reported on their preparations in Tetrahedron Letters 2663 (1965). A common method of preparation is to react, for example, diphenylcyclopropenone with excess phosphorous oxychloride and the aromatic or heterocyclic compound desired to be substituted for the oxo radical in the cyclopropenone.

Suitable sensitizers used in the invention include the following representative compounds:

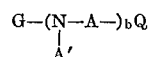
TABLE A

No.	Name
1	1-(p-dimethylaminophenyl) - 2,3 - diphenylcyclopropenylm fluoborate
2	1-(p-diethylaminophenyl) - 2,3 - diphenylcyclopropenylm fluoborate
3	1-[(N-methyl-N-ethyl-aminophenyl)]-2,3 - diphenylcyclopropenylm perchlorate
4	1-[p-(2 - dimethylaminobenzoethenyl)phenyl] - 2,3-diphenylcyclopropenylm perchlorate
5	1-phenylethenyl-2,3-diphenylcyclopropenylm chloride
6	1-(p-ethylphenyl)-2,3-diphenylcyclopropenylm sulfonate
7	1-(p-diphenylaminophenyl)-2,3 - diphenylcyclopropenylm perchlorate
8	1-(p-diphenylaminophenyl) - 2,3 - [bis(tolyl)]cyclopropenylm perchlorate
9	1-(N-methyl-N-ethyl-aminoethenyl) - 2,3 - diphenylcyclopropenylm perchlorate
10	1-(p-dimethylaminophenyl)-2-tolyl - 3 - (chlorophenyl)cyclopropenylm perchlorate
11	1-(1,3,3-triethyl-2-methyleneindolenyl)-2,3 - (diphenyl)cyclopropenylm perchlorate
12	1-[p-(dimethylaminostyryl)phenyl] - 2 - indolyl - 3-phenylcyclopropenylm perchlorate
13	1-(p-dimethylaminophenyl)-2-(2-pyridyl)-3 - phenylcyclopropenylm chloride
14	1-(p-diethylaminophenyl)-2-(2-thienyl) - 3 - phenylcyclopropenylm sulfonate
15	1-(p-ethylphenyl)-2-(2-quinolyl)-3-chlorophenyl cyclopropenylm perchlorate
16	1-[p-(N-methyl-N-ethylaminophenyl)]-2-(N - ethylpyrryl)-3-phenyl cyclopropenylm perchlorate
17	1-(p-dimethylaminophenyl)-2,3 - dibenzothienylcyclopropenylm perchlorate

Electrophotographic elements of the invention can be prepared with a variety of organic photoconductive compounds and the sensitizing compounds of this invention in the usual manner, i.e., by blending a dispersion or solution of the photoconductive compound together with an electrically insulating, film-forming resin binder when necessary or desirable and coating or forming a self-supporting layer with the photoconductive composition. Generally, a suitable amount of the sensitizing compound is mixed with the photoconductive coating composition so that after thorough mixing the sensitizing compound is uniformly distributed throughout the desired layer of the coated element. The amount of sensitizer that can be added to a photoconductor containing layer to give effective increases in speed can vary widely. The optimum concentration in any given case will vary with the specific photoconductor and sensitizing compound used. In general, substantial speed gains can be obtained where an appropriate sensitizer is added in a concentration range

from about 0.0001 to about 30 percent by weight based on the weight of the film-forming coating composition. Normally, a sensitizer is added to the coating composition in an amount from about 0.005 to about 5.0 percent by weight of the total coating composition.

The sensitizers used in the invention are effective for enhancing the electrophotosensitivity of a wide variety of photoconductors. The preferred photoconductors are those organic compounds which exhibit an electrophotosensitivity to light and are capable of forming transparent elements. A useful class of organic photoconductors is referred to herein as "organic amine" photoconductors. Such organic photoconductors have as a common structural feature at least one amino group. Useful organic photoconductors which can be spectrally sensitized in accordance with this invention include, therefore, arylamine compounds comprising (1) diarylamines such as diphenylamine, dinaphthylamine, N,N'-diphenylbenzidine, N-phenyl-1-naphthylamine, N - phenyl-2-naphthylamine, N,N'-diphenyl-p-phenylenediamine, 2 - carboxy-5-chloro-4' - methoxydiphenylamine, p - anilinophenol, N,N'-di-2-naphthyl-p-phenylenediamine, the materials described in Fox U.S. Patent 3,240,597 issued Mar. 15, 1966, and the like, and (2) triarylamines including (a) nonpolymeric triarylamines, such as triphenylamine, N,N,N',N'-tetraphenyl-m-phenylenediamine; 4 - acetyltriphenylamine, 4-hexanoyltriphenylamine; 4-lauroyltriphenylamine, 4-hexyltriphenylamine, 4 - dodecyltriphenylamine, 4,4'-bis(diphenylamino)benzil, 4,4' - bis(diphenylamino)-benzophenone and the like and (b) polymeric triarylamines such as poly(N,4'-(N,N',N'-triphenylbenzidine, polyadipyltriphenylamine, polysebacyltriphenylamine, polydecamethylenetriphenylamine; poly-N - (4 - vinylphenyl)diphenylamine, poly-N-(vinylphenyl) - α,α' -dinaphthylamine and the like. Other useful amine-type photoconductors are disclosed in U.S. Patent 3,180,730 issued Apr. 27, 1965. In addition, photoconductive substances capable of being spectrally sensitized in accordance with this invention are disclosed in Fox U.S. Patent 3,265,496 issued Aug. 9, 1966, and include those represented by the following general formula:



wherein A represents a mononuclear or polynuclear divalent aromatic radical, either fused or linear (e.g., phenyl, naphthyl, biphenyl, binaphthyl, etc.) or a substituted divalent aromatic radical of these types wherein said substituent can comprise a member such as an acyl group having from one to about six carbon atoms (e.g., acetyl, propionyl, butyryl, etc.), an alkyl group having from one to about six carbon atoms (e.g., methyl, ethyl, propyl, butyl, etc.), an alkoxy group having from one to about six carbon atoms (e.g., methoxy, ethoxy, propoxy, pentoxy, etc.) or a nitro group; A' represents a mononuclear or polynuclear monovalent aromatic radical, either fused or linear (e.g., phenyl, naphthyl, biphenyl, etc.) or a substituted monovalent aromatic radical wherein said substituent can comprise a member such as an acyl group having from one to about six carbon atoms (e.g., acetyl, propionyl, butyryl, etc.), an alkyl group having from one to about six carbon atoms (e.g., methyl, ethyl, propyl, butyl, etc.), an alkoxy group having from one to about six carbon atoms (e.g., methoxy, propoxy, pentoxy, etc.) or a nitro group; Q can represent a hydrogen atom, a halogen atom or an aromatic amino group, such as A'NH—; b represents an integer from one to about 12; and G represents a hydrogen atom, a mononuclear or polynuclear aromatic radical, either fused or linear (e.g., phenyl, naphthyl, biphenyl, etc.), a substituted aromatic radical wherein said substituent comprises an alkyl group, an alkoxy group, an acyl group, a nitro group or a poly(4'-vinylphenyl) group which is bonded to the nitrogen atom by a carbon atom of the phenyl group.

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Other compounds include polyaryllalkane photoconductors which are particularly useful in accordance with the present invention. Such photoconductors are described in U.S. Pat. 3,274,000; French Pat. 1,383,461 and in copending application of Seus and Goldman entitled "Photoconductive Elements Containing Organic Photoconductors" filed Apr. 3, 1967. These photoconductors include leuco bases of diaryl or triarylmethane dye salts, 1,1,1-triaryllalkanes wherein the alkane moiety has at least two carbon atoms and tetraarylmethanes, there being substituted an amino group on at least one of the aryl groups attached to the alkane and methane moieties of the latter two classes of photoconductors which are nonleuco base materials.

Preferred polyaryl alkane photoconductors can be represented by the formula:



wherein each of D, E, and G is an aryl group and J is a hydrogen atom, an alkyl group, or an aryl group, at least one of D, E and 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 alkyl and alkoxy typically having one to eight 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 fluorene moiety, for example. The amino substituent can be represented by the formula



wherein each L can be an alkyl group typically having one to eight carbon atoms, a hydrogen atom, an aryl group or together the necessary atoms to form a heterocyclic amino group typically having five to six atoms in the ring such as morpholino, pyridyl, pyrrol, etc. At least one of D, E, and G is preferably p-dialkylaminophenyl group. When J is an alkyl group, such an alkyl group more generally has one to seven carbon atoms.

Representative useful polyaryllalkane photoconductors include the compounds listed below:

TABLE B

Compound No.	Compound Name
1	4,4'-benzylidene-bis(N,N-diethyl-m-toluidine)
2	4,4'-diamino-4-dimethylamino-2,2'-dimethyltriphenylmethane
3	4,4'-bis(diethylamino)-2,6-dichloro-2,2'-dimethyltriphenylmethane
4	4,4'-bis(diethylamino)-2,2'-dimethyl-diphenyl-naphthylmethane
5	2,2'-dimethyl-4,4'-tris(dimethylamino)triphenylmethane
6	4,4'-bis(diethylamino)-4-dimethylamino-2,2'-dimethyltriphenylmethane
7	4,4'-bis(diethylamino)-2-chloro-2,2'-dimethyl-4-dimethylaminotriphenylmethane
8	4,4'-bis(diethylamino)-4-dimethylamino-2,2'-trimethyltriphenylmethane
9	4,4'-bis(dimethylamino)-2-chloro-2,2'-dimethyltriphenylmethane
10	4,4'-bis(diethylamino)-2,2'-dimethyl-4-methoxytriphenylmethane
11	Bis(4-diethylamino)-1,1,1-triphenylethane
12	Bis(4-diethylamino)tetraphenylmethane
13	4,4'-bis(benzylethylamino)-2,2'-dimethyltriphenylmethane
14	4,4'-bis(diethylamino)-2,2'-diethoxytriphenylmethane
15	4,4'-bis(dimethylamino)-1,1,1-triphenylethane

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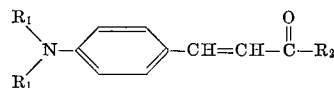
16—1-(4-N,N-dimethylaminophenyl)-1,1-diphenylethane

17—4-dimethylaminotetraphenylmethane

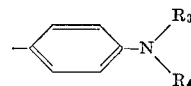
18—4-diethylaminotetraphenylmethane

Additional organic photoconductors which can be employed with the sensitizing compounds described herein are non-ionic cycloheptenyl compounds such as those described in copending application Ser. No. 654,091, filed July 18, 1967; the N,N-bicarbazyl and tetra-substituted hydrazines; the 3,3'-bis-1,5-diarylpzrazolines; triarylamines having at least one of the aryl radicals substituted by either a vinyl radical, or a vinylene radical having at least one active hydrogen-containing group such as p-diphenylamino-cinnamic acid; triarylamines substituted by an active hydrogen-containing group, e.g., 4-carboxytriphenylamine; and those described in Australian Pat. No. 248,402.

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:



wherein R₁ and R₂ are each phenyl radicals including substituted phenyl radicals and particularly when R₂ is a phenyl radical having the formula:



where R₃ and R₄ are each aryl radicals, aliphatic residues of one to 12 carbon atoms such as alkyl radicals preferably having one to four carbon atoms or hydrogen. Particularly advantageous results are obtained when R₁ is a phenyl radical including substituted phenyl radicals and where R₂ is diphenylaminophenyl, dimethylaminophenyl or phenyl.

Preferred binders for use in preparing the present photoconductive layers comprise polymers having fairly high dielectric strength which are good electrically insulating film-forming vehicles. Materials of this type comprise styrene-butadiene copolymers; silicone resins; styrene-alkyd resins; silicone-alkyl resins; soya-alkyd resins; poly(vinyl chloride); poly(vinylidene chloride); vinylidene chloride-acrylonitrile copolymers; poly(vinyl acetate); vinyl acetate-vinyl chloride copolymers; poly(vinyl acetals), such as poly(vinyl butyral); polyacrylic and methacrylic esters, such as poly(methylmethacrylate), poly(n-butylmethacrylate), poly(isobutyl methacrylate), etc.; polystyrene; nitrated polystyrene; polymethylstyrene; isobutylene polymers; polyesters, such as poly(ethylene alkaryloxyalkylene terephthalate); phenol-formaldehyde resins; ketone resins; polyamides; polycarbonates; polythiocarbonates; poly(ethyleneglycol-co-bishydroxyethoxyphenyl propane terephthalate); nuclear substituted polyvinyl haloarylates; etc. Methods of making resins of this type have been described in the prior art, for example, styrene-alkyd resins can be prepared according to the method described in U.S. Pats. 2,361,019 and 2,258,423. Suitable resins of the type contemplated for use in the photoconductive layers of the invention are sold under such trade names as Vitel PE-101, Cymac, Piccopale 100, Saran F-220 and Lexan 105. Other types of binders which can be used in the photoconductive layers of the invention include such materials as paraffin, mineral waxes, etc.

Solvents of choice for preparing coating compositions of the present invention can include a number of solvents such as benzene, toluene, acetone, 2-butanone, chlorinated hydrocarbons, e.g., methylene chloride, ethylene chloride, etc., ethers, e.g., tetrahydrofuran, or mixtures of these solvents, etc.

In preparing the coating composition useful results are obtained where the photoconductor substance is present

in an amount equal to at least about one weight percent of the coating composition. The upper limit in the amount of photoconductor substance present can be widely varied in accordance with usual practice. In those cases where a binder is employed, it is normally required that the photoconductor substance be present in an amount from about one weight percent of the coating composition to about 99 weight percent of the coating composition. A preferred weight range for the photoconductor substance in the coating composition is from about ten weight percent to about 60 weight percent.

Coating thicknesses of the photoconductive composition on a support can vary widely. Normally, a coating in the range of about 0.001 inch to about 0.01 inch before drying is useful for the practice of this invention. The preferred range of coating thickness is found to be in the range from about 0.002 inch to about 0.006 inch before drying although useful results can be obtained outside of this range.

Suitable supporting materials for coating the photoconductive layers of the present invention can include any of a wide variety of electrically conducting supports, for example, paper (at a relatively humidity above 20 percent), aluminum foil-paper laminates; metal foils such as aluminum foil, zinc foil etc.; metal plates, such as aluminum, copper, zinc, brass and galvanized plates; vapor deposited metal layers such as silver, nickel, aluminum and the like coated on paper or conventional photographic film bases such as cellulose acetate, polystyrene, poly(ethylene terephthalate) etc. Such conducting materials as nickel can be coated by vacuum deposition on transparent film supports in sufficiently thin layers to allow electrophotographic elements prepared therewith to be exposed from either side of such elements. An especially useful conducting support can be prepared by coating a support material such as poly(ethylene terephthalate) with a conducting layer containing a semiconductor dispersed in a resin. Such conducting layers both with and without insulating barrier layers are described in U.S. Pat. 3,245,833. Likewise, a suitable conducting coating can be prepared from the sodium salt of a carboxyester lactone of maleic anhydride and a vinyl acetate polymer. Such kinds of conducting layers and methods for their optimum preparation and use are disclosed in U.S. 3,007,901 and 3,267,807.

The elements of the present invention can be employed in any of the well-known electrophotographic processes which require photoconductive layers. One such process is the aforementioned xerographic process. As explained previously, in a process of this type the electrophotographic element is given a blanket electrostatic charge by placing the same under a corona discharge which serves to give a uniform charge to the surface of the photoconductive layer. This charge is retained on the layer by virtue of the substantial 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 photoconducting layer is then selectively dissipated from the surface of the layer by exposure to light through an image-bearing transparency by a conventional exposure operation such as, for example, by contact-printing technique, or by lens projection of an image, etc., to form an electrostatic latent image in the photoconducting layer. By exposure of the surface in this manner, a charged pattern is created by virtue of the fact that light causes the charge to be conducted away in proportion to the intensity of the illumination in a particular area. The charge pattern remaining after exposure is then developed, i.e., rendered visible, by treatment with a medium comprising electrostatically attractive particles having optical density. The developing electrostatically attractive particles can be in the form of a dust or a pigment in a resinous carrier or a liquid developer can be used in which the developing particles are carried in an electrically insulating liquid carrier. Methods of development of this type are widely known and have been described in the patent literature in such

patents, for example, as U.S. 2,297,691 and in Australian Pat. 212,315. In processes of electrophotographic reproduction such as in xerography, by selecting a developing particle which has a low-melting resin as one of its components, it is possible to treat the developed photoconductive material with heat and cause the powder to adhere permanently to the surface of the photoconductive layer. In other cases, a transfer of the image formed on the photoconductive layer can be made to a second support which would then become the final print. Techniques of the type indicated are well known in the art and have been described in a number of U.S. and foreign patents such as U.S. Patents 2,297,691 and 2,551,582 and in "RCA Review," vol. 15 (1954), pages 469-484.

The following examples are included for a further understanding of the invention.

EXAMPLE 1

Control coatings are prepared from the following ingredients:

- 0.50 g. polymeric binder
- 0.15 g. organic photoconductor
- 5.0 ml. methylene chloride (solvent)

The polymeric binder is a polyester of terephthalic acid and 2,2-bis[4-(β -hydroxyethoxy)phenyl]propane in which the substituted propane is replaced in a 50:50 molar ratio with ethylene glycol. The photoconductors used are (A) triphenylamine or (B) 4,4'-benzylidenebis(N,N-diethyl-m-toluidine). After mixing the above materials the compositions are coated at a wet thickness of 0.004 inch on an aluminum plate to form photoconductive elements. Corresponding elements are then prepared in which 0.002 g. of a sensitizer have been added to the photoconductive composition. The sensitizers used are (I) 1,2-diphenyl-3-(1,3,3-trimethyl-2-methyleneindolenyl)cyclopropenylum perchlorate, (II) 1-(p-dimethylaminophenyl)-2,3-diphenylcyclopropenylum fluoborate, and (III) 1-(p-diphenylaminophenyl)-2,3-diphenylcyclopropenylum perchlorate. The resultant electrophotographic elements are then electrostatically charged under a corona source until the surface potential, as measured by an electrometer probe, reaches about 600 volts. The charged elements are then exposed to a 3000° K. tungsten light source through a stepped density gray scale. The exposure causes reduction of the surface potential of the elements under each step of the gray scale from its initial potential, V_0 , to some lower potential, V , whose exact value depends on the actual amount of exposure in meter-candle seconds received by the area. The results of these measurements are then plotted on a graph of surface potential V vs. log exposure for each step. The actual positive or negative speed of the photoconductive composition used can then be expressed in terms of the reciprocal of the exposure required to reduce the surface potential to any fixed arbitrarily selected value. Herein, unless otherwise stated, the actual positive or negative speed is the numerical expression of 10^4 divided by the exposure in meter-candle-seconds required to reduce the 600 volt charged surface potential to a value of 500 volts (100 volt shoulder speed) or to a value of 100 volts (100 volt toe speed). The speeds of the elements are recorded in Table I below.

TABLE I

No.	Sensitizer	Photoconductor	+100 v. toe speed
1		A	0
2	I	A	11
3		B	0
4	II	B	22
5		B	0
6	III	B	25

After measuring the speeds, the latent electrostatic images on element Nos. 2, 4, and 6 are toned to form developed

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images by cascading a developer mixture over the photoconductive layer. The developer is comprised of a carrier of glass beads and toner particles of carbon black dispersed in poly(methyl methacrylate). Similar results are obtained when 1-[p-(dimethylaminostyryl)phenyl]-2-indolyl-3-phenylcyclopropenylium perchlorate or 1-(p-dimethylaminophenyl)-2-(2-thienyl)-3-phenylcyclopropenylium chloride are used as the sensitizers.

EXAMPLE 2

Two electrophotographic elements are made in a manner similar to that of Example 1 using sensitizer III with no photoconductor in element No. 7 and with 0.15 g. of photoconductor A in element No. 8. The photoconductive compositions are then coated at a wet thickness of 0.004 inch onto a 4 mil. poly(ethylene terephthalate) film support carrying a conductive layer of the sodium salt of a polymeric lactone as described in U.S. Patent No. 3,260,706. The elements are then charged, exposed and measured for speed as previously. The positive 100 v. toe speed for element No. 7 is 0 and the +100 v. toe speed for element No. 8 is 25. After measuring the speed, element No. 8 is toned as in Example 1 to form a developed image.

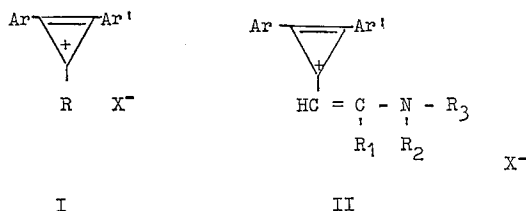
EXAMPLE 3

Three electrophotographic elements are made in accordance with Example 1 using 1-(p-diethylaminophenyl)-2,3-diphenylcyclopropenylium perchlorate as the sensitizer. The three elements numbered 8, 9, and 10 contain photoconductors (A) triphenylamine, (B) 4,4'-benzylidene bis(N,N-diethyl-m-toluidine) and (C) 4,4'-bis(diphenylamino)chalcone, respectively. The elements are charged, exposed and measured for speed as previously. The positive 100 v. toe speeds are 20, 20, and 5 respectively. After measuring the speeds, the elements are toned as in Example 1 to produce visible developed images. Similar results are obtained when 1-(p-ethylphenyl)-2-(2-quinolyl)-3-chlorophenyl cyclopropenylium perchlorate and 1-(p-(N-methyl-N-ethylaminophenyl))-2-(N-ethylpyrrol)-3-phenyl cyclopropenylium perchlorate are used as the sensitizers with the above photoconductors.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. A photoconductive composition comprising an organic photoconductive electrically insulating material sensitized with a cyclopropenylium salt selected from the group of compounds having the formula:



wherein:

X⁻ is an anion;

R is selected from the group consisting of an aralkenyl radical having from 2 to 4 carbon atoms in the alkenyl moiety and an aryl radical;

Ar and Ar' are each selected from the group consisting of an aryl radical and a heterocyclic radical containing from five to ten atoms and containing a hetero atom selected from oxygen, nitrogen and sulfur;

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R₁, when taken alone, is selected from the group consisting of a hydrogen atom and an alkyl radical of 1 to about 4 carbon atoms and when taken together with R₂, represents the atoms necessary to form a heterocyclic ring of up to six atoms;

R₂, when taken alone, is selected from the group consisting of a hydrogen atom and an alkyl radical of 1 to about 6 carbon atoms and when taken together with R₁, represents the atom necessary to form a heterocyclic ring of up to six atoms; and

R₃ represents an alkyl radical of 1 to about 6 carbon atoms.

2. A photoconductive composition as in claim 1 wherein the cyclopropenylium salt is selected from the group consisting of:

1-(p-dimethylaminophenyl)-2,3-diphenylcyclopropenylium fluoborate,

1-(p-diethylaminophenyl)-2,3-diphenylcyclopropenylium fluoborate,

1-[p-(N-methyl-N-ethyl-aminophenyl)]-2,3-diphenylcyclopropenylium perchlorate

1-[p-(2-dimethylaminobenzoethenyl)phenyl]-2,3-diphenylcyclopropenylium perchlorate,

1-(phenylethenyl)-2,3-diphenylcyclopropenylium chloride,

1-(p-ethylphenyl)-2,3-diphenylcyclopropenylium sulfonate,

1-(p-diphenylaminophenyl)-2,3-diphenylcyclopropenylium perchlorate,

1-(p-diphenylaminophenyl)-2,3-[bis(tolyl)]cyclopropenylium perchlorate,

1-(N-methyl-N-ethyl-aminoethenyl)-2,3-diphenylcyclopropenylium perchlorate,

1-(p-dimethylaminophenyl)-2-tolyl-3-(chlorophenyl)cyclopropenylium perchlorate,

1-(1,3,3-triethyl-2-methyleneindolenyl)-2,3-(diphenyl)cyclopropenylium perchlorate,

1-[p-(dimethylaminostyryl)phenyl]-2-indolyl-3-phenylcyclopropenylium perchlorate,

1-(p-dimethylaminophenyl)-2-(2-pyridyl)-3-phenylcyclopropenylium chloride,

1-(p-diethylaminophenyl)-2-(2-thienyl)-3-phenylcyclopropenylium sulfonate,

1-(p-ethylphenyl)-2-(2-quinolyl)-3-chlorophenylcyclopropenylium perchlorate,

1-[p-(N-methyl-N-ethylaminophenyl)]-2-(N-ethylpyrrol)-3-phenylcyclopropenylium perchlorate, and 1-(p-dimethylaminophenyl)-2,3-dibenzothienylcyclopropenylium perchlorate.

3. A photoconductive composition as in claim 1 wherein the photoconductive electrically insulating material comprises a mixture of an organic photoconductor and an electrically insulating, film-forming resin binder.

4. A photoconductive composition as in claim 3 wherein the organic photoconductor is selected from the group consisting of an arylamine, a polyaryllalkane and a diaryl-amino-substituted chalcone.

5. An electrophotographic element comprising a support having coated thereon a layer of a photoconductive composition as described in claim 2.

6. An electrophotographic element comprising a support having coated thereon a layer of a photoconductive composition as described in claim 1.

7. An electrophotographic element as in claim 6 wherein the support is electrically conducting.

8. An element as in claim 6 wherein the photoconductive electrically insulating material comprises a mixture of an organic photoconductor and an electrically insulating, film-forming resin binder.

9. An electrophotographic element as in claim 8 wherein the organic photoconductor is selected from the group consisting of an arylamine, a polyaryllalkane and a diaryl-amino-substituted chalcone.

10. A photoconductive composition comprising an organic photoconductive electrically insulating material

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sensitized with a cyclopropenyl cation salt having substituted thereon at least two radicals selected from the group consisting of an aryl radical and a heterocyclic radical containing from five to ten atoms and containing a hetero atom selected from oxygen, nitrogen and sulfur, and also having substituted thereon a third radical selected from the group consisting of an aralkenyl radical having from 2 to 4 carbon atoms in the alkenyl moiety and an aryl radical.

11. An electrophotographic element comprising a support having coated thereon a layer of a photoconductive composition as described in claim 10.

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CHARLES E. VAN HORN, Primary Examiner

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