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[54] **PACKAGE OF CHARGED PHOTOCONDUCTIVE RECORDING ELEMENTS FOR ELECTROPHOTOGRAPHY**
1 Claim, No Drawings

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[50] **Field of Search** 96/1, 1.5, 1.8; 117/17.5; 206/62; 95/66

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ABSTRACT: An electrophotographic recording element which is precharged and held in charged condition for subsequent reuse, utilizing a backing member of a resistivity sufficient to prevent leakage away of the applied charge which can be rendered at least temporarily conductive prior to exposure to permit the charge to leak away at image areas.

PACKAGE OF CHARGED PHOTOCONDUCTIVE RECORDING ELEMENTS FOR ELECTROPHOTOGRAPHY

This invention relates to electrophotography, and in particular relates to an improved photoconductive recording member for use in electrophotography and electrostatic printing.

The known processes of electrophotography involve the use of a photoconductive insulative material, such as vitreous selenium, photoconductive zinc oxide in an insulating binder, or organic photoconductors such as polyvinylcarbazoles or the like, contained as a layer on a relatively conductive support such as a metal sheet or paper web or the like. Such sheet forms a photoconductive recording member which is sensitized by being subjected to a corona discharge or similar means whereby the photoconductor receives a uniform electrostatic charge on its working surface. The sensitized sheet is then exposed to the desired radiation pattern and developed by known developing processes which involve either the use of dry electroscopic powders or the so-called liquid developers, which consist essentially of coloring matter suspended in insulating liquids. Insulating liquids in this sense are defined as liquids having a volume resistivity in excess of 10^9 ohm. cm. and dielectric constant less than three.

A disadvantage of the prior art electrophotographic processes is the necessity to impart an electrostatic charge to the photoconductor surface as part of the general processing procedure. This necessitates the provision of high-voltage generators in such equipment as office copying machines and the like, which adds to the expense and power requirements of such machines and can also be a hazard to the operator under some conditions.

It thus appears that electrostatic copying could be greatly simplified by the elimination of the charging operation from the general processing procedure, and while so called "chargeless" techniques have been proposed in the past, these have not generally been applicable to electrophotographic photocopying due to the extended developing times involved.

It is known that prior art electrophotographic printing elements may be produced in such a manner that they are capable of holding a small electrostatic charge on their sensitive surface for many months. Such charges are generally of the order of 50 volts or less and known processing techniques have generally proved to be of insufficient sensitivity to develop image charges of such low magnitude. We have proposed toners for liquid dispersion which are capable of developing such low magnitude image charges and of producing copy of acceptable quality for office copying purposes, however such results could be still further improved by the attainment of an electrophotographic printing element capable of greater charge retention under dark conditions and for longer periods than are at present possible.

We have now found that a electrophotographic printing element with charge holding characteristics considerably better than those of prior art materials can be produced in accordance with the teachings of this present invention.

The present invention thus involves an electrophotographic process in which the charging operation may be performed many months prior to use of the photoconductive printing element for photocopying or the like to obtain results greatly superior to those possible with prior art materials both with regards image intensity and cleanliness of nonimage or background areas. Further such electrophotographic printing elements may advantageously be used in conjunction with selectively sensitized liquid-dispersed toners previously disclosed by us.

The present invention involves the use of an organic photoconductor on a charge-sustaining base. The photoconductor sheet as produced is subjected to a corona discharge device to receive a uniform electrostatic charge of the desired polarity and of a predetermined level which is below the level at which dielectric breakdown occurs and which varies depending on the particular photoconductor and backing member used. The charged sheets are stacked and packed

under dark conditions and in a dry state to prevent charge transfer from the photoconductor surface to the back of the overlying sheet. The packed sheets are stored in this condition for an extended period, and then used without further charging in an electrostatic copier or the like. Alternatively the electrophotographic recording element may be in the form of a continuous web which is charged and rereeled for storage prior to use. When such images are developed, particularly with a liquid developer of the selectively sensitized type, surprisingly high-contrast clean images are obtained, even after storage periods of many months. Biasing means in the developing step can be also used, if so desired.

The organic photoconductor is preferably but not necessarily selected from a group represented by the following: polyvinylcarbazoles, 4,5-diphenyl-imidozolidinethione-2, acyl-hydrozone compounds, (4-N,N-dimethylamino-benzylidene)-3-amino-pyridine, 1-(-napthylidene)-amino-2 methyl-S-nytrobenzene, or the like, which may be incorporated in an insulating binding agent such as a resin or the like, if desired. Sensitizing agents can be also incorporated with the organic photoconductors.

The charge supporting backing member may be a paper web, preferably dried, an insulating synthetic paper, a plastic sheet, or an insulating resin subcoat between the photoconductor layer and the paper base. The paper base may also contain solvent-repellent materials, known in the art as "carrier barriers," although this is not necessary to achieve the results of the present invention. Further the charge supporting nature of the backing need only be of a temporary nature, as this feature is only necessary during storage of the presensitized photoconductor sheets. Thus the backing may be a dried paper which is maintained in the dried condition until the sheet has been separated from the stack prior to exposure. Thus in an office copying machine for instance a water wetted roller or wiper or other means may be provided to wet the back of the sheet to enhance selective discharge during the exposure operation.

We have found that electrophotographic printing elements prepared and used in accordance with the above disclosure may be used for office copying purposes many months after preparation to give highly satisfactory results.

In order that the invention may be more fully understood reference will no be made to the following examples, but it should be understood that these examples are to be considered in the illustrative sense only, and that one skilled in the art of electrophotography will be able to adapt the teachings of the present disclosure to the use of other organic photoconductors and charge sustaining backing members without departing from the scope of this invention.

EXAMPLE 1

A photoconductive recording element was prepared by incorporating poly-n-vinylcarbazole with an equal weight of a 20 percent solution by weight of n-butyl methacrylate in toluene. The resultant mixture was coated on a substantially dried paper web, and the solvent evaporated. The web was separated into two halves, one of which was sheeted while the other was left as a continuous web. The resultant photoconductive recording elements were dried prior to charging in order to increase the volume resistivity of the paper backing to 10^{12} ohm. cm. Each of the recording elements was charged by subjecting it to a corona charging device which allowed the application of a DC potential within the range 3–15 kv. The threshold voltage obtainable on this photoconductive recording element was of the order of 500 volts. The charged sheets were stacked together, all facing in the same direction, in the dark, and the resultant stack wrapped in a moisture impervious polyethylene film. The continuous web was reeled after charging and also wrapped in an impervious polyethylene film. Several months later a sample from each pack was found to be carrying a surface charge of the order of 300 volts and acceptable image deposits were also produced after a further

several months, when the surface charge on the photoconductor had been reduced to 100 volts. The paper backing of each sample was wetted with water prior to exposure, and the latent images so produced were developed in a liquid-dispersed toner consisting of

phthalocyanine blue, CI Pigment Blue No. 16,	1 g.
n-heptane	100 g.

in which the pigment had been ground with a portion of the n-heptane to produce a pigment dispersion with a particle size of 1 micron maximum.

A high-density background-free image was obtained.

EXAMPLE 2

The dried paper-backing member of example I was replaced with a synthetic paper, which consisted of a white pigmented rayon, polyvinyl alcohol complex with a volume resistivity of 10^{13} ohm. cm. The threshold voltage was increased to 600 volts, and the long term dark decay was less than in example 1.

EXAMPLE 3

The backing of example I was replaced with a cellulose acetate sheet 0.004 **inch thick. Charge-holding characteristics were generally similar to those of example I.**

EXAMPLE 4

The backing of example I was replaced with an 0.0005-inch thick layer of acrylic resin, applied as a subcoat to a paper backing prior to application of the photoconductor coating. The charge-holding characteristics of the so-formed electrophotographic recording element were substantially similar to those of example 2.

EXAMPLES 5–8

The acrylic binder of examples 1–4 was omitted, thus the photoconductive coating consisted of poly-N-vinylcarbazole only. The charge holding characteristics were generally similar to those of examples 1–4.

EXAMPLES 9–16

The poly-N-vinylcarbazole of examples 1–8 was replaced with (4-N,N-dimethylamino-benzylidene)-3-amino-pyridine.

EXAMPLES 17–24.

The poly-N-vinylcarbazole of Examples 1–8 was replaced with 1-(-napthylidene)-amino-2 methyl-S-nitrobenzene.

We have found that organic photoconductors which have sufficiently high-charge-holding capabilities for use in conventional prior art electrophotographic processes are usable in accordance with the present invention. In addition, sensitization of prior art organic photoconductors practiced to enhance their speed of photographic response may also be used with the present invention. Thus the present invention is applicable to known prior art organic photoconductors, provided they are used in combination with a backing material which has a volume resistivity of at least 10^{12} ohm. cm., and also providing that such charge-sustaining backing member is at least capable of a temporary decrease in resistivity prior to exposure.

While not wishing to be bound to any theory, we believe that the enhanced charge-holding characteristics of photoconductive recording elements produced in accordance with the teachings of the present invention are due to a combination of two properties, these being the charge-sustaining nature of the relatively insulating backing member and the inherently smooth surface which is characteristic of organic photoconductor layers, which in effect allows the stack of charged sheets or the rolled charged continuous web to act as a very slow decay charged condenser laminate, and we have found surprisingly that such charged stacks or rolls retain a usable charge for many months. Thus such photoconductive recording elements are usable in office copying machines or the like without the necessity for provision of charging equipment within such machines.

What I claim is:

1. Improved photoconductive recording elements for electrophotography arranged in a tight pack and all facing the same way, each element consisting essentially of a layer of organic photoconductor disposed on a paper-backing member, each element being further characterized by said organic photoconductor layer being electrostatically charged to a level below the level of dielectric breakdown of such photoconductor layer, such charge level being of the order of 500 volts, and being packed unimaged in said charged condition in a moisture and lightproof container prior to delineating a latent image thereon and in such manner that the charged surface of one element in the pack is in contact with the backing member of the next element in the pack, and further characterized by each of said backing members being of sufficiently high resistivity, about 10^{12} ohm cm. to prevent leakage of said electrostatic charge from said surface of said photoconductor layer disposed thereon while also preventing contact discharge of the electrostatic charge contained on the surface of the underlying photoconductor layer in contact therewith.