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XEROGRAPHIC PROCESS

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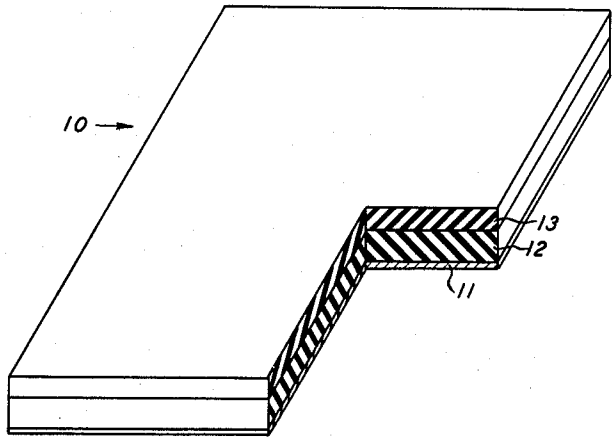

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XEROGRAPHIC PROCESS

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

The xerographic process is described in U.S. 2,297,691 to Chester 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. If desired, the transfer step may be omitted and the image fixed to the plate itself.

As originally described by 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 have 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.

Whether the xerographic plate comprises a uniform layer of photoconductive insulator or a finely ground photoconductor dispersed in a resin binder, it is often desirable to protect the light-sensitive surface by overcoating the surface with a protective material. 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 now available can not 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 Serial 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.

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 highly flexible 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 co-pending application of Middleton and Reynolds, Ser. No. 668,165, filed June 26, 1957, now U.S. Pat. No. 3,121,006. The process involves reversing the normal method of preparation of the xerographic plate, that is, rather than applying the photoconductive material to an electrically conductive support member, the photoconductive material is instead applied to a thin pellicle of a highly polymerized, solvent resistant resin. A thin electrically conductive film is then applied on the free surface of the photoconductor. Particularly preferred overcoatings suitable for use as described are polytetrafluoroethylene and polyester resins particularly polyethylene terephthlate. In addition, other materials which may be used as described are polyamide films such as those prepared from caprolactam and nylon 66. Suitable films may also be prepared from polyacrylonitrile and copolymers thereof as is well known to those skilled in the art. The resin film can be no more than about 0.5 mil thick and preferably is no more than about 0.25 mil thick. The conductive coating on the free surface of the photoconductor may be formed by vacuum evaporating a thin film of metal, as aluminum, thereon, or, if the photoconductive film is highly temperature sensitive, by vacuum evaporating copper iodide which is electrically conductive and has a very low temperature for evaporation. Alternatively a colloidal dispersion of graphite may also be sprayed or painted on the free surface to provide the electrically conductive layer. If desired the conductive layer need not be an integral part of the plate structure in which case the free photoconductive insulating surface is contacted with an electrically conductive support member during the necessary steps of the xerographic process.

In the drawing the figure represents a xerographic plate according to the instant invention. As shown the figure illustrates a xerographic plate **10**, comprising a pellicle of translucent, electrically insulating solvent-resistant, highly polymerized resin **13**, having coated thereon a photoconductive insulating layer **12** covered by a thin electrically conductive layer **11**. In order to more clearly depict the structure of the plate, the drawing is not to scale. However, as is clearly shown, the conductive layer **11** is not a support layer but rather is merely a thin flexible layer providing the necessary electrical ground plane to one side of the photoconductive insulating layer

12. In the instant structure the support layer is the insulating pellicle 13 which, being itself flexible, results in a flexible reusable plate 10. Any of the photoconductive insulating layers known to those skilled in the art may be used in formulating plates according to the instant invention. Such photoconductive insulating layers 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 U.S. Patent No. 2,970,906; and the aforesaid application of Middleton and Reynolds.

The general scope and nature of the invention having been set forth, the following examples are given as typical illustrations of the invention and not by way of limitation.

Example 1

A quarter mil film of polyethylene terephthlate (obtained from E. I. du Pont de Nemours & Co. under the trade name Mylar) was attached to a platen and placed in a bell jar. The air was then evacuated from the system and a layer of selenium about 20 microns thick evaporated onto the Mylar. The vacuum was then broken and a crucible containing aluminum substituted for the crucible from which the selenium had been evaporated. A layer of aluminum a few microns thick was then deposited on the selenium. The plate so prepared was then tested in the xerographic process utilizing a commercial charging and exposure apparatus obtained from Haloid Xerox Inc., Rochester, New York, under the trade name Xerox Copier Model D. The resulting electrostatic image formed on the selenium was made visible by cascading over the Mylar surface a mixture of toner and carrier as described in U.S. 2,618,552. The development apparatus used therefor was the commercial developing tray forming a part of the Model D. A succession of images were developed in this manner, the previous image being cleaned by rubbing with a linen cloth, with absorbent cotton, with paper tissue and by wiping with the hand. All of the cleaning processes were completely operable for removing the previous toner image. The toner image could also be easily transferred to a suitable support material such as metal, paper or plastic.

Example 2

A xerographic plate was prepared by applying to a film of quarter mil Mylar a coating mixture comprising 2.5 parts, by weight, of zinc oxide to 1 part of a silicone resin obtained from The General Elcetric Company under the trade name SR–82, the resin-pigment mixture being dispersed in toluene. The resulting binder film was about 35 microns thick. The free surface of the photoconductive layer was then swabbed with a graphite dag obtained from Acheson Colloids Inc., Port Huron, Michigan. The resulting xerographic plate was then utilized in the xerographic process and cleaned as described in Example 1. Again easy cleanability and high resistance to scratching was obtained.

Heretofore, the backing member of the xerographic plate, that is the electrically conductive or semiconductive layer, has been utilized as the support member for the xerographic plate. One reason for this is that to prevent excessive loss in image resolution, overcoating layers are generally no more than about 2 microns thick. In the instant invention it has been found, however, that with plates prepared as described herein the overcoating layer may be from about 6 to 12 microns thick without undue loss of image resolution. It is believed that the reason for the improved properties of the plates prepared herein is that on application of the resin solution having the pigment particles dispersed therein unto the overcoating layer, the pigment particles are naturally oriented relative to the film. Further, gravity aids in settling the pigment particles while the resin solution dries. Primarily, however, it is believed that the "polar"

forces between the pigment particles and the interface with the pellicle attract the pigment preferentially toward the pellicle. As a result, the distribution of pigment in the resin in the instant invention is the reverse of that obtained in the normal process for manufacturing xerographic binder plates. In particular, such a plate is characterized by a relatively high and very uniform concentration of pigment particles distributed along the light sensitive surface. As a result of the uniformity and high concentration, enhanced resolution is obtainable.

Further, by eliminating geometrical irregularities, previously characteristic of xerographic binder plates, the localized fringing electrostatic fields formed in background areas by such irregularities are eliminated thereby reducing background deposition of toner particles during image development. In addition, plates prepared according to the instant invention are not only easily cleaned and, hence, highly reusable, but are also flexible permitting high adaptability to a variety of machine applications. Again, the highly insulating external surface permits transfer of toner images to electrically conductive support members without danger of arcing through the photoconductive surface.

With regard to selenium plates prepared in this manner, the resulting plates are highly flexible despite the vitreous (i.e., glass-like) nature of the selenium permitting the use of selenium plates in machine configurations requiring such plates.

While the present invention has been described herein as carried out in specific embodiments thereof, there is no desire to be limited thereby, but it is intended to cover the invention broadly within the spirit and scope of the appended claims. As one such variation, it has been found that xerographic toner images may be transferred from a sheet of polyetetrafluoroethylene (obtained from E. I. du Pont de Nemours & Co. under the trade name "Teflon") to almost any surface with very high efficiency. Since the Teflon has very high resistance to elevated temperatures, the Teflon can be heated above the melting point of the toner and pressed against a sheet of paper whereupon the softened of liquefied toner is completely transferred to the paper. This transfer technique will also work with the other overcoating surfaces formed in the instant invention. This process is particularly useful when the overcoating pellicle is applied to a binder plate as temperatures in the range sufficient to melt the toner image, rather than harming a binder material, appear to have the beneficial effect of eliminating fatigue. Such a process makes it possible to effect complete image transfer and image fixing simultaneously. Thus, plate cleaning is unnecessary in such a process. Because of the chemical resistance of the pellicles used in the instant process, it is also possible to soften the toner image by vapor or other chemical means instead of by heat and, accordingly, to use the process with photoconductive layers such as selenium which are sensitive to heat.

I claim:

1. A process of xerography for forming electrostatic images on a flexible xerographic member comprising applying a photoconductive insulating material to a pellicle of solvent resistant, highly polymerized electrically insulating organic resin translucent to activating radiation, said pellicle being no more than about 12μ thick, and applying a thin conductive coating to the free surface of said photoconductive insulating material to form a firmly bonded, unitary structure consisting of said pellicle, said photoconductive insulating material and said conductive coating, applying a ground to the side of photoconductive layer not in contact with said pellicle while placing sensitizing electrostatic charges on said pellicle, and exposing said photoconductive layer to activating radiation through said pellicle to thereby form an electrostatic image on said unitary structure.

2. A process according to claim 1 wherein said photoconductive insulating layer is vitreous selenium.

3. A process according to claim 1 wherein said photoconductive insulating layer comprises an insulating organic resin binder having dispersed therein finely divided particles of a photoconductive insulating pigment.

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