

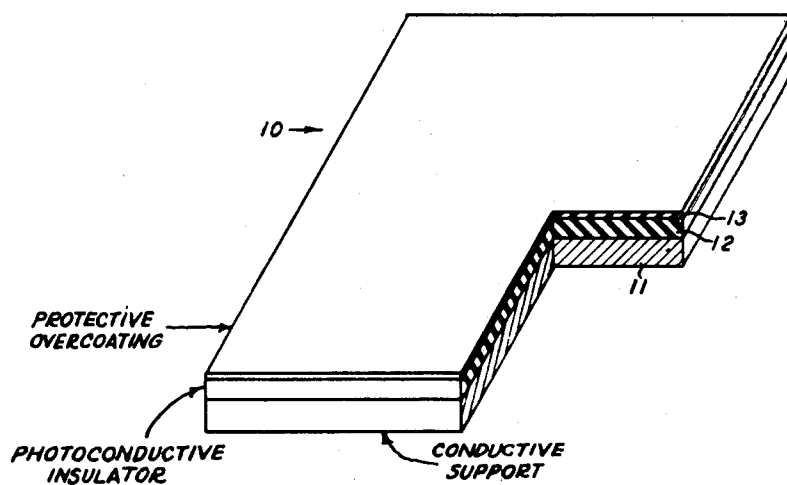
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PROCESS FOR ADHERING PLASTIC TO VITREOUS SELENIUM

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3,146,145

PROCESS FOR ADHERING PLASTIC TO VITREOUS SELENIUM

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The present invention relates to xerographic plates and more particularly to a novel method of fabricating xerographic plates.

The xerographic process is described in U.S. Patent No. 2,297,691 to C. F. Carlson and involves the sensitization of a xerographic plate as by placing an electrostatic charge thereon and the exposure of the sensitized plate to an original image to be reproduced. The exposed plate is developed by contacting the plate surface with electrostatically-charged, finely-divided powder particles to produce a powder image which is either used or fixed in situ or thereafter transferred from the plate to a final support, the transferred image being fixed thereon to form the final print.

As originally described by C. F. Carlson, the xerographic plate consisted of a thin layer of sulfur, anthracene or anthraquinone, either singly or in combination, applied to a relatively conductive base by melting and flowing onto the base or by evaporating the material onto the base which is kept at a lower temperature so as to condense the vapor.

A tremendous advance was made in xerography when it was discovered that vitreous selenium was highly photoconductive. A selenium xerographic plate generally comprises a metal backing plate, as aluminum, having coated on one side, as by vacuum evaporation, a layer of very high purity vitreous selenium. In the dark the selenium layer has an extremely high resistivity, but when exposed to light the resistivity is reduced many orders of magnitude, the amount depending on the intensity and wavelength of the light. By reason of its high electrical resistivity in the dark, the selenium layer can be charged electrostatically, which charge is retained for a prolonged period should no light impinge thereon. The outstanding ability of vitreous selenium to hold a charge for an appreciable period in the dark coupled with its high light sensitivity, has made the selenium plate the standard commercial plate of xerography. Such plates are costly to fabricate but may be used a thousand or more times in the xerographic process so that the cost per image developed is small. Thus, the selenium plate requires reusability to obtain reasonable operating costs.

Another advance was made in the field of xerographic plates with the discovery of the binder plate. Such plates are described by Arthur E. Middleton in U.S. Patent 2,663,636. As there described it was found that an efficient xerographic plate can be obtained by coating a relatively conductive base with a photoconductive insulating composition prepared by intimately mixing and grinding together any photoconductive insulating material, a binder of high electrical resistance and a solvent.

Where the binder and photoconductor are selected from low cost materials and the backing comprises an inexpensive material such as paper, it is economically feasible to utilize the xerographic plate only once, that is, use it as a disposable xerographic plate. However, necessarily such a plate is significantly more expensive than non-light-sensitive paper. Thus, for high volume applications, reusability of the xerographic plate is essential no matter whether a uniform photoconductor is used or a binder composition. In a disposable binder plate, the photoconductor is selected primarily on the basis of cost, rather than on the merits of its xerographic properties. If, however, the plate is reusable, then the cost of the photocon-

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ductor is not such an overriding consideration. Thus, in present commercial xerography utilizing a reusable plate, as in the vitreous selenium plate, the photoconductive layer is generally the most expensive as well as the most easily damaged element of the plate.

In high speed, continuous xerographic applications as described for example in U.S. 2,357,809 to C. F. Carlson, it is important to apply a protective layer or coating over the photoconductive insulating material so as to extend the life of the plate. Generally, the overcoating is formed by applying a solvent solution of an organic resin to the plate surface and allowing the solution to evaporate. However, many of the highly polymerized, solvent-resistant resins cannot be applied by this method. Further, it has been found that the solvents necessary often have a deleterious effect upon the photoconductor. Thus, for example, as described in pending U.S. patent application Ser. No. 482,896, filed January 19, 1955, by Harold E. Clark and now abandoned, where the overcoating is applied to a binder plate, it has been found that the solvent for the overcoating must be so selected as not to attack the binder. Where the solvent softens the binder, it has been found to materially affect the image-forming qualities of the xerographic plate. In the case of the silicone resin now widely used commercially in the preparation of binder plates, the resin binder dissolves in such a wide variety of solvents that the selection of the proper solvent for the overcoating is exceedingly difficult. In the case of selenium, it has been found that many solvents induce crystallization of the selenium causing it to convert to metallic selenium. This allotropic form of selenium, that is, crystalline selenium, has too low a resistivity to support an electrostatic charge. In addition, xerographic plates build up a film of toner in the image development process requiring washing the plate with an organic solvent to remove this deleterious film. Where the overcoating itself is solvent soluble, it is apparent that the treatment necessary to remove the toner film may also remove the protective overcoating.

I have now found a process whereby highly polymerized solvent-resistant resin overcoatings may be applied to a xerographic plate. There is thus obtained a reusable plate characterized by exceptional ease of cleaning and overall efficiency in a repetitive xerographic process. The photoconductor may be either in the form of a continuous uniform layer as in the case of vitreous selenium or may be in the form of a binder plate. Preferred binder-photoconductor combinations are described in the pending application of Middleton and Reynolds, Ser. No. 668,165, filed June 26, 1957. In general, the process involves placing a thin pellicle of highly polymerized, solvent-resistant resin in contact with the photoconductive insulating surface and then subjecting the assembly to ion bombardment in a vacuum.

In the drawing the figure represents a xerographic plate according to the instant invention. As shown the figure illustrates a xerographic plate, 10, comprising an electrically conductive support 11 such as metal having coated thereon a photoconductive insulating layer 12 protected by an overcoating 13 applied as described below. To illustrate the instant invention, a quarter mil film of polyethylene terephthalate (obtained from E. I. du Pont de Nemours & Company under the trade name Mylar) was placed in contact with the photoconductive insulating surface of a commercial xerographic plate obtained from Haloid Xerox Inc., Rochester, New York. This xerographic plate comprises a layer of amorphous selenium about 20 microns thick coated on an aluminum backing. The assembly, that is, the xerographic plate with the polyethylene terephthalate film resting in contact with the selenium layer, was placed in an evacuation chamber and the chamber then evacuated to a vapor pressure of 10

microns of mercury. The polyethylene terephthalate film was then subjected to ion bombardment using a 5,000 volt, 75 milliampere current for 1-2 minutes. The bombardment was then stopped, air admitted to the chamber and the plate removed. It was found that the Mylar sheet was firmly and uniformly adhered to the selenium without air pockets. In addition, the temperature increase due to the bombardment caused no visible crystallization of the selenium. When used in the xerographic process, high quality xerographic images were developed thereon using the regular xerographic process.

In addition to the polyethylene terephthalate, other materials may be used as described, such as polyamide films such as those prepared from caprolactum and Nylon 66, polyacrylonitrile and copolymers thereof, polytetrafluoroethylene, etc.

Selenium being the photoconductor of choice in commercial xerography, it is preferred to use the instant process in applying photoconductive coatings to selenium. However, the nature of the photoconductive insulating layer is not critical so that the process may be used to affix overcoating layers to any photoconductive insulating material such as selenium alloys (Se-Te, Se-As, etc.), anthracene, other continuous films and binder plates as described hereinbefore. As is well known in the xerographic art, any electrically conductive support layer may be used for the photoconductive insulating layer. The process is particularly useful in applying a protective overcoating to vitreous selenium or selenium alloy plates. Crystallization of such layers destroys their utility as photoconductive insulating layers. Although selenium is easily crystallized by heat, the ion bombardment as utilized herein to adhere the plastic films causes no apparent crystallization. Alloy selenium plates are often constructed in a layer structure where a thin alloy layer (as of Se-Te or Se-As) is coated on a layer of vitreous selenium thus combining the excellent photoresponse of the alloy with the excellent electrical characteristics (charge storage, dark decay, residual potential, fatigue, etc.) of vitreous selenium. Such plates are described, for example in U.S. 2,803,541 to Paris. The alloy layer being extremely thin (of the order of one micron) is particularly susceptible to erosion and abrasion damage. Thus, the process of the instant invention is particularly useful in preserving such alloy layers from damage. The tenacity of the bond formed, the uniformity of adhesion and the concomitant absence of air pockets, and the use of pellicles which combine solvent resistance and physical toughness with excellent electrical properties make the process useful with any type of reusable xerographic plate.

The conditions for the ion bombardment are not critical. Thus, various combinations of voltage from about 1000-10,000 and currents from 10-200 ma. may be used. The residual pressure is generally air, though reduced atmospheres of other gases may be used. High energy electron bombardment may also be used.

The process of the instant invention may be used to apply overcoatings to any of the xerographic plates known to those skilled in the art. Such plates are described, as to preparation, composition, thickness and other parameters, for example, in U.S. 2,803,542 to Ullrich; 2,803,541 to Paris; 2,745,327 to Mengali; 2,863,768 to Schaffert; U.S. application S.N. 526,781, filed August 5, 1955, by Bixby, now Patent No. 2,970,906; and the aforesaid application of Middleton and Reynolds. The pellicles applied

as overcoatings may be as thin as is consistent with ease of handling. In any case, however, they should not be thicker than about 12 microns and, desirably, are only 6 microns thick or less.

I claim:

1. The process for applying a protective overcoating to a photoconductive insulating layer of a xerographic plate comprising placing a layer of highly polymerized transparent electrically insulating resin on the photoconductive insulating layer of said xerographic plate to form an interface and then subjecting the side of said resin layer opposite said interface to ion bombardment under a partial vacuum whereby said resin layer is firmly bonded to said photoconductive insulating layer.

2. A process according to claim 1 in which said photoconductive insulating layer is selected from the group consisting of amorphous selenium and its alloys with tellurium and arsenic.

3. A process according to claim 1 in which said layer of highly polymerized, transparent, electrically insulating resin is selected from the group consisting of polyethylene terephthalate, polyacrylonitrile, polyamide, and polytetrafluoroethylene.

4. A process according to claim 1 in which said photoconductive insulating layer is selected from the group consisting of amorphous selenium and its alloys with tellurium and arsenic and in which said highly polymerized transparent electrically insulating resin is selected from the group consisting of polyethylene terephthalate, polyacrylonitrile, polyamide, and polytetrafluoroethylene.

5. A process according to claim 1 in which said ion bombardment is carried out using a current of from about 10 to about 200 milliamperes applied for from about 1 to about 2 minutes.

6. A process according to claim 4 in which said ion bombardment is carried out using a current of from about 10 to about 200 milliamperes applied for from about 1 to about 2 minutes.

7. A process according to claim 6 in which said ion bombardment is carried out in a chamber evacuated to a vapor pressure of about 10 microns of mercury.

8. The process for applying a protective overcoating to the amorphous selenium layer of a xerographic plate comprising placing a layer of polyethylene terephthalate on said amorphous selenium layer to form a selenium-polyethylene terephthalate interface, placing said xerographic plate with said polyethylene terephthalate in contact with it under a partial vacuum equal to a pressure of about 10 microns of mercury, and subjecting that side of said polyethylene terephthalate layer opposite said interface to ion bombardment using a current of about 75 milliamperes applied for from about 1 to about 2 minutes.

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