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Ohta et al.

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[54] **ELECTROPHOTOGRAPHIC PHOTOSENSITIVE PLATE**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **96/1.5,** 252/501, 117/200, 117/217, 117/107

[51] **Int. Cl.** **G03g 5/06**

[58] **Field of Search** 96/1.5; 117/200, 117/107; 252/501

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[57] **ABSTRACT**

An electrophotographic photosensitive plate is provided consisting of a conductive substrate support, a first thin film or layer of gold, platinum or selenium deposited on said support and a second photoconductive insulating film or layer of selenium deposited on said first layer. The second film or layer consisting essentially of selenium is deposited at a temperature in the range about 20°C – 40°C. The gold or platinum of said first film can be deposited by vacuum deposition or plating on said support and the selenium of said first film is deposited at a temperature in the range about 60°C – 75°C. The resulting plate when employed in a repetitive electrostatic copying operation exhibits almost negligible residual potential.

17 Claims, 3 Drawing Figures

PATENTED NOV 27 1973 3,775,109

FIG. 1

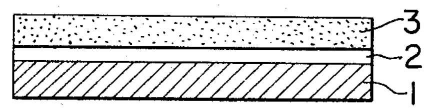


FIG. 2

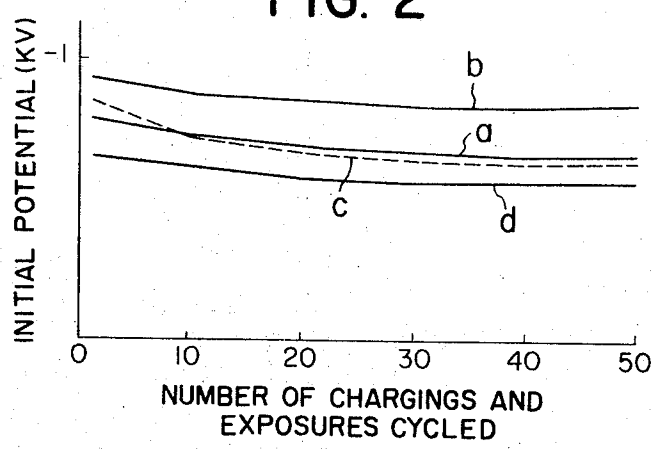
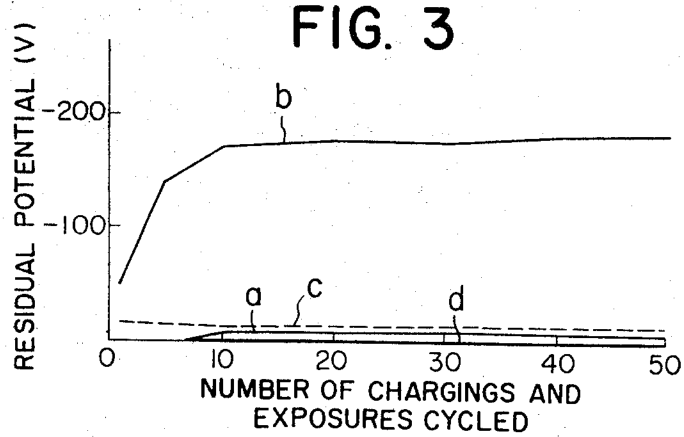


FIG. 3



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ELECTROPHOTOGRAPHIC PHOTOSENSITIVE PLATE

BACKGROUND OF THE INVENTION

The present invention relates to an electrophotographic photosensitive plate employing amorphous selenium as a main photoconductive insulating member.

In Xerography, the so-called Xerography plate is positively charged by a corona discharge in the dark and a light image is projected upon the plate, whereby a positively charged pattern is formed. This pattern is contacted with electrostatically charged marking particles termed "toner" in the dark. These particles adhere to the areas where the electrostatic charges remain, forming a powder image corresponding to the electrostatic image. The visible image so obtained is transferred to a permanent image recording medium such as paper. The xerography plate is cleaned by physical means such as a soft brush so as to remove the remaining toner for re-use. Generally positive copies are obtained from a positive original in Xerography. If the positively charged toner is used, it will be possible to produce the positive copies from a negative original. In this case, there arise the problems that the toner must be replaced continuously in order to keep it positively charged and that the edge effect is enhanced, so that sharp images cannot be obtained.

It is therefore required that a photosensitive plate must retain not only positive charge but also negative charge at high potential in order that both of the positive and negative copies may be obtained by using the toner having the same polarity.

In case of a photosensitive plate which is disclosed in U. S. Pat. No. 2,901,348 and is widely used, an insulating barrier thin layer is formed upon a conductive substrate or support in order to increase the charge retaining time in the dark and a photoconductive insulating layer consisting of amorphous selenium is formed upon the insulating barrier layer. As the barrier layer, the aluminum oxide thin layer obtained by the oxidization of the surface of an aluminum substrate is generally used. Alternatively, thin layers of other suitable insulating substance such as polystyrene may be used. When the photosensitive plate having a construction described above is imparted with the charge in the dark and is projected with a light pattern of an original to be copied, the charge is dissipated corresponding to the original, so that the surface potential is dropped. But this surface potential drop will not become less than a certain value even when the light image is kept projected upon the photosensitive member. That is, a charge remains upon the photosensitive plate (termed "residual potential"). The residual potential is almost negligible when the photosensitive plate is positively charged, but when the photosensitive plate is charged negatively, the residual potential is of the order of from 50V to 100V. When the cascade process in which the toner is cascaded upon the photosensitive plate is used for development, the residual potential in this degree does not present serious problems. However, when the photosensitive member is repetitively used in a relatively fast cycle, the residual potential is gradually accumulated, so that the copied images have low contrast. Especially when the positively charged toner is used, the whole image will be fogged, resulting in poor quality copies.

SUMMARY OF THE INVENTION

It is therefore the primary object of the present invention to provide an electrophotographic photosensitive plate which can be positively or negatively charged and which avoids the build-up of residual potential during a repetitive copying operation.

The present invention is based upon the observed fact that when the temperature of the support is in the range from about 20°C to about 40°C during selenium deposition the resulting deposited photosensitive film consisting essentially of amorphous selenium may be positively or negatively charged uniformly to the same potential. For example, when the selenium photosensitive plate having a selenium film deposited under the aforesaid condition to a thickness of 70μ, it was charged up to 1,000V.

It is therefore one of the objects of the present invention to provide an electrophotographic photosensitive member having a photoconductive insulating layer consisting essentially of selenium deposited thereon while maintaining the support at a temperature from 20° to 40°C so as to enable the photosensitive plate to be capable of being positively or negatively charged. In accordance with this invention the electrophotographic photosensitive member has a metallic or other thin layer interposed between the selenium photoconductive insulating layer and the support so as to prevent the build-up of residual potential.

Since the photosensitive plate in accordance with the present invention may be positively or negatively charged, not only the positive copies are obtained from a positive original, but also positive copies are obtained from a negative original by using the toner having the same polarity and the problem of the residual potential can be completely eliminated.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of the preferred embodiments thereof taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic diagram illustrating the construction of an electrophotographic photosensitive plate in accordance with the present invention; and

FIGS. 2 and 3 are graphs for explanation of the characteristics of various photosensitive plates in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, conductive substrate or support 1 is provided with an intermediate layer 2 of amorphous selenium which is formed by vacuum deposition while the support is maintained at a temperature 60°C–75°C. Gold and platinum might also be deposited on support 1 instead of selenium. Photoconductive insulating layer 3 consisting essentially of amorphous selenium is then desposited on layer 2, while the temperature of the support 1 is maintained at 20°C – 40°C.

The photosensitive plate so obtained may be charged positively or negatively and has a low residual potential 0 – 20V. Even after the photosensitive plate is subjected to repetitive charging and exposure, no residual potential is accumulated. Even when the photosensitive plate is charged positively, there will be no residual potential.

The following examples are illustrative of the present invention:

EXAMPLE I

A. Gold was vapor deposited on an aluminum plate having a well polished surface to a thickness about 50A at a vacuum of 5×10^{-5} mm Hg. Next selenium of 99.99 percent in purity was vacuum deposited to a thickness about 70 μ while the support was maintained at 30°C. The distance between the selenium vaporization source and the support was 30 cm; the vacuum was 1×10^{-4} mm Hg; and the deposition time was 40 minutes.

B. For the sake of comparison, selenium was vapor deposited upon a clean aluminum plate having an aluminum oxide layer of about 100A. The Xerographic plates so obtained were imparted with the negative charge by needle electrodes for 1 minute with a corona current of 3.5 μA and then subjected to the dark decay for 15 seconds. Thereafter, the exposure was made for 1 minute by a 10 lux tungsten lamp having a color temperature of 3,000°K. The above charging and exposure steps were cycled in order to measure the variation in surface potential. The results are shown in FIGS. **2** and **3.**

FIG. **2** shows the relationship between the initial potential and a number of chargings and exposures cycled while FIG. **3,** the relationship between the residual potential and a number of chargings and exposures cycled. Curve *a* indicates the characteristic of the photosensitive plate A in the Example I consisting of the support, the gold layer and the selenium layer. Curve *b* indicates the characteristic of the photosensitive plate B including the aluminum oxide thin film. From FIG. **2,** it is readily seen that the photosensitive plate A had a tendency to reduce its initial potential slightly but after 20 cycles, the same initial potential was maintained. This means that the photosensitive plate A could maintain the sufficient charge to be developed.

As described hereinabove, in order to provide a Xerographic plate having a less dark decay, an intermediate barrier layer must be interposed between the support and the photoconductive insulating layer. The photosensitive plate B had this intermediate barrier layer and showed the tendency that the surface potential was reduced to 90 percent within 15 seconds while the photosensitive plate A, to 80 percent. This means that when the photosensitive plate is used at a relatively high repetition rate, it presents no problem in practice even when the intermediate barrier layer is not provided.

From FIG. 3, the photosensitive plate B exhibited the tendency of accumulating the residual potential as the number of charging and exposure cycle was increased. On the other hand, the photosensitive plate A showed a very low residual potential 0 – 10V and the accumulation of the residual potential was almost negligible.

EXAMPLE II

C. In order to evaporate platinum, a platinum wire was twisted with a tungsten wire and the evaporated platinum was deposited to a thickness of about 250A upon a clean aluminum plate. An electrophotographic photosensitive plate was then prepared by selenium deposition in accordance with the invention. The characteristics of thus obtained photosensitive plate are indicated by the curves *c* in FIGS. **2** and **3.** It is seen that the residual potential of this photosensitive plate C was very low.

EXAMPLE III

D. Selenium was deposited upon a well polished copper plate to a thickness of about 2mu in a vacuum of 10^{-4} mm Hg by employing a tantalum boat while the support was maintained at 60°C. Thereafter, the selenium coated copper substrate or support was cooled to about 30°C and element of selenium which comprises admixing therewith an amount of element of tellurium of 5 percent by weight was then deposited to a thickness about 70μ in the same manner as in Example I. The characteristics of thus obtained xerographic plate are indicated by curves *d* in FIGS. **2** and **3.** It is seen that the residual potential was not detected at all.

In the preparation of plates in accordance with this invention any suitable electrically conductive substrate or support may be used in place of aluminum and copper.

We claim:

1. An electrophotographic photosensitive plate comprising a conductive support, a first film of a metal selected from the group consisting of gold, platinum and selenium deposited on said support and a second film consisting essentially of selenium deposited on said first film, said second film having been deposited under conditions such that said support and said first film upon which said second film was deposited were at a temperature in the range about 20° – 40°C as said second film was deposited.

2. A plate in accordance with claim **1** wherein said first film is gold.

3. A plate in accordance with claim **1** wherein said first film is platinum.

4. A plate in accordance with claim **1** wherein said first film is selenium deposited on said support at a temperature in the range about 60° – 75°C.

5. A plate in accordance with claim **1** wherein said support is provided by a smooth or polished surface of an electrically conductive material.

6. A plate in accordance with claim **1** wherein said support is provided by a smooth or polished surface of an electrically conductive metal.

7. A plate in accordance with claim **6** wherein said electrically conductive metal is selected from the group consisting of aluminum and copper.

8. A plate in accordance with claim **1** wherein said first film has a thickness in the range from about 50A to about 250A.

9. A plate in accordance with claim **1** wherein said second film has a thickness of about 50–100 microns.

10. A plate in accordance with claim **1** wherein said second film is amorphous selenium having a thickness of about 70 microns.

11. A plate in accordance with claim **1** wherein said support is a metal selected from the group consisting of aluminum and copper, said first film has a thickness in the range from about 50A to about 2 microns and said second film of selenium is a film of amorphous selenium having a thickness in the range of 50–100 microns.

12. A plate in accordance with claim **11** wherein said film of amorphous selenium has a thickness of about 70 microns.

13. A plate in accordance with claim **1** wherein said first film is a selenium film deposited on said support at a temperature in the range from about 60°C to about 75°C and having a thickness of about 2 microns and wherein said second film is a film of amorphous selenium having a thickness of about 70 microns.

14. A plate in accordance with claim **1** wherein said first film is gold having a thickness in the range from about 50A to about 250A.

15. A plate in accordance with claim **1** wherein said first film is platinum having a thickness in the range from about 50A to about 250A.

16. A plate in accordance with claim **1** wherein said first film is a selenium film deposited on said support which said support was at a temperature in the range about 60–75°C and wherein said selenium film has a thickness in the range about 0.5–5.0 microns.

17. In a method for the production of electrophotographic photosensitive plates comprising a conductive support and a photoconductive layer, the improvement which comprises forming the photoconductive layer by first depositing a first film of metal selected from the group consisting of gold, platinum and selenium on said support, and, thereafter, depositing a second film of selenium while maintaining the temperature of the first film coated support at a temperature in the range from 20°C. – 40°C.

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