

[54] **PHOTOCONDUCTIVE ELEMENTS
CONTAINING ORGANO-METALLIC
PHOTOCONDUCTORS**

260/446, 447

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[58] Field of Search ...**96/1.5, 1.6; 252/501; 260/440,**

[56] **References Cited**

UNITED STATES PATENTS

2,331,833	10/1943	Hamilton.....	260/440
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[57] **ABSTRACT**

Photoconductive compositions and elements containing a Group Va organo-metallic photoconductive compound.

15 Claims, No Drawings

PHOTOCONDUCTIVE ELEMENTS CONTAINING ORGANO-METALLIC PHOTOCONDUCTORS

This is a division of U. S. Pat application Ser. No. 650,664, PHOTOCONDUCTIVE ELEMENTS CONTAINING ORGANO-METALLIC PHOTOCONDUCTORS, filed July 3, 1967, now U. S. Pat. No. 3,647,429.

This invention relates to electrophotography, and in particular to photoconductive compositions and elements.

The process of xerography, as disclosed by Carlson in U.S. Pat. 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, generally in the dark after a suitable period of dark adaptation. It is then 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 of 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. 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 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 the present-day document copying applications.

Since the introduction of electrophotography, a great many organic compounds have also been screened for their photoconductive properties. As a result, a very large number of organic compounds have been known to possess some degree of photoconductivity. Many organic compounds have revealed a useful level of photoconduction and have been incorporated into photoconductive compositions.

Typical of these organic photoconductors are the triphenylamines and the triarylmethane leuco bases. Optically clear photoconductor-containing elements having desirable electrophotographic properties can be especially useful in electrophotography. Such electrophotographic elements can be exposed through a transparent base if desired, thereby providing usual 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. Thus far, the selection of various compounds for incorporation into photoconductive compositions to form electrophotographic layers has proceeded on a compound-by-compound basis. Nothing as yet has been discovered from the large number of different photoconductive substances tested which permits effective prediction, and therefore selection of the particular compounds exhibiting the desired electrophotographic properties.

It is, therefore, an object of this invention to provide a novel class of photoconductors having high photosensitivity when electrically charged.

It is another object to provide novel photoconductor-containing compositions which exhibit high electrical speeds.

It is also an object to provide novel photoconductor-containing compositions which can be positively and negatively charged.

It is another object to provide novel transparent electrophotographic elements having high speed characteristics.

It is a further object of this invention to provide novel electrophotographic elements useful for producing images electrophotographically by reflex or bireflex processes.

These and other objects of this invention are accomplished with electrophotographic elements having coated thereon photoconductive compositions containing as photoconductors organo-metallic compounds having at least one amino-aryl substituent attached to a Group IVa or Group Va metal atom.

The metallic substituents of these organo-metallic photoconductors are Group IVa or Group Va metals in accordance with the Periodic Table of the Elements (Handbook of Chemistry and Physics, 38th edition, pp. 394-95) and include silicon, germanium, tin and lead from Group IVa and phosphorus, arsenic, antimony and bismuth from Group Va. The organo-metallic photoconductors of this invention can be substituted in the metallo nucleus with a wide variety of substituents but at least one of the substituents must be an amino-aryl radical. The amino radical can be positioned anywhere on the aromatic nucleus, but best results are obtained if the aryl moiety is a phenyl radical having the amino group in the four or para position. Typical substituents attached to the metal nucleus include the following:

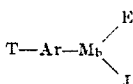
- a. a hydrogen, sulfur or oxygen atom,
- b. an alkyl radical,
- c. aryl radical including unsubstituted as well as substituted aryl radicals such as aminoaryl, alkylaryl and haloaryl,
- d. an oxygen-containing radical such as an alkoxy or aryloxy radical,
- e. an amino radical including unsubstituted and substituted amino radicals such as mono- and diarylamines and mono- and dialkylamines,
- f. a heterocyclic radical and
- g. a Group IVa or Va organo metallic radical.

Illustrative photoconductors of this invention are represented by the following structures:

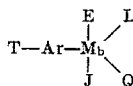


3

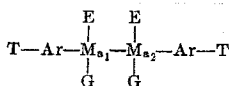
(2)



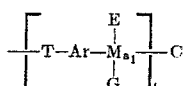
(3)



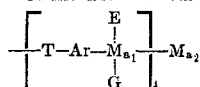
(4)



(5)



(6)



where E, G, L and Q can be

- a. a hydrogen atom
- b. an aryl radical including unsubstituted as well as substituted aryl radicals such as a phenyl radical, a naphthyl radical, a dialkylaminophenyl radical, or a dialkylaminonaphthyl radical,
- c. an alkyl radical having one to eight carbon atoms,
- d. an alkoxy radical having one to eight carbon atoms,
- e. an aryloxy radical such as a phenoxy radical,
- f. an amino radical having the formula



wherein R₁ and R₂ can be hydrogen atoms or alkyl radicals having one to eight carbon atoms, or

g. a heterocyclic radical having five to six atoms in the hetero nucleus including at least one nitrogen atom such as a triazolyl, a pyridyl radical, etc. ;

T is an amino radical such as an alkylamino radical having one to eight carbon atoms or an arylamino radical such as a phenylamino radical;

An is an aromatic radical such as phenyl or naphthyl;

M_a and M_a are the same or different Group IVa metals; M_b is a Group Va metal;

D can be any of the substituents set forth above for E, G, L and Q and in addition can be

a Group IVa organo-metallic radical or when taken with E, an oxygen atom or a sulfur atom;

J can be any of the substituents set forth above for E, G, L and Q and in addition can be

when taken with E, an oxygen atom or a sulfur atom.

Some typical organo-metallic photoconductors of this invention include

triphenyl-p-diethylaminophenylsilane
methyl-diphenyl-p-diethylaminophenylsilane
triphenyl-p-diethylaminophenylgermane
triphenyl-p-dimethylaminophenylstannane
triphenyl-p-diethylaminophenylstannane
diphenyl-di-(p-diethylaminophenyl)stannane
triphenyl-p-diethylaminophenylplumbane
tetra-p-diethylaminophenylplumbane

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phenyl-di-(p-diethylaminophenyl)phosphine
bis(p-diethylaminophenyl)phosphine oxide
tri-p-dimethylaminophenylarsine
tri-p-diethylaminophenylarsine

- 5 2-methyl-4-dimethylaminophenylarsine oxide
- tri-p-diethylaminophenylbismuthine
- methyl-di-(p-diethylaminophenyl)arsine
- methyl-di-(p-diethylaminophenyl)phosphine
- diphenyl-p-diethylaminophenylsilane
- 10 p-diethylaminophenylarsine
- tetrakis-[diphenyl-(p-diethylaminophenyl)plumbyl]
methane
- tetrakis-[diphenyl-(p-diethylaminophenyl)stannyl]
stannane
- 15 bis-[phenyl-(p-diethylaminophenyl)]dibismuthine
- tri-(p-diethylaminophenyl)phosphine sulfide
- di-(p-diethylaminophenyl)thioxotin

The organo-metallic photoconductors of this invention can generally be prepared by known methods. For example, the amino-aryl lead and tin compounds can be prepared in accordance with J.A.C.S. 54, 3726-9 (1932) or J. Org. Chem. 15, 994 (1950). The amino-aryl germanium compounds are made by the method set forth in C.A. 60, p. 395d. A method for making the amino-aryl bismuthines has been described by Gilman and Yablunsky (J.A.C.S. 63, 207-211, 1941). Amino-aryl derivatives of arsenic are prepared in accordance with the J. Indian Chemical Soc. 16, 515-518 (1939). Phosphorus and antimony compounds containing aminoaryl moieties may be prepared by methods described in C.A. 28, 3392³ and C.A. 40, 4689⁶ respectively.

Electrophotographic elements of the invention can be prepared with the photoconducting compounds of the invention in the usual manner, i.e., by blending a dispersion or solution of a photoconductive compound together with a binder, when necessary or desirable, and coating or forming a self-supporting layer with the photoconductor-containing material. Mixtures of the photoconductors described herein can be employed. Likewise, other photoconductors known in the art can be combined with the present photoconductors. In addition, supplemental materials useful for changing the spectral sensitivity or electrophotosensitivity of the element can be added to the composition of the element when it is desirable to produce the characteristic effect of such materials.

Sensitizing compounds useful with the photoconductive compounds of the present invention can include a wide variety of substances such as pyrylium, thiapyrylium, and selenapyrylium salts of U.S. Pat. No. 3,250,615, issued May 10, 1966; fluorenes, such as 7,12-dioxo-13-dibenzo(a,h)fluorene, 5,10-dioxo-4a,11-diazabenzobenzofluorene, 3,13-dioxo-7-oxadibenzobenzofluorene, trinitrofluorenone, tetranitrofluorenone and the like; aromatic nitro compounds of U.S. Pat. No. 2,610,120; anthrones of U.S. Pat. No. 2,670,285; quinones of U.S. Pat. No. 2,670,286; benzophenones of U.S. Pat. No. 2,670,287; thiazoles of U.S. Pat. No. 2,732,301; mineral acids; carboxylic acids, such as maleic acid, dichloroacetic acid, and salicylic acid; sulfonic and phosphoric acids; and various dyes such as triphenylmethane, diarylmethane, thiazine, azine, oxazine, xanthene, phthalein, acridine, azo, anthraquinone dyes and many other suitable sensitizing dyes. The preferred sensitizers for use with the

compounds of this invention are pyrylium and thiapyrylium salts, fluorenes, carboxylic acids, and triphenylmethane dyes.

Where a sensitizing compound is to be used within a photoconductive layer as disclosed herein it is conventional practice to mix a suitable amount of the sensitizing compounds with the coating composition so that, after thorough mixing, the sensitizing compound is uniformly distributed throughout the desired layer of the coated element. In preparing the photoconducting layers, no sensitizing compound is needed for the layer to exhibit photoconductivity. The lower limit of sensitizer required in a particular photoconductive layer is, therefore, zero. However, since relatively minor amounts of sensitizing compound give substantial improvement in the electrophotographic speed of such layers, the use of some sensitizer is preferred. The amount of sensitizer that can be added to a photoconductor-incorporating 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 by weight from about 0.005 to about 5.0 percent by weight of the total coating composition.

Preferred binders for use in preparing the present photoconductive layers are film-forming polymeric binders 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-alkyd 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(ethylenealkaryloxyalkylene terephthalate); phenolfomaldehyde resins; ketone resins; polyamides; polycarbonates; polythiocarbonates; poly(ethyleneglycol ∞ -bishydroxyethoxyphenyl propane terephthalate); copolymers of vinyl haloarylates and vinyl acetate such as poly(vinyl-m-bromobenzoate-covinylacetate); 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. Pat. Nos. 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 tradenames 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 1 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 1 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 10 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 was 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 relative humidity above 20 percent); aluminum-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 or aluminum and the like. An especially useful conducting support can be prepared by coating a support material such as polyethylene terephthalate with a layer containing a semi-conductor dispersed in a resin. Such conducting layers both with and without insulating barrier layers are described in U.S. Pat. No. 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. Pat. Nos. 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 previously explained, 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 by the layer owing to 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 a 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 attractable particles having optical density. The developing electrostatically attractable particles can be in the form of a dust, e.g., powder, pigment in a resinous carrier, i.e., toner, or a liquid developer may 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. Pat. No. 2,297,691 and in Australian Pat. No. 212,315. In processes of electrophotographic reproduction such as in xerography, by selecting a developing particle which has as one of its components, a low-melting resin, 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. Pat. Nos. 2,297,691 and 2,551,582, and in "RCA Review," vol. 15 (1954), pages 469-484.

The present invention is not limited to any particular mode of use of the new electrophotographic materials, and the exposure technique, the charging method, the transfer (if any), the developing method, and the fixing method as well as the materials used in these methods can be selected and adapted to the requirements of any particular technique.

Electrophotographic materials according to the present invention can be applied to reproduction techniques wherein different kinds of radiations, i.e., electromagnetic radiations as well as nuclear radiations, can be used. For this reason, it is pointed out herein that although materials according to the invention are mainly intended for use in connection with methods comprising an exposure, the term "electrophotography" wherever appearing in the description and the claims, is to be interpreted broadly and understood to comprise both xerography and xeroradiography.

The invention is further illustrated by the following examples which include preferred embodiments thereof.

EXAMPLE 1

Preparation of Triphenyl-p-Dimethylaminophenyl Stannane

A rapidly stirred mixture of 1.96 grams (0.28 g. atoms) of lithium wire and 400 ml. of Mallinckrodt dry diethyl ether are kept under nitrogen and are treated (during 10 minutes) with a solution of 26 g. (0.13 moles) of p-bromo-N,N-dimethylaniline in 100 ml. of dry ether. The resulting mixture is heated on a steam bath for 15 minutes. Approximately 1 gram of lithium dispersion is added and the mixture is heated to reflux temperature. The mixture is concentrated on a steam bath to one-third the original volume. At this point the reaction started and vigorous refluxing is continued for about 30 minutes without external heating. The result-

ing brown mixture is heated under reflux for 1½ hours and then is filtered through glass wool into a rapidly stirred mixture of 44.6 g. (0.116 moles) of triphenyl tin chloride and 200 ml. of ether. The result is stirred at room temperature for 3 hours, allowed to stand overnight and then is stirred in a cold ammonium chloride solution. The dark red ether layer is dried over anhydrous sodium sulfate and the blue residue which resulted on removal of solvent is dissolved in 20 ml. of chloroform and is treated with 400 ml. of boiling absolute alcohol. The volume is reduced to about 300 ml. in a Roto-Vac and the solid is filtered, washed and dried in air at room temperature. There are obtained 18.4 g. of white solid. This compound is recrystallized first from 450 ml. of Ligroin (Eastman Chemical No. P1628), and then from 425 ml. of Ligroin. There are obtained 10.8 g. of white solid having a melting point of 132°-134.5° C.

EXAMPLE 2

Preparation of Triphenyl-p-Diethylaminophenylstannane

A stirred mixture of 1.44 g. (0.06 moles) of magnesium turnings, 30 ml. of distilled tetrahydrofuran and 4.6 g. (0.02 moles) of distilled p-bromo-N,N-diethylaniline is kept under nitrogen and is heated at reflux temperature for 15 minutes. The volume is reduced by a water aspirator to about ½ the original volume and then the mixture is kept at reflux temperature for 1 hour. The temperature is lowered to just below reflux and the mixture is treated rapidly with a solution of 7.7 g. (0.02 moles) of triphenyl tin chloride in 50 ml. of distilled tetrahydrofuran. The resulting mixture is heated under reflux for 1 hour, allowed to stand overnight and then is filtered into 1 liter of a stirred mixture of ice and ammonium chloride solution. The solid which is precipitated is dissolved in 320 ml. of absolute alcohol, cooled to room temperature and filtered. The filtrate is cooled in a refrigerator, filtered and the solid is dried in air at room temperature. There are obtained 4.4 g. of white crystalline solid. It is recrystallized again from 125 ml. of absolute alcohol and 2.7 g. are obtained having a melting point of 100.5° to 102° C.

EXAMPLE 3

Preparation of Tetra-p-Diethylaminophenylplumbane

A stirred mixture of 6.5 g. (0.27 moles) of magnesium, 20.5 g. (0.09 moles) of distilled p-bromo-N,N-diethylaniline and 90 ml. of distilled tetrahydrofuran is heated under reflux for 45 minutes and then is treated with a mixture of 11.1 g. (0.04 moles) of lead dichloride and 60 ml. of distilled tetrahydrofuran. The resulting dark brown reaction mixture is heated under reflux for 8 hours. The result is filtered (after standing overnight) and the filtrate affords white crystals on standing 15-20 minutes. They are filtered off and the filtrate is stirred in a mixture of 3 liters of ice and ammonium chloride solution. At room temperature the mixture is extracted with 300 ml. of chloroform, dried over anhydrous sodium sulfate and the solvent is removed by a Roto-Vac. The resulting oil is stirred in 25 ml. of absolute alcohol, filtered, washed with acetone and then recrystallized from 45 ml. of acetone. There is obtained 0.35 g. of white crystalline solid having a melting point of 220.5° to 221.5° C.

EXAMPLE 4

Preparation of Tri-p-Dimethylaminophenylarsine

A mixture of 26.8 g. (0.222 moles) of N,N-dimethylaniline and 50 g. (0.276 moles) of arsenic trichloride is heated on a steam bath for 2 hours and then poured into 800 ml. of stirred water. The mixture is filtered and the filtrate is made alkaline with about 350 ml. of 10 percent sodium hydroxide. The gummy solid which precipitates is washed with P1628 Ligroin, dissolved in 200 ml. of methylene chloride, dried over anhydrous sodium sulfate and the solvent is removed by a Roto-Vac. The residue is recrystallized from a mixture of 50 ml. absolute alcohol and 20 ml. chloroform and is dried in air at room temperature. There is obtained 0.94 g. of a white crystalline solid having a melting point of 237° to 240° C.

EXAMPLE 5

Preparation of Tri-p-Diethylaminophenylarsine

A stirred mixture of 8.64 g. (0.36 moles) of magnesium, 27.6 g. (0.12 moles) of distilled p-bromo-N,N-diethylaniline and 120 ml. of distilled tetrahydrofuran is heated under reflux for 1 hour. The resulting brown mixture is treated dropwise (during 10 minutes) with a solution of 7.3 g. (0.04 moles) of arsenic trichloride in 70 ml. of distilled tetrahydrofuran at such a rate as to maintain reflux. Heating is continued for 2 hours and the mixture is filtered into a stirred mixture of ice and ammonium chloride solution. The yellow solid is dried in air at room temperature and then recrystallized from a mixture of 500 ml. absolute alcohol and 300 ml. chloroform. There are obtained 11.1 g. of a yellow solid. A second recrystallization from a mixture of 600 ml. alcohol and 300 ml. chloroform gives 7.6 g. of a white crystalline solid having a melting point of 211.5°-214° C.

EXAMPLE 6

Preparation of 2-Methyl-4-Dimethylaminophenylarsine Oxide

A mixture of 20.3 g. (0.15 moles) of N,N-dimethyl-m-toluidine and 27.0 g. (0.15 moles) of arsenic trichloride are heated on a steam bath for 20 minutes and then poured into 1 liter of stirred water. The resulting solution is made alkaline with 180 ml. of 10 percent sodium hydroxide. The solid which precipitates is washed with P1628 Ligroin, dissolved in a boiling mixture of 50 ml. Ligroin-17 ml. chloroform and the volume is concentrated to 45 ml. The yellow solid which precipitates on standing overnight is dried in air at room temperature. 0.47 g. of solid is obtained having a melting point of 214°-217° C.

EXAMPLE 7

Preparation of Bis(p-Diethylaminophenyl)Phosphine Oxide

A homogeneous mixture of 37.5 g. (0.276 moles) of phosphorus trichloride and 33.1 g. (0.222 moles) of N,N-diethyl-aniline is heated on a steam bath for 2.5 hours, cooled to room temperature and poured slowly into 1 liter of stirred water. The resulting solution is made alkaline with 300 ml. of 10 percent sodium hydroxide and is extracted with two 100 ml. portions of methylene chloride. The combined extracts are dried over anhydrous sodium sulfate and the solvent is

removed on a steam bath. The resulting oil is stirred in 200 ml. of boiling P1628 Ligroin, filtered while hot and the filtrate is cooled to room temperature. There is obtained 0.34 g. of white crystalline solid having a melting point of 126.5°-128° C.

EXAMPLE 8

Organo-metallic photoconductors of the type described herein are separately incorporated into a coating dope having the following composition:

Organic photoconductor	0.15 g.
Polymeric binder	0.50 g.
Sensitizer	0.002 g.
Methylene chloride	5 ml.

The resulting compositions are handcoated at a wet thickness of 0.004 inch on a conducting layer comprising the sodium salt of a carboxyester lactone, such as described in U.S. Pat. No. 3,120,028, which in turn is coated on a cellulose acetate film base. The coating blocks are maintained at a temperature of 90° F. These electrophotographic elements are charged under a positive or negative corona source until the surface potentials, as measured by an electrometer probe, reach about 600 volts. They are then subjected to exposure from behind a stepped density gray scale to a 3,000° K tungsten source. The exposure causes reduction of the surface potentials of the elements under each step of the gray scale from their 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 areas. The results of the measurements are plotted on a graph of surface potential V vs. log exposure for each step. The shoulder speed is the numerical expression of 10^4 multiplied by the reciprocal of the exposure in meter-candle-seconds required to reduce the 600 volt charged surface potentials by 100 volts. The toe speed is the numerical expression of 10^4 multiplied by the reciprocal of the exposure in meter-candle-seconds required to reduce the 600 volt charged surface potentials to 100 volts. The speeds of the various organo-metallic photoconductive compositions are shown in Table I below. The sensitizers referred to in the Table are as follows:

- A. no sensitizer added
 - B. 2,6-bis(4-ethylphenyl)-4-(4-amyloxyphenyl)thiapyrylium perchlorate
 - C. 2,4-bis(4-ethylphenyl)-6-(4-styrylstyryl)pyrylium perchlorate
- The binder is [4,4'-isopropylidene bis-(phenylox-yethyl)-co-ethylene terephthalate] sold commercially under the tradename Vitel 101.

Table I

Example	Organo-metallic Photoconductor	Sensitizer	Positive Shoulder Speed
60	a. Methyl-diphenyl-p-diethylaminophenyl silane	A B C	160 200 400
	b. Triphenyl-p-dimethylaminophenyl stannane	A B C	10 500 320
65	c. Triphenyl-p-diethylaminophenyl stannane	A B C	5 630 250
	d. Diphenyl-di-(p-diethylaminophenyl) stannane	A B C	400 120 400

e. Triphenyl-(p-diethylamino phenyl)plumbane	A	12
	B	100
f. Tetra-p-diethylaminophenyl plumbane	B	40
	C	50
g. Tri-p-dimethylaminophenyl arsine	A	32
	B	160
	C	250
h. Tri-p-diethylaminophenyl arsine	A	23
	B	250
	C	230
i. 2-Methyl-4-dimethylamino-phenyl arsine oxide	B	120
j. Tri-p-diethylaminophenyl bismuthine	B	50
	C	200

EXAMPLE 9

Example 8 is repeated except that the coating dope contains the following:

Photoconductor- 0.97×10^{-3} moles for each gram of solids in the final coating composition

Sensitizer-2 percent of the final weight of the coating composition

Binder- 6.0 g.

The sensitizer is 4-(4-bis(2-chloroethyl)aminophenyl)-2,6-di-phenylthiapyrylium perchlorate. The binder is Lexan-105, a polycarbonate resin by the General Electric Co. prepared by reacting phosgene and a dihydroxydiarylalkane or from the ester exchange between diphenyl carbonate and 2,2-bis-4-hydroxyphenylpropane. The speeds are set forth in Table II below.

Table II

Example Organo-metallic Photoconductor	100 volt Toe Speed positive	negative
a. Methyl-diphenyl-p-diethylamino-phenyl silane	120	
b. Triphenyl-p-dimethylaminophenyl silane	50	950
c. Triphenyl-p-diethylamino-phenyl silane	250	1100
d. Diphenyl-di-(p-diethylaminophenyl) stannane	400	3400
e. Triphenyl-p-diethylaminophenyl plumbane	380	2000
f. Tri-p-diethylaminophenylarsine	230	630

EXAMPLE 10

The coating dopes of Examples 8 and 9 are again coated in the manner described in Example 8. In a darkened room, the surface of each of the photoconductive layers so prepared is charged to a potential of about +600 volts under a corona charger. The layer is then covered with a transparent sheet bearing a pattern of opaque and light transmitting areas and exposed to the radiation from an incandescent lamp with an illumination intensity of about 75 meter-candles for 12 seconds. The resulting electrostatic latent image is developed in the usual manner by cascading over the surface of the layer a mixture of negatively charged black thermoplastic toner particles and glass beads. A good reproduction of the pattern results in each instance.

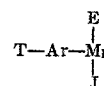
The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a Group Va organo-metallic photoconductive compound having attached to a Group Va metal atom at least one amino-aryl group.

2. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a Group Va organo-metallic photoconductive compound having attached to a Group Va metal atom (1) at least one amino-aryl group, and (2) at least one substituent selected from the group consisting of a hydrogen atom, an oxygen atom, an alkyl radical and an aryl radical.

3. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a photoconductor represented by the formula:



wherein:

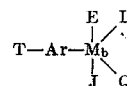
T is an amino radical;

Ar is an aryl radical;

M_b is a Group Va metal; and

E and J are selected from the group consisting of a hydrogen atom, an alkyl radical, an aryl radical and, when taken together, an oxygen atom.

4. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a photoconductor represented by the formula:



wherein:

T is an amino radical;

Ar is an aryl radical;

M is a Group Va metal; and

L and Q are each selected from the group consisting of a hydrogen atom, an alkyl radical and an aryl radical; and

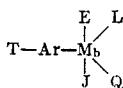
E and J are each selected from the group consisting of an alkyl radical, an aryl radical and, when taken together, an oxygen atom.

5. A photoconductive composition comprising an electrically insulating, film-forming polymeric binder containing at least 1 percent by weight of a Group Va organo-metallic photoconductive compound having attached to a Group Va metal atom (1) at least one amino-aryl group, and (2) at least one substituent selected from the group consisting of a hydrogen atom, an oxygen atom, an alkyl radical and an aryl radical.

6. A photoconductive composition comprising an electrically insulating, film-forming polymeric binder

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containing at least 1 percent by weight of a photoconductor represented by the formula:



wherein:

T is an amino radical;

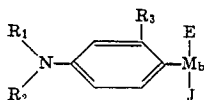
Ar is an aryl radical;

M_b is a Group Va metal;

L and Q are each selected from the group consisting of a hydrogen atom, an alkyl radical and an aryl radical; and

E and J are each selected from the group consisting of an alkyl radical, an aryl radical and, when taken together, an oxygen atom.

7. A photoconductive composition comprising an electrically insulating, film-forming polymeric binder containing at least 1 percent by weight of a photoconductor represented by the formula:



wherein:

R₁ and R₂ are alkyl radicals having one to eight carbon atoms;

R₃ is selected from the group consisting of a hydrogen atom and an alkyl radical having one to eight carbon atoms;

M_b is a Group Va metal; and

E and J are each selected from the group consisting of an alkyl radical having one to eight carbon atoms, a phenyl radical and, when taken together, an oxygen atom.

8. The photoconductive composition of claim 7 wherein the photoconductor is sensitized with a compound selected from the group consisting of pyrylium, thiapyrylium and selenapyrylium salts.

9. A photoconductive composition comprising an electrically insulating, film-forming polymeric binder containing at least 1 percent by weight of a photoconductor represented by the formula:



wherein:

R₁ and R₂ are alkyl radicals having one to eight carbon atoms;

M_b is a Group Va metal;

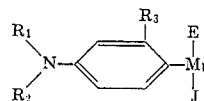
L and Q are each selected from the group consisting of a hydrogen atom, an alkyl radical having one to eight carbon atoms and a phenyl radical; and

E and J are each selected from the group consisting of an alkyl radical having one to eight carbon atoms, a phenyl radical and, when taken together, an oxygen atom.

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10. The photoconductive composition of claim 9 wherein the photoconductor is sensitized with a compound selected from the group consisting of pyrylium, thiapyrylium and selenapyrylium salts.

11. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a photoconductor represented by the formula:



wherein:

R₁ and R₂ are alkyl radicals having one to eight carbon atoms;

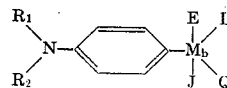
R₃ is selected from the group consisting of a hydrogen atom and an alkyl radical having one to eight carbon atoms;

M_b is a Group Va metal; and

E and J are each selected from the group consisting of an alkyl radical having one to eight carbon atoms, a phenyl radical and, when taken together, an oxygen atom.

12. The electrophotographic element of claim 11 wherein the photoconductor is sensitized with a compound selected from the group consisting of pyrylium, thiapyrylium and selenapyrylium salts.

13. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a photoconductor represented by the formula:



wherein:

R₁ and R₂ are alkyl radicals having one to eight carbon atoms;

M_b is a Group Va metal;

L and Q are each selected from the group consisting of a hydrogen atom, an alkyl radical having one to eight carbon atoms and a phenyl radical; and

E and J are each selected from the group consisting of an alkyl radical having one to eight carbon atoms, a phenyl radical and, when taken together, an oxygen atom.

14. The electrophotographic element of claim 13 wherein the photoconductor is sensitized with a compound selected from the group consisting of pyrylium, thiapyrylium and selenapyrylium salts.

15. An electrophotographic element comprising an electrically conducting support having thereon a photoconductive composition comprising an electrically insulating, film-forming polymeric binder and a photoconductor, said photoconductor being an organo-metallic compound selected from the group consisting of:

tri-p-diethylaminophenyl bismuthane,
phenyldi-(p-diethylaminophenyl)phosphine,

bis(p-diethylaminophenyl)phosphine oxide,
tri-p-dimethylaminophenylamine,
tri-p-diethylaminophenylamine, and
2-methyl-4-dimethylaminophenylamine oxide.

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