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ORGANIC PHOTOCONDUCTIVE COMPOSITIONS AND THEIR USE
IN ELECTROPHOTOGRAPHIC PROCESSES
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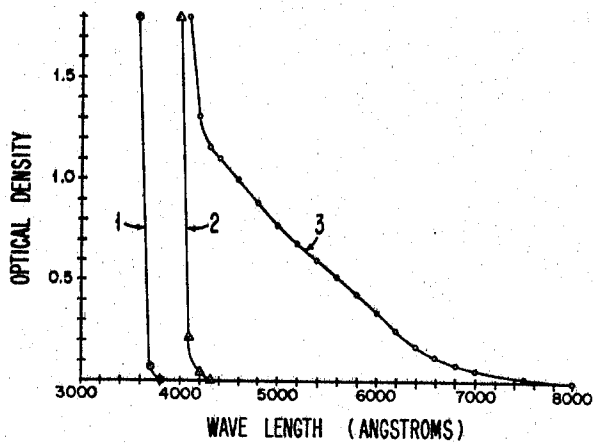


FIG. 1

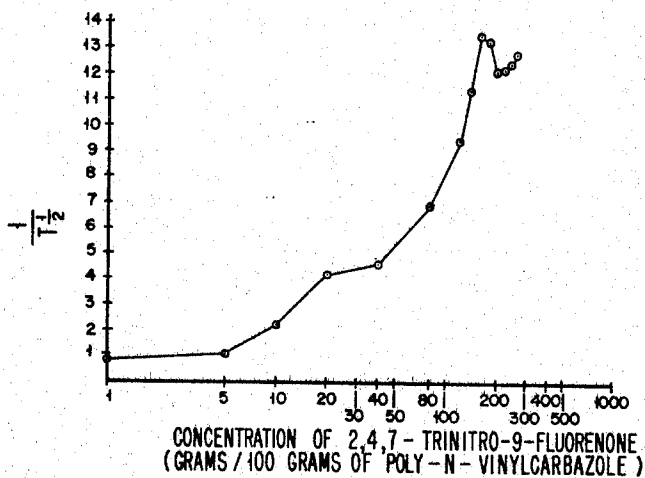


FIG. 2

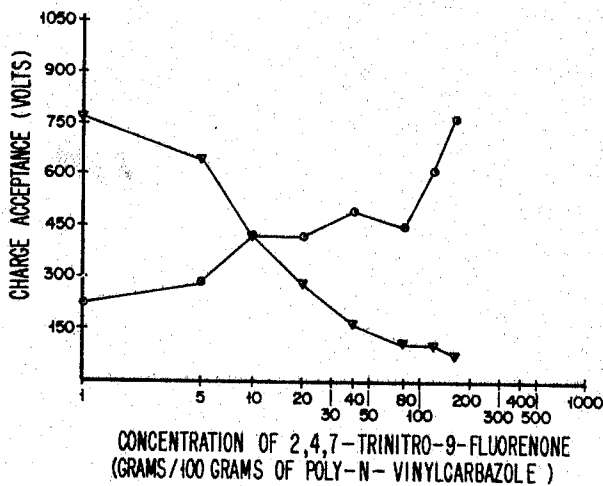


FIG. 3

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ORGANIC PHOTOCONDUCTIVE COMPOSITIONS AND THEIR USE IN ELECTROPHOTOGRAPHIC PROCESSES

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U.S. Cl. 96—1.5

8 Claims

ABSTRACT OF THE DISCLOSURE

An organic photoconductive composition comprising from about 0.49 to about 1.23 moles of 2,4,7-trinitro-9-fluorenone per monomeric unit of a polymerized vinylcarbazole compound.

This invention relates to photoconductors and, more particularly, to organic photoconductive compositions and their use in electrophotographic processes.

In the xerographic mode of electrophotography, a uniform electrostatic charge is applied to a photoconductive surface and the surface subsequently is exposed to a light pattern. The exposed areas now are conductive and provide a conductive discharge path for the electrostatic charge, thereby leaving an electrostatic charge pattern on the photoconductive surface. This charge pattern then is developed or made visible by one of the conventional methods, such as cascading electroscopic particles or toner across the photoconductive surface.

In recent years, there has been an increasing interest in the use of organic photoconductors for electrophotographic purposes. This is because organic photoconductors are easy to prepare into photoconductive plates at low cost and have the advantage of mechanical flexibility so that they can be used in a belt configuration. However, even though organic photoconductors have these desirable characteristics, they also have undesirable characteristics. For example, essentially all of the organic photoconductors absorb light primarily in the ultraviolet region of the spectrum. Because of this, the photoconductors are not sensitive to the longer wavelength colors and inexpensive visible light sources cannot be used. To overcome these disadvantages, dyestuff sensitizers are added to the organic photoconductors to shift their absorption into the visible region of the spectrum. The addition of dyestuff sensitizers, however, has a further disadvantage in that the sensitizers are not stable and bleach out relatively quickly in use so that the photoconductors lose their sensitivity in the visible region.

A further undesirable characteristic is the low sensitivity or exposure speed of organic photoconductors. Attempts have been made to increase the sensitivity of organic photoconductors, such as polyvinylcarbazole, by the incorporation of activators or electron acceptors as disclosed in U.S. Patent 3,037,861 which states that from 1-2% weight for weight of the activator to the polyvinylcarbazole is preferred. However, even with the addition of an activator, the sensitivity or exposure speed of the polyvinylcarbazole photoconductive composition still is at least 14 times slower, depending upon the particular activator selected, than the exposure speed of selenium in the xerographic mode. Moreover, a subsequent British Patent 990,368 states that the amount of the activator must be limited to less than 100 moles of activator to 1000 moles of photoconductor (16.3% by weight) because it states that a greater amount of activator causes

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the dark conductivity to become too high and the photoconductive composition will no longer accept sufficient electrostatic charge to be useful in electrophotography.

Because of the combination of lack of stability and low sensitivity, organic photoconductive compositions have been competitively unfit for use in a high speed optical xerographic copier in which the photoconductor is reused thousands of times. That is, the known organic photoconductive compositions have not compared favorably with the sensitivity or exposure speed and stability of commercial selenium presently being used in xerographic copiers. To be competitive with selenium, an organic photoconductive composition has to have a sensitivity or exposure speed not less than two times slower than the exposure speed of selenium.

It has now been discovered that organic photoconductive compositions, comprising from about 0.49 to about 1.23 moles of 2,4,7-trinitro-9-fluorenone per mole of monomeric unit of a polymerized vinylcarbazole compound, not only have a dark conductivity low enough to be more than adequately suited for electrophotography, but have significantly enhanced sensitivity, absorb in the visible region of the spectrum so that the addition of dyestuff sensitizers is not necessary, and have good chemical stability. Specifically, these compositions are at least 14 times faster than the polyvinylcarbazole compositions containing 1-2% of an activator and are equal to or greater than selenium in sensitivity or exposure speed, depending upon the exposure source.

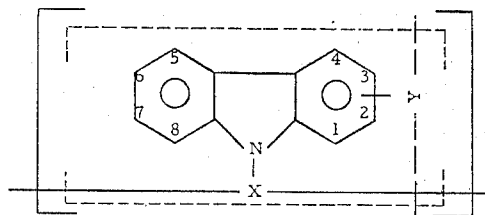
The foregoing summary of the invention and other features and advantages of the invention will be apparent from the following more particular description of the preferred embodiments of the invention, taken together with the following figures in which:

FIGURE 1 is a graph showing the absorption spectrum of poly-N-vinylcarbazole, the absorption spectrum of 2,4,7-trinitro-9-fluorenone, and the absorption spectrum of a photoconductive composition of poly-N-vinylcarbazole and 2,4,7-trinitro-9-fluorenone in a ratio of one mole of 2,4,7-trinitro-9-fluorenone per mole of N-vinylcarbazole monomeric unit.

FIGURE 2 is a semi-logarithmic graph plotting sensitivity versus concentration, in grams of 2,4,7-trinitro-9-fluorenone per 100 grams of poly-N-vinylcarbazole.

FIGURE 3 is a semi-logarithmic graph plotting charge acceptance versus concentration, in grams of 2,4,7-trinitro-9-fluorenone per 100 grams of poly-N-vinylcarbazole.

Polymerized vinylcarbazole compounds suitable for use in the present invention are poly-N-vinylcarbazole and polyvinyl-N-lower alkylcarbazoles. Such compounds have the following structural formula:



wherein X is selected from the group consisting of vinyl and lower alkyl; and wherein Y is vinyl only when X is lower alkyl. (The above numbering is based on the International Union of Pure and Applied Chemistry—Definitive Rules for Nomenclature of Organic Compounds, IACS 82, 5545-5574, 5568 (1960).) Examples of polyvinyl-N-lower alkylcarbazoles are poly-2-vinyl-N-methylcarbazole, poly-3-vinyl-N-ethylcarbazole, poly-2-vinyl-N-

ethylcarbazole, poly-3-vinyl-N-methylcarbazole, poly-3-vinyl - N-isopropylcarbazole, poly-2-vinyl-N-butylcarbazole, poly-3-vinyl-N-butylcarbazole, poly-2-vinyl-N-pentylcarbazole, poly-3-vinyl-N-pentylcarbazole, poly-2-vinyl-N-hexylcarbazole, poly-3-vinyl-N-hexylcarbazole, poly-2-vinyl-N-heptylcarbazole, and poly-3-vinyl-N-heptylcarbazole. Mixtures and copolymers of the polymerized vinylcarbazole compounds also may be used.

Poly-N-vinylcarbazole, which is the preferred polymer, is an addition polymerization product of N-vinylcarbazole and is commercially available from Badische Anilin-und Sodafabrik A.G., Ludwigshafen/Rhein, under the registered trademark Luvican. A method of producing poly-N-vinylcarbazole is described in U.S. Patent 2,072,465. This polymer is a colorless material and a 6 micron coating has an absorption spectrum line 1, as shown in FIGURE 1. Its use as a photoconductor is described in U.S. Patent 3,037,861 which states that, when an electrostatically charged layer of poly-N-vinylcarbazole is exposed to ultraviolet light, it becomes conductive and the charge in the light struck area is dissipated.

The preparation of and use as photoconductors in electrophotography of most of the vinyl-N-lower alkylcarbazole polymers are described in U.S. Patent 3,232,755. As therein described, poly-2-vinyl-N-methylcarbazole is prepared by heating together 5 parts by weight of N-methylcarbazolyl-(2)-methylcarbinol and 0.3 part by weight of potassium hydrogen sulfate for 2 hours to 170° C. under a reduced pressure of 10^{-2} torr. The polyvinyl compound thus obtained is dissolved in methylene chloride and reprecipitated by adding petroleum ether to the solution. A colorless pure product is obtained. N-methylcarbazolyl-(2)-methylcarbinol (melting point 78° C.) is obtained by catalytically reducing 2-acetyl-N-methylcarbazole under an excess hydrogen pressure of 100 atmospheres, gauge, using Raney nickel as a catalyst. Poly-2-vinyl-N-ethylcarbazole is prepared by analogy to the methyl compound just described. The polymeric compound is purified by dissolving it in benzene and passing the solution dropwise into methanol. This polymerizate is also colorless. Poly-3-vinyl-N-methylcarbazole and poly-3-vinyl-N-ethylcarbazole are prepared analogously. The N-ethyl - carbazolyl-(3)-methylcarbinol (melting point 75° C.) required for the preparation of poly-3-vinyl-N-ethylcarbazole is prepared in a simple manner by reducing 3-acetyl-N-ethylcarbazole (melting point 114-115° C.) by means of sodium borohydride. 3-acetyl-N-ethylcarbazole is prepared in known manner by ethylating 3-acetylcarbazole with diethylsulfate. Alternatively, the N-ethylcarbazolyl-(3)-methylcarbinol may be prepared by means of a Grignard reaction. For this purpose, the known N-ethylcarbazole-3-aldehyde is reacted in known manner with methyl magnesium iodide. Poly-3-vinyl-N-isopropylcarbazole is prepared by reacting 23.7 parts by weight of N-isopropylcarbazole-3-aldehyde with the Grignard compound obtained from 2.7 parts by weight of magnesium and 17.1 parts by weight of methyl iodide, dissolved in the benzene-ether mixture. The intermediary carbinol which forms splits off water during this reaction and polymerizes. The crude product is dissolved in benzene and reprecipitated, in the form of a colorless product, by adding methanol to the benzene solution. The N-isopropylcarbazole-3-aldehyde (melting point 114° C.) used as a starting material is obtained by formylation of N-isopropylcarbazole by means of N-methylformanilide and phosphorous oxychloride. The N-isopropylcarbazole (melting point 122° C.) is obtained by reacting potassium carbazole with isopropyl bromide. (It is believed that the above 2-vinyl compounds are more properly named 3-vinyl and the above 3-vinyl compounds are more properly named 2-vinyl.) The N-butyl, N-pentyl, N-hexyl and N-heptyl, 2-vinyl and 3-vinylcarbazole polymers are prepared by methods analogous to the ones recited above.

Serving as the activator or electron acceptor for the polymerized vinylcarbazole compounds is 2,4,7-trinitro-9-

fluorenone, which is a yellow crystalline compound commercially available by name from a number of chemical companies—for example, Eastman Kodak, and can be prepared by the method described in Organic Synthesis, Coll. vol. III, page 837. A solution of this compound, comparable in concentration to a 6 micron coating, has an absorption spectrum line 2, as shown in FIGURE 1. The use of 2,4,7-trinitro-9-fluorenone as an activator or electron acceptor with poly-N-vinylcarbazole is disclosed in U.S. Patent 3,159,483 and with poly-N-lower alkylcarbazoles is disclosed in U.S. Patent 3,232,755. In both of these patents, the upper amount of the activator is limited to 100 moles per 1000 moles of photoconductor.

For purposes of illustrating the present invention, the following description in reference to FIGURES 1 through 3 is based on compositions of the present invention in which the polymerized vinylcarbazole compound is the preferred poly-N-vinylcarbazole. It will be understood that the results obtained based on these compositions containing poly-N-vinylcarbazole will be essentially the same as the results obtained based on compositions containing the vinyl-N-lower alkyl carbazole polymers.

As shown in FIGURE 1, the absorption spectrum line 3 is of a 6 micron coating of a 1:1 molar composition (163% by weight) of 2,4,7-trinitro-9-fluorenone and N-vinylcarbazole monomeric units of poly-N-vinylcarbazole. It will be noted that absorption spectrum lines 1 and 2 of 2,4,7-trinitro-9-fluorenone alone and poly-N-vinylcarbazole alone, respectively, are primarily in the ultraviolet region whereas, the absorption spectrum of a 1:1 molar ratio of these compounds, as shown by line 3, has shifted into the visible portion of the electromagnetic spectrum. Moreover, once the molar ratio of such a composition has reached 0.49:1 (80% by weight) the two essentially colorless compounds now form a dark brown composition. Thus, the photoconductor compositions of the present invention are highly sensitive to colors and can be used with relatively cheap incandescent light sources without the necessity of incorporating dyestuffs into the composition.

Turning to FIGURE 2, there is shown a semi-logarithmic plot in relative terms of the reciprocal of the exposure time required, with an incandescent light source, to decay the negative charge on the photoconductor to one-half its original charge versus concentration of 14 micron thick coatings of 2,4,7-trinitro-9-fluorenone in poly-N-vinylcarbazole. It is seen that a 1%, by weight of 2,4,7-trinitro-9-fluorenone to poly-N-vinylcarbazole composition has a relative sensitivity of 0.8 and this sensitivity remains substantially constant up to the addition of 5 grams or 5% by weight of 2,4,7-trinitro-9-fluorenone. From 5% to 20%, there is a gradual increase in sensitivity by the further addition of 2,4,7-trinitro-9-fluorenone and, at a concentration of 20% by weight, the relative sensitivity is 4.2. Further addition of this activator up to 40% by weight only has a slight effect on the sensitivity of the photoconductive composition, i.e.—an increase in relative sensitivity of only 0.4 units to 4.6.

In accordance with the present invention, if the concentration of the 2,4,7-trinitro-9-fluorenone is greater than 20% by weight of the polymerized vinylcarbazole compound and especially if it has a molar ratio from about 0.49 to about 1.23 of the former compound to the monomeric units of the latter compound, the sensitivity is increased significantly so that these compositions are capable of use in a high speed optical xerographic copier. For example, as shown in FIGURE 2, a 1:1 molar ratio (163% by weight) of 2,4,7-trinitro-9-fluorenone and N-vinylcarbazole monomeric units of poly-N-vinylcarbazole, the preferred composition, has reached 13.5, almost 17 times greater than a composition with 1-5% 2,4,7-trinitro-9-fluorenone. Moreover, the sensitivity of the 0.49:1 molar ratio (80% by weight) is only two times less sensitive than selenium and the 1:1 molar ratio (163% by weight) essentially is equal to selenium in sensitivity so as to be competitive with it. Above a concentration of

200% by weight of 2,4,7-trinitro-9-fluorenone to the monomeric unit of the polymerized vinylcarbazole compound, some of the compositions start to become crystalline.

In conjunction with the increased sensitivity by the addition of 2,4,7-trinitro-9-fluorenone, the charge acceptance also radically changes with increased concentration. For example, FIGURE 3 shows a semi-logarithmic plot of charge acceptance of both positive and negative charges versus concentration of 2,4,7-trinitro-9-fluorenone in poly-N-vinylcarbazole. It is seen by this plot that 1% by weight, of 2,4,7-trinitro-9-fluorenone to poly-N-vinylcarbazole readily accepts positive charge but only accepts negative charge to a minor degree. That is, with a 14 micron thick 1% composition layer and using a 7000 volt corona unit, the charge acceptance with positive corona is 750 volts whereas it is only 225 volts with negative corona. However, as the concentration of 2,4,7-trinitro-9-fluorenone is increased, the charge acceptance from positive corona drops off sharply and the charge acceptance from negative corona gradually begins to increase with a crossover point at about 10% by weight. With the concentration of 2,4,7-trinitro-9-fluorenone at 40% by weight, the charge acceptance of positive corona is down to 165 volts whereas the charge acceptance of negative corona has risen to 495 volts. A further increase in the concentration of 2,4,7-trinitro-9-fluorenone to 80% by weight causes a slight decrease in the charge acceptance of negative corona and a further decrease of positive corona. From this point on, however, the charge acceptance of negative corona sharply increases up to a maximum of 765 volts at 163% by weight whereas the positive corona drops off slightly with a low of 75 volts.

Coatings of the photoconductive compositions of the present invention are prepared by dissolving the polymerized vinylcarbazole compound in a solvent, followed by the addition of 2,4,7-trinitro-9-fluorenone to the polymer solution and a mixing of the solution for about 30 minutes. By way of example, a specific formulation of the preferred composition is as follows: 100 gms. of a 10% (wt./wt.) polyvinylcarbazole solution in tetrahydrofuran; and 16.3 gms. of 2,4,7-trinitro-9-fluorenone added to the polymer solution. The solution then is coated on a substrate, preferably a mat finish (sandblasted) aluminum plate, using either a doctor blade set, for example, at a 0.007 inch gap or a kiss coating technique, which can be used advantageously when large coatings are desired. This latter coating technique is accomplished with a continuous belt which passes into the coating solution such that a meniscus is formed between the surface of the belt and the surface of the coating solution. The thickness of the coating is determined by the concentration of the coating solution, the speed the belt is driven, and the number of passes through the solution. Preferably, the coating speed is approximately 2 feet/minute and two passes are sufficient to yield the preferred coating thickness of about 18 microns.

While tetrahydrofuran is the preferred solvent, other solvents such as 1,2-dichloroethene and chlorobenzene may be used. Also, aluminum has been described as the preferred substrate for the coating, but any material which satisfies the requirements of electrophotography, e.g. metal, glass, paper, or foils made of electroconductive resins or plastics may be used. Examples of other useful substrates are: chrome, stainless steel, brass, copper, beryllium copper, polyethylene terephthalate coated with a thin layer of aluminum or copper, and NESA glass.

The photoconductive compositions of the present invention are useful in the conventional xerographic process in which an electrostatic image is formed on a photoconductive element and the electrostatic image is developed. That is, the photoconductive element is electrostatically charged and exposed to a pattern of light and

dark to form an electrostatic image. Thereafter, the electrostatic image either can be developed with a conventional electroscopic developer on the photoconductive element and the developed image transferred to plain paper or, conversely, the electrostatic image can be transferred to a dielectric paper and developed with electroscopic developer, powder or liquid. If desired, heat can be utilized to develop the electrostatic image so as to form a thermoplastic image. In addition, the photoconductive layer containing the composition of the present invention can be overcoated with a dielectric layer to form the photoconductive element. Also, the electrostatic charging and exposing steps can be carried out simultaneously, such as is done in the process described in U.S. Patent 3,124,456. Moreover, while the photoconductor composition of the present invention is highly useful with an optical exposure, these compositions may also be exposed by conventional contact printing.

The invention will be further illustrated by reference to the following specific examples in which sensitivity or exposure speed of a 163% by weight of 2,4,7-trinitro-9-fluorenone to poly-N-vinylcarbazole composition of the present invention is compared with sensitivity or exposure speed of commercial selenium and a poly-N-vinylcarbazole composition containing 20% by weight 2,4,7-trinitro-9-fluorenone. In addition, a comparison is made between the color sensitivity of a 163% composition of the present invention and commercial selenium. A stability test of the 163% composition also is given. These examples are not intended to limit the present invention in any way.

Example I

For purposes of comparison, two separate photoconductive plates were prepared by coating two separate .006 inch thick aluminum substrates with two separate photoconductive composition coatings, one containing 20% and the other 163% of 2,4,7-trinitro-9-fluorenone, by weight, of poly-N-vinylcarbazole. Both coatings were about 25 microns thick.

With the two plates prepared, a Xerox #4 camera with a Wallensak lens 10¼", f/10, apochromatic raptar with four EBR 375 watt tungsten lamps was used for exposure. The timer on the camera was set so that all the exposures of both plates would be for ten seconds. Both plates were processed on a Xerox Model D processor in which they were charged to a surface potential of -600 volts, cascade toned with commercially available positive (negative going) toner and developer, and the toned images transferred to paper. For fusing the toner to the paper, a Xerox heat fuser was used and each copy paper was heated for about 20 seconds in the fuser.

First, the plate containing 163% was charged by the processor and exposed with an f/32 stop setting on the camera for 10 seconds. The electrostatic image was developed in the processor and the developed image transferred to a sheet of copy paper and fused in the fuser. The plate then was wiped clean with a pad of cotton. Repeating this procedure, except for the f-stop setting, the plate was exposed three more times. The f-stop settings for these three exposures were f/22, f/16, and f/10. Each lower f-stop increases the amount of light by about a factor of two.

Using the same procedure and equipment, the photoconductive plate containing 20% by weight of 2,4,7-trinitro-9-fluorenone was used to prepare four copies for comparison. Each time this plate was charged, exposed, developed, the toned image transferred, and the plate cleaned in the same manner as the 163% plate. The exposures in preparing these four copies were at f-stop settings of f/32, f/22, f/16, and f/10.

The following table describes the quality of copy obtained from these two photoconductive plates:

f-stop	Quality of Copy			
	163% plate		20% plate	
	Image	Background	Image	Background
f/32.....	Dark.....	Light.....	Dark.....	Heavy.
f/22.....	do.....	Essentially no.....	do.....	Medium.
f/16.....	do.....	No.....	do.....	Light.
f/10.....	do.....	No.....	do.....	No.

The above table shows by a comparison of the copy quality that the photoconductive plate containing 20% of 2,4,7-trinitro-9-fluorenone needs a 10 second exposure at an f-stop setting of f/10 whereas the photoconductive plate containing 163% of 2,4,7-trinitro-9-fluorenone needs a 10 second exposure at only an f-stop setting of approximately f/22. Since the amount of light increases by a factor 2, this proves that the 163% plate is approximately four times more sensitive than the 20% plate, which is in good agreement with the sensitometric curve of FIGURE 2.

Example II

For a comparison of the sensitometric properties of a photoconductive plate containing 163% of 2,4,7-trinitro-9-fluorenone by weight of poly-N-vinylcarbazole with commercially available selenium under machine conditions, a robot was used comprising: a charging station having a variable controlled corona unit; an exposing station with a light source capable of accepting both a photocopy green aperture-type 60 watt flood lamp and a cool white 15 watt lamp, and a 15 mm. Ilex, 3 inch, f/1.9 ascilloparagon lens; a developing station for cascade toning; a toner transfer station having a corona unit; and a cleaning station comprising a fur brush rotating at 1000 r.p.m. Except for fusing the toner to the paper by using a Xerox heat fuser, all of the steps of the xerographic process were automatically carried on the robot. First, a commercially available selenium drum was mounted on a rotatable shaft of the robot and positioned so that all of the stations were sequentially arranged around the periphery of the drum. The drum was rotated at the charging station and electrostatically charged by varying the potential on the corona unit such that the surface potential of the selenium drum is at +800 volts. Using the photocopy green lamp, as described above, the charged selenium drum was exposed with the lens set at f/2.8 while traveling past the exposure station at 20 linear feet per minute. At the developing station, a commercially available negative (positive going) toner and developer were cascaded across the electrostatic image to develop it. After transferring the toned image to paper at the transfer station using the corona unit in back of the paper at about +7000 volts potential, the drum was cleaned by the fur brush at the cleaning station and was ready for the next copy. Five more copies were made with the lens set at f/4, f/5.6, f/8, f/11, and f/16, all other conditions remaining the same.

Next, the photocopy green lamp was removed and replaced with the cool white lamp, as described above. Six copies were prepared on the selenium drum using the same procedure as described above except the lens settings started at f/1.9 and ended at f/11. That is, lens settings of f/1.9, f/2.8, f/4, f/5.6, f/8, and f/11 were used.

Now, for purposes of comparison, the commercially available selenium drum was removed from the robot and replaced with a drum carrying a 17 micron coating of photoconductive composition of 163%, by weight, of 2,4,7-trinitro-9-fluorenone to poly-N-vinylcarbazole on a mat finish (sandblasted) .006 inch aluminum plate. The toner and developer were changed to the commercially available positive (negative going) toner and developer of Example I and the polarity of the corona units in the charging station and the toner transfer station were

switched to the opposite polarity. That is, the corona unit at the charging station was set so as to apply a surface potential of -800 volts on the photoconductive coating and the corona unit at the transfer station was at a potential of about -7000 volts. Otherwise, the robot operated in the same manner as when the commercially, available selenium drum was used. Using the above described photocopy green lamp, six copies were prepared on the robot by exposing at 20 linear feet per minute with the lens set at the same f-stops that were used in preparing the six copies with the selenium drum. That is, the lens was set at f/2.8, f/4, f/5.6, f/8, f/11 and f/16.

As a final comparison, the photocopy green lamp was removed and the above described cool white lamp was inserted in its place. Again, the polarity of the corona units at the charging and toner transfer stations were negative rather than positive as in the case with the commercially available selenium drum and the commercially available positive (negative going) toner and developer were used. Otherwise, the conditions were exactly the same, such as the exposure being at 20 linear feet per minute. Six copies were prepared with the lens set at f/2.8, f/4, f/5.6, f/8, f/11 and f/16.

All of the above 24 copies were fused individually on the Xerox fuser in which each copy was heated for about 20 seconds.

The following table describes the quality of copy obtained from the above comparison of a commercially available selenium drum and the photoconductive composition of the present invention:

f-stop	Quality of Copy			
	1:1 molar		Selenium	
	Image	Background	Image	Background
White light				
f/1.9.....	Medium.....	No.....	Faint.....	No.
f/2.8.....	Dark.....	No.....	Medium.....	No.
f/4.....	do.....	No.....	Dark.....	No.
f/5.6.....	do.....	No.....	do.....	No.
f/8.....	Medium to dark.	No.....	do.....	No.
f/11.....	Light to medium.	No.....	Light to medium.	Light.
Green light				
f/2.8.....	Medium.....	No.....	Faint.....	No.
f/4.....	Dark.....	No.....	Medium to dark.	No.
f/5.6.....	do.....	No.....	Dark.....	No.
f/8.....	do.....	No.....	do.....	No.
f/11.....	do.....	No.....	do.....	No.
f/16.....	Light to medium.	Light.....	Light.....	Light.

Defining sensitivity as the least amount of exposure required to achieve an acceptable copy (highest f-stop number), the above table shows by comparison of copy quality that the 163% by weight (1:1 molar) composition is faster than selenium when exposed by a photocopy green lamp because f/11 was required for selenium whereas f/16 almost was sufficient for the 163% composition. In addition, the 163% (1:1 molar) composition has 1-2 f-stops more latitude than selenium and a greater image density at the highest f-setting (f/16). Using the white fluorescent lamp, the 163% (1:1 molar) composition is approximately equal to selenium in sensitivity in that f/8 was needed for selenium whereas f/8 was not quite sufficient for 163% composition.

Example III

Using the same robot as described in Example II, both the 163% (1:1 molar) composition and selenium were compared for color sensitivity. That is, copies were prepared using both photocopy green and white fluorescent lamps from the following originals in all combinations of the following print colors: (black, helio (purple), blue, green, brown, orange, and yellow) on the following background colors: (blue, yellow, green, brown, orange, and red). From this comparison, the color sensitivity of the

163% (1:1 molar) composition was superior to selenium using both the green and white lamps. Also, it was found that selenium has better color sensitivity with green illumination than with white illumination while the reverse is true for the 163% (1:1 molar) composition.

Example IV

Using the same robot as described above in Example II and the same 163%, by weight, 2,4,7-trinitro-9-fluorenone to poly-N-vinylcarbazole photoconductive composition, 5000 copies were prepared to test the stability of the photoconductive composition. All of the copies had excellent dark images and, due to a slight filming on the photoconductor, a faint background became visible after the 4000th copy. Thus, this extended cycling test shows the good chemical stability of the photoconductive composition of the present invention.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that variations in form may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An organic photoconductive composition comprising from about 0.49 to about 1.23 moles of 2,4,7-trinitro-9-fluorenone per monomeric unit of a polymerized vinylcarbazole compound.
2. The composition of claim 1 wherein the polymerized vinylcarbazole compound is selected from the group consisting of poly-N-vinylcarbazole and polyvinyl-N-lower alkylcarbazole.
3. The composition of claim 1 wherein said polym-

erized vinylcarbazole compound is poly-N-vinylcarbazole.

4. The composition of claim 3 wherein the molar ratio is 1:1.

5. An electrophotographic process comprising the steps of:

forming an electrostatic image on a photoconductive element comprising from about 0.49 to about 1.23 moles of 2,4,7-trinitro-9-fluorenone per monomeric unit of a polymerized vinylcarbazole compound, and developing the electrostatic image.

6. The process of claim 5 wherein the polymerized vinylcarbazole compound is selected from the group consisting of poly-N-vinylcarbazole and polyvinyl-N-lower alkylcarbazole.

7. The process of claim 5 wherein the polymerized vinylcarbazole compound is poly-N-vinylcarbazole.

8. The process of claim 7 wherein the molar ratio is 1:1.

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NORMAN G. TORCHIN, Primary Examiner

J. R. HIGHTOWER, Assistant Examiner

U.S. Cl. X.R.

252—501

Notice of Adverse Decision in Interference

In Interference No. 98,047, involving Patent No. 3,484,237, M. D. Shattuck and U. Vahtra, ORGANIC PHOTOCONDUCTIVE COMPOSITIONS AND THEIR USE IN ELECTROPHOTOGRAPHIC PROCESSES, final judgment adverse to the patentees was rendered Jan. 16, 1981, as to claim 1.
[Official Gazette June 2, 1981.]