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Ciuffini

[11] **3,837,849**

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[54] **MULTILAYERED VARIABLE SPEED PHOTORECEPTOR AND METHOD OF USING SAME**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

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[52] **U.S. Cl.** ..... **96/1 R,** 96/1.5, 252/501

[51] **Int. Cl.** **G03g 5/04,** Go3g 13/22

[58] **Field of Search** ..... 96/1 R, 1.5; 252/501

[56] **References Cited**

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Primary Examiner—Roland E. Martin, Jr.

[57] **ABSTRACT**

A xerographic member which comprises a supporting substrate having thereon an insulating blocking layer, a layer of halogen doped selenium overlaying the insulating layer, and a transport layer of vitreous selenium overlaying the halogen doped layer. The member is imaged by charging to a negative polarity followed by uniformly exposing to light which results in the negative charge being trapped in the halogen doped layer. The member is then uniformly positively charged and exposed to a pattern of light which results in the formation of a latent electrostatic image.

10 Claims, 4 Drawing Figures

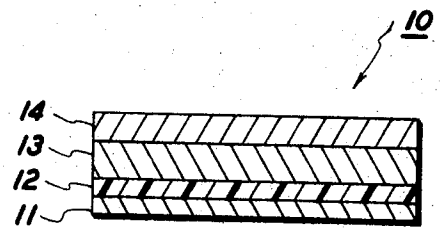


FIG. 1

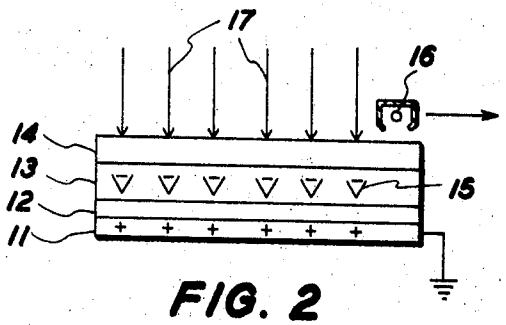


FIG. 2

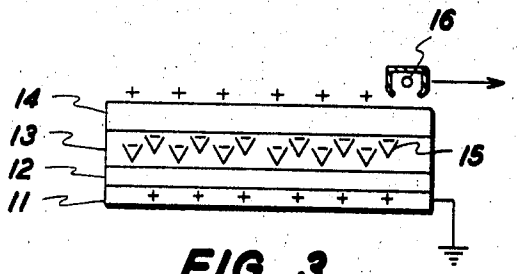


FIG. 3

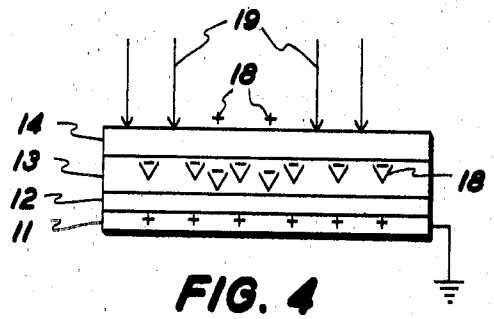


FIG. 4

MULTILAYERED VARIABLE SPEED PHOTORECEPTOR AND METHOD OF USING SAME

BACKGROUND OF THE INVENTION

This application relates to xerography, and more specifically, to a novel xerographic device and method of imaging.

In the art of xerography, a xerographic plate containing a photoconductive insulating layer is imaged by first uniformly electrostatically charging its surface. The plate is then exposed to a pattern of activating electromagnetic radiation such as light, which selectively dissipates the charge in the illuminated areas of the photoconductive insulator while leaving behind a latent electrostatic image in non-illuminated areas. This latent electrostatic image may then be developed to form a visible image by depositing finely divided electroscopic marking particles on the surface of the photoconductive insulator. This concept was originally described by Carlson, in U.S. Pat. No. 2,297.691, and is further amplified and described in many related patents in the field.

When used in the conventional xerographic mode, a xerographic photoreceptor is normally in the form of a drum and is cycled through at least six basic steps. These include: (1) uniformly electrostatically charging the surface of the drum; (2) imaging the charged drum in the dark by exposure to a pattern of light which results in the formation of a latent electrostatic image on the drum surface; (3) developing the latent electrostatic image by cascading the drum with electroscopic toner particles which adhere to the drum surface to form a powder image; (4) transferring the powder image to a sheet of plain bond paper; (5) fusing the transferred image to a sheet of paper to form a permanent visible copy of the original image; and (6) cleaning the drum surface. In order to prepare a drum for a second duplicate image, all of the above six steps are normally carried out a second time.

It can therefore be seen that if a photoconductor drum is to be used for high speed duplicating where the same image is copied a plurality of times, each of the above six steps must be repeated when using conventional xerographic imaging methods. In repeating the above six steps a great many times, the photoreceptor will exhibit gradual deterioration due to repeated exposure to light, chemical solvents, abrasion and heat. It can also be seen that the elimination of one or more of these steps would significantly increase the speed of the process and also add to the useful life of the drum.

Vitreous selenium, as taught by Bixby in U.S. Pat. No. 2,970,906, has become a widely used material in conventional reusable xerography. Although selenium is highly satisfactory for use in conventional reusable xerography, it does have a somewhat limited quantum efficiency under normal charging and discharge cycling. In addition, the electron transport range for selenium is very low, and for normal xerographic applications, selenium must be charged to a positive polarity in order to allow the transport of holes through the selenium layer during the discharge portion of the imaging cycle. In addition, the overall xerographic discharge in conventional xerography is highly influenced by the electrical characteristics of the interface.

In conventional reusable xerography, the photoreceptor is normally capable of storing a latent electrostatic image in the dark for a relatively short period of time, and image storage for long periods such as several hours or a day, generally is not feasible.

It can be seen from the above that a photoreceptor which would provide for variable quantum efficiencies, and which would be capable of storing a latent image for an indefinite period of time would have obvious advantages over conventional photoreceptors.

OBJECTS OF THE INVENTION

It is, therefore, an object of this invention to provide a method of imaging which overcomes the above noted disadvantages.

It is another object of this invention to provide a photoreceptor which exhibits a variable quantum efficiency.

It is a further object of this invention to utilize a photoreceptor having an interface which prevents charge transfer to the supporting substrate.

It is a further object of this invention to provide a method of imaging a photoreceptor in which a developable image may be stored for an indefinite period of time.

It is a further object of this invention to provide an imaging device which may be used in a reflex mode under cycling conditions.

SUMMARY OF THE INVENTION

The foregoing objects and others are accomplished in accordance with this invention by providing a xerographic member having a composite photoreceptor portion. This member is particularly adaptable for use in xerographic duplicating and/or image storage in which either multiple copies may be made of the same image or a developable image may be stored for an indefinite time period and later developed. The structure contemplated by this invention comprises a support member such as a metal substrate having an overlaying blocking interface which is overlayed with a relatively thin photoreceptor layer such as selenium doped with a halogen. The halogen doped layer is overlayed with a photoreceptor transport layer which may comprise selenium.

In operation, the plate is first electrostatically charged to a negative polarity while being simultaneously illuminated with an erase lamp. This step results in negative charge being trapped in the halogen doped layer. The second imaging step consists of uniformly positively charging the top surface layer and results in a uniform positive charge being formed at the exposed surface of the top selenium layer. The structure is then imaged by exposing to a pattern of light which selectively dissipates the surface charge resulting in the formation of the latent electrostatic image on the surface of the drum. This image may then be developed by any conventional technique. Due to the fact that negative charge is stored or trapped within halogen doped layer, the interface is selected so that no charge carrier can effectively flow across this layer. The supporting substrate is thus electrically isolated from the interface, and the latent electrostatic image may be stored for an indefinite period of time.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages of the instant invention will become

apparent upon consideration of the following disclosure of the invention, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 represents a schematic illustration of one embodiment of the xerographic member as contemplated for use in the instant invention.

FIG. 2 is a schematic illustration representing the first step in the imaging process of the instant invention.

FIG. 3 represents the second step of the imaging process.

FIG. 4 represents the third step of the imaging process.

DETAILED DESCRIPTION OF THE DRAWINGS

In the FIG. 1 of the drawing, reference character **10** illustrates one embodiment of an improved photoreceptor device suitable for use in the instant invention. Reference character **11** designates a support member which is preferably an electrically conductive material. A support may comprise any conventional metal such as brass, aluminum, steel, or the like. The support may also be in any convenient thickness, rigid or flexible, transparent and in any suitable form such as a sheet, web, cylinder, or the like. The support may also comprise other materials such as metalized paper, plastic sheets covered with a thin coating of aluminum or copper iodine, or glass coated with a thin conductive layer of chromium or tin oxide.

Reference character **12** illustrates an electrically insulating barrier layer that must be made thick enough to withstand the electrical fields contemplated for use in the instant invention. Thicknesses in the range of about **2** microns to **5** mils have proven satisfactory. The barrier layer must be on an inert material and thick enough so that no charge carriers of either polarity can flow across this layer, making it electrically isolated from the supporting conductive substrate. The material comprising this interface may be of any suitable material such as an insulating resin or oxide coating. Typical materials include; polycarbonate resin, aluminum oxide or epoxies. Overlaying the barrier layer, is a trapping layer **13** which comprises halogen doped vitreous selenium. Optionally this layer may also contain a vitreous halogen doped selenium layer containing arsenic in an amount up to about 5 weight percent. Suitable halogens include, chlorine, iodine, bromine or fluorine in a concentration of about 2 to 1,000 parts per million (ppm) by weight. The thickness, this layer is not particularly critical, with thicknesses in the range of about 2 to 100 microns being satisfactory. Overlaying the halogen doped layer is a transport layer **14** which comprises vitreous selenium. Optionally this layer may also contain arsenic in an amount up to about 5 weight percent. This layer should be relatively thicker than trapping layer **13,** with thickness in the range of about 10 to 200 microns being satisfactory.

In imaging the device of the instant invention the first step includes uniformly negative corona charging the surface of the selenium transport layer **14** with corona device **16,** while simultaneously flood exposing the surface to light **17.** This results in the trapping of electrons in layer **13** is illustrated by reference character **15** in FIG. **2.** Following this step the imaging device is then uniformly charged to a positive potential resulting in an electric field being impressed across the selenium storage layer **14** from its surface to the trapped electron sites **15** (see FIG. **3**). In addition, the fields balance relative to the dielectric constants and thicknesses of layers **12** and **14** as shown in FIG. **3.** The imaging member is then exposed to imaging light **19** (see FIG. **4**), resulting in the selective discharge of the positive surface charge and the formation of the latent electrostatic image **18** between the surface of transport layer **14** and the trapped negative charge in layer **13** (see FIG. **4**). This latent image may be stored for an indefinite period of time or may be developed immediately, depending on when a visible image is desired. When it is desired to form an additional image, the top photoconductive layer is given a negative pre-charge and illumination simultaneously which sweeps free holes and retraps electrons at the electron trap sites **15,** thus renewing the structure for another positive charging and imaging cycle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following examples further specifically define the present invention with respect to a method of making and imaging a multilayered photoreceptor storage member. The percentages in the disclosure, examples and claims are by weight unless otherwise indicated. The following examples and data are intended to illustrate various preferred embodiments of the instant invention. The photoconductive vitreous selenium and vitreous selenium alloys of the instant invention may be conveniently formed by any conventional vacuum deposition techniques well known to the art. U.S. Pat. Nos. 2,753,278 and 3,312,548, incorporated herein by reference, illustrate typical methods of vacuum deposition which are suitable for use in forming the photoconductive layers of the present invention.

EXAMPLE

A xerographic plate exemplary of the present invention is prepared as follows: A brass substrate 10.2 inches wide and **15** inches long is first coated to form a dried polycarbonate barrier or blocking layer 20 microns thick. The blocking layer is made by dip coating the brass plate in a methylene dichloride solution of polycarbonate. The solution is prepared by dissolving 300 grams of polycarbonate in 1,800 ml. of methylene chloride. A 10 micron layer of vitreous selenium containing 30 parts per million by weight chlorine is vapor deposited under vacuum conditions over the polycarbonate blocking layer. A 50 micron top layer of vitreous selenium is then vapor deposited over the chlorine containing layer. This plate is then taped to a 30 inch circumference aluminum cylinder. The plate is imaged by simultaneously charging the top surface of the drum with a negative corona discharge while uniformly exposing the surface to white light. The negative charge is transported through the top photoconductive layer and trapped within the chlorine containing selenium layer. The charging is adjusted to establish a trapped charging potential of about −800 volts. The top surface of the drum is then uniformly charged to a positive surface potential of about +800 volts. The plate is then exposed to imaged light which selectively discharges the plate in the light struck areas both at the surface and at the electron trap sites within the plate. A latent electrostatic image remains on the plate surface. This latent image is then developed by cascading toner material over the plate surface.

In an alternative embodiment, positive surface charge remaining after the imaging step may be removed by using a conductive rubber roller, and the negative reversal image stored in the chlorine doped layer developed. This image is capable of remaining stored for indefinite periods of time such as several days or more.

If desired, the uniform exposure step, which normally is carried out simultaneously with the initial negative charging, may be accomplished as a separate step after the charging.

It will be obvious to those skilled in the art that by varying the field across layer **14** by varying the amount of negative charge stored, that the quantum efficiency increases with the increasing fields. In conventional xerographic operations at 16 volts per micron and exposure using 400 millimicron radiation, a quantum efficiency of about 0.5 is observed. At higher fields greater than about 16 volts per micron, quantum efficiency is limited only by the ability of the device to trap electrons and resist surface charge injection. At a field strength of 75 volts per micron, the quantum efficiency was computed to be 0.95 using 400 millimicron radiation.

Other modifications and ramifications of the present invention would appear to those skilled in the art upon reading the disclosure. These are also intended to be within the scope of this invention.

What is claimed is:

1. A xerographic member which comprises:

a supporting conductive substrate having thereon an overlaying electrically insulating blocking layer about 2 microns to 5 mils in thickness, said layer being sufficient to prevent charges of either polarity from flowing across said layer, a layer of halogen doped vitreous selenium about 2 to 100 microns thick overlaying said insulating layer, said halogen being in a concentration of about 2 to 1,000 parts per million by weight, and a transport layer of vitreous selenium about 10 to 200 microns thick overlaying said halogen doped layer, with said transport layer being relatively thicker than said halogen doped layer.

2. The member of claim **1** in which the barrier layer comprises an insulating material selected from the group consisting of a polycarbonate resin, an epoxy resin and aluminum oxide.

3. The member of claim **1** in which the halogen doped layer further contains arsenic in an amount of up to about 5 percent by weight.

4. The member of claim **1** in which the transport layer further contains arsenic in an amount of up to about 5 percent by weight.

5. The member of claim **1** in which both the halogen doped layer and transport layer contain arsenic in an amount of up to about 5 percent by weight.

6. A method of imaging which comprises:

a. providing an imaging member which comprises a supporting substrate having thereon an overlaying electrically insulating blocking layer about 2 microns to 5 mils in thickness, said layer being sufficient to prevent charges of either polarity from flowing across said layer, a layer of halogen doped vitreous selenium about 2 to 100 microns thick overlaying said insulating layer, said halogen being in a concentration of about 2 to 2,000 parts per million by weight, and a transport layer of vitreous selenium about 10 to 200 microns thick overlaying said halogen doped layer, with said transport layer being relatively thicker than said halogen doped layer,

b. uniformly charging the top surface of said imaging member to a negative polarity,

c. uniformly exposing the member to a source of activating radiation which results in the negative charge being trapped within the halogen doped layer,

d. uniformly positively charging said member, and

e. exposing said member to a pattern of activating radiation which results in the formation of a latent electrostatic image.

7. The method of claim **6** in which the latent image is developed to form a visible image.

8. The method of claim **6** in which subsequent to forming the latent image, the member is uniformly negatively charged, resulting in a dissipation or recombination of the remaining image charge.

9. The method of claim **6** in which the initial uniform negative charging and uniform exposure are carried out simultaneously.

10. The method of claim **6** in which the positive surface charge remaining after image exposure is removed and the stored negative latent image developed.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,837,849 Dated September 24, 1974

Inventor(s) Anthony J. Ciuffini

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

In the Abstract of the Disclosure, line 7, "to" should be --the--.

In Claim 6, column 6, line 19, "2,000" should be --1,000--.

Signed and sealed this 11th day of February 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

FORM PO-1050 (10-69)

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