XEROGRAPHIC SYSTEM

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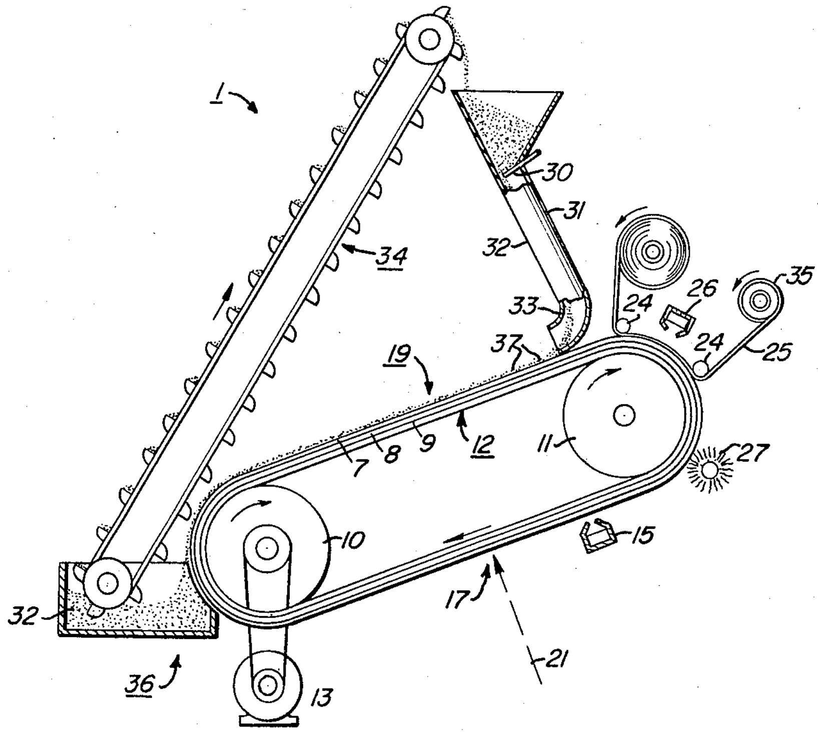

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XEROGRAPHIC SYSTEM

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ABSTRACT OF THE DISCLOSURE

An electrically conductive yet electronic charge carrier blocking interface comprising graphite between a support base and photoconductive insulating material of a xerographic plate, and a process of making and using the plate.

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation of application Ser. No. 669,477, filed Sept. 21, 1967, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to xerography and in particular to novel xerographic plates, their fabrication and their use in xerography.

In the process of xerography, for example, as disclosed in Carlson Pat. 2,297,691: a xerographic plate comprising a layer of photoconductive insulating material on an electrically conductive backing is given a uniform electric charge over its surface and is then exposed to a light and shadow image pattern of the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the radiation intensity that reaches them and thereby creates an electrostatic latent image on or in the photoconductive layer corresponding to the light and shadow image pattern. Development of the latent image is effected with an electrostatically charged, finely divided material, such as an electroscopic powder, that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. The developed, xerographic marking material image may be fixed or made permanent on the xerographic plate itself. Alternatively, if it is desired, to apply the developed xerographic powder image to paper, metal foil, plastic film or other transfer material, the developed image may be transferred from the xerographic plate to such a support surface to which it may be affixed by any suitable means. Fixing of the developed image onto the xerographic plate itself becomes attractive for relatively inexpensive plates such as those comprising photoconductive material impregnated into paper. Illustratively, paper may be impregnated, by melting or from solution, with organic or inorganic photoconductive materials, such as anthracene or sulfur. It is also well-known, in the art, that materials such as zinc oxide in a binder may also be used as a photoconductive layer on paper. See Young, C. J., and Greig, H. G., RCA Review, 15, No. 4, 471 (1954) and Thomsen Pats. 2,727,807 and 2,727,808. Said Carlson patent also relates that a paper backed xerographic plate may be layered with conductive material such as bronze or carbon powder held in a binder, the photoconductive insulating material then being applied to the conductive surface.

However, as is known by those skilled in the art, it is generally found to be preferred to interpose a thin, in the region of from about 25 angstorm units to 2 microns thick, layer of insulating material between the conductive backing and the photoconductive insulating layer in xerographic plate construction in order to increase the

ability of the plate to hold a charge in the dark without adversely affecting the plate's ability to rapidly dissipate charge in light struck areas. In the art such layers are called "barrier" layers because they serve as a barrier between the charged photoconductor and the electrically conductive substrate to prevent or retard the dissipation of charge in the dark and thereby prevent the loss of charge from the plate at least during the period between the time of charging of the plate and exposure to an image to be copied and between the time of forming the latent electrostatic image and image development. The effect of such thin electrically insulating interfaces in xerographic plates is more fully described in Dessauer et al. Pat. 2,901,348.

Dielectric barrier layers are not entirely satisfactory since they must be kept extremely thin to minimize the build up of a residual potential in the barrier layer which, in recycled reusable xerographic plates, undesirably, raises the background development level and lowers contrast and resolution of resultant xerographic prints.

Also, commercially used interfaces often take the form of a thin layer of the oxide of the metal substrate of the xerographic plate, for example, aluminum. These oxide, insulating interfaces are often found to be fragile and subject to local defects, due to thin spots, cracks, discontinuities, or chemical impurities which give rise to "powder deficient spots" and other print imperfections. This tendency to degrade is, of course, aggravated by prolonged cycling conditions which modern way xerographic copiers are being increasingly subjected to. The requirement of avoiding these localized failures makes it difficult to use such well known blocking layers as aluminum oxide over aluminum sheet, because of their fragility under belt flexing conditions. This is unfortunate because belts made of metals such as brass and aluminum, otherwise possess the desired mechanical properties required in flexible xerographic belt operation.

In addition, such thin insulating barrier layers are found to be unsatisfactory over such highly injecting substrates such as brass and similar alloys which mechanically and otherwise are highly desirable substrates especially for continuous flexible web xerographic members, because of the significant decrease in charge acceptance of the member as in prolonged cycling found when these substrates are used with such important photoconductors as those comprising amorphous selenium or phthalocyanine enamels further as described in copending application Ser. No. 375,191, filed June 15, 1964, now abandoned.

Also, since the previously known dielectric barrier layers used on brass had to be extremely thin in order to minimize residual potential, they could not serve as effective chemical barrier layers between selenium and the brass substrate and specialized barriers such as chromate interfaces, for example, see copending application Ser. No. 341,774, filed Jan. 31, 1964, now U.S. Pat. 3,352,669, had to be resorted to to prevent the gradual contamination of the amorphous selenium by the substrate. This contamination was found to substantially degrade the electrical properties of the plate if the plate was aged a few months. Especially drastic was the decrease in charge acceptance brought about by this contamination.

Generally, in xerographic plate fabrication, preferred photoconductive insulating materials, for example, those comprising amorphous selenium, have been deposited upon rigid backing materials such as flat plates or rigid cylindrical drums and it is found that using ordinary cleaning procedures for the substrate, the physical bond existing between the supporting base or substrate and the deposited photoconductor is sufficient to ensure an adequate commercial life for the xerographic plate.

However, in order to increase the speed of commercial xerographic copiers, interest has recently been shown in going from the rigidly backed plate to a xerographic plate wherein the backing takes the form of a flexible belt, for example, similar to the one shown in Clark et al. Pat. 3,146,688. Such a plate configuration and variations thereof offer an increased reproduction surface thereby permitting an increased rate of reproduction of copies from an original.

However, the use of such a flexible belt system has a number of attendant problems. A major problem is one of obtaining sufficient adhesion of photoconductor to the belt base since it is found that the continuous flexing of the photoconductive layer as it is passed around, for example entraining pulleys or rollers, often leads to cracks and separation of the photoconductor from the base. In addition, such relatively frangible but preferred photoconductors such as amorphous selenium optionally doped with various additives or mixed with various other materials such as arsenic and tellurium suffer even more from cracking and spalling or flaking problems due to flexing and other strains including those produced by differences in thermal expansion between the backing or substrate and the photoconductive layer. A xerographic plate in a commercial machine may be subjected to a substantial temperature difference between cool periods when out of use and unavoidable heating due, for example, to the proximity of a thermal fuser to fuse the transferred toner image.

There is also the problem of the mechanical and electrical discontinuity at the connecting seam of a supporting flexible belt substrate. Continuity is necessary to provide for uniform quality prints even across the seam. Belt bases may be connected at the seam, for example, by welding, soldering, glueing or other connecting means. The seam produced by present belt fabrication methods seriously complicates machine design since the seam portion is often left uncoated or unevenly coated with photoconductor, using present coating methods, and hence these areas will not print or if coated the electrical and xerographic properties, particularly insofar as dark charge injection is concerned, are effected by the solder or adhesive used to join the ends of the support together to form a belt. Also, the seam is thicker than the belt thickness and thus close processing tolerances required for optimum charging, electrode development and so on, must be relaxed.

These problems have been approached in copending application Ser. So. 579,826, filed Sept. 16, 1966, now abandoned, wherein a resinous interfacial layer of about 0.1 to about 5 microns thick is deposited on an electrically conductive substrate and the photoconductive material deposited thereover. Satisfactory bonding and electrical characteristics have been obtained using this approach but a characteristic of this teaching is that the interfacial layer, because it generally has an electrical resistivity of between about 10^8–10^{15} ohm-centimeters, dictated by the resistivities of the resins used, must be deposited on an electrically conductive substrate in order to ensure the rapid dissipation of charge from light struck areas of the plate. This means that a belt like support layer which is not electrically conductive must first be layered with an electrically conductive layer which can be a costly and difficult to control process. Such a process also generally leaves the seam in the underlying belt substrate as a discontinuity even after deposition of the electrically conductive layer. In addition, this interfacial layer is electrically insulating and may suffer from the inherent disadvantages of such insulating layers, as pointed out herein.

Also, in copending application Ser. No. 578,502, filed Sept. 12, 1966, now abandoned, it is suggested that an interfacial adhesive coating of about 0.5 to about 5 microns of a photoconductive phthalocyanine pigment in an insulating resin binder be coated on the electrically conductive substrate and this interfacial binder then be overcoated with the photoconductor amorphous selenium. In this approach also the substrate must be electrically conductive. Also, an interface of a particular photoconductive insulating material with a particular photoconductor overlayer are specified. Also, in both of the mentioned copending applications, the maximum thickness of the interfacial layer is quite thin necessitating carefully controlled layering techniques.

Also, unless the interfacial layer also serves as an effective barrier layer, then the fabrication of a flexible belt type xerographic plate is further complicated by the requirement of depositing such a barrier layer over the interfacial layer during plate fabrication.

Thus, it is seen there is a continuing need for an inexpensive, simple and workable system to provide for a xerographic plate and especially a flexible belt type xerographic plate with acceptable mechanical and electrical characteristics.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide a xerographic plate and a method of fabricating and using same which overcomes the above-noted disadvantages and satisfies the above-noted wants.

It is a further object of this invention to provide a layer backing the photoconductor in a xerographic plate which serves both as an electrically conductive layer and, surprisingly, additionally serves as an excellent barrier layer over electronic charge carrier injecting metals.

It is a further object of this invention to provide an interfacial coating permitting photoconductive insulating materials to tenaciously adhere to a support base especially during bending and flexing of the base irrespective of whether the base is electrically conducting or insulating.

It is a further object of this invention to provide a barrier layer which is not subject to oxidation and chemical change during storage and operation.

It is a further object of this invention to provide a xerographic plate with excellent adhesion of the photoconductor to a wide variety of support bases.

It is a still further object of this invention to provide a xerographic plate fabricating method that permits fabricating flexible belt type photoconductors on pre-formed belt bases fabricated in a conventional manner.

It is a still further object of this invention to provide a flexible belt xerographic plate fabricating method which eliminates electrical and mechanical discontinuities at the support base seam.

It is a still further object of this invention to provide an interface between a photoconductor and a base which is thought to permit minute slipping of photoconductor relative to the base to prevent cracking and spalling of the photoconductor.

It is a still further object of this invention to provide an interface between a photoconductor and a base, the interface comprising a material conventionally known as a lubricant but which, as used herein actually improves the adhesion of the photoconductor especially during bending and flexing of the base.

The foregoing objects and others are accomplished in accordance with this invention by providing an interface comprising predominantly (at least 50% by weight) the material known as a lubricant, namely graphite between a support base and an overcoated photoconductor of a xerographic plate to unexpectedly improve the adhesion of the photoconductor to the base while simultaneously providing a layer which is both electrically conductive and unexpectedly electronic charge carrier blocking.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the invention as well as other objects and further features thereof, reference is made to the following detailed disclosure of this invention taken in conjunction with the accompanying drawing showing a schematic, partially sectional view of an embodiment of an automatic xerographic copying apparatus employing a xerographic plate according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The inventive xerographic plates of the present invention are preferably prepared by applying the graphite to a pre-formed xerographic plate base and applying thereover a layer of photoconductive insulating material, in a manner to be described, to optimize the adhesive and the other mechanical properties of the inventive interlayer and to optimize as well the electrical properties including the electrically conductive yet effective barrier layer characteristics of the interface. It was by no means expected or obvious that a graphite interlayer should act as its own effective blocking layer, requiring no added dielectric layer to prevent substantial dark injection of carriers from the electrode into the photoconductive insulator. Since, once it is coated with graphite, the support may be selected without concern for its electrical properties, the latter may be either a conductor, such as a brass belt, or a plastic dielectric, such as Mylar.

While this invention is particularly applicable and advantageous in fabricating flexible belt type xerographic plates it should be noted that the invention is entirely applicable to rigid substrates even though the problem of constant flexing is not present and the adhesive advantages of the invention may not be completely appreciated.

Referring now to the figure, there is shown automatic xerographic copying apparatus **1**. The apparatus is seen to include a pair of rollers **10** and **11** about which is supported a xerographic plate **12** in the form of an endless flexible belt comprising, according to the invention, basically three layers, an overlying layer of photoconductive insulating material **7**, a graphite interfacial layer according to the invention **8** and flexible belt support layer **9**. Layer thicknesses are exaggerated for purposes of illustration.

Because of the invention herein, belt base **9** need not be electrically conductive as was required in the prior art. Especially preferred electrically conductive substrates because of the excellent adhesion of the graphite to the base are brass, steel and aluminum, for example, cold rolled and from about 2 to 10 mils thick. Any suitable electrically conductive belt base may be used. However, any suitable electrically conductive or insulating support material may be used. Typical electrically conductive supports include plastic webs such as aluminized polyethylene terephthlate polyester film, the polyester film available under the trademark Mylar from Du Pont and other metals. Especially preferred electrically insulating substrates because of the excellent adhesion of the graphite to the base are acrylics especially if the plastic is vapor tackified prior to application of the graphite, paper including ordinary bond and cardboard, polycarbonate, cellulose acetate, polypropylene, rubber and polyvinyl chloride foam. Typical electrically insulating supports include paper, plastics, rubbers, film formable polymeric materials other than Mylar, for example, see a partial list in copending application Ser. No. 598,279, filed Dec. 1, 1966, now U.S. Pat. 3,519,124, woven or non-woven fibrous cloth belts, for example of glass, cotton, flax, silk or like fibers or fibrous resin belts, for example of acrylonitrile, polyester, nylon, rayon, acetate and tri-acetate, ethylene, propylene or other olefins, polycarbonate or like fibers which belts may optionally be impregnated with a flexible resin or polymeric type material.

The inventive interlayer **8** may comprise solely particulate graphite for example when applied to base **9** in a fugitive carrier or may comprise particulate graphite in a suitable non-fugitive carrier, so that the layer desirably has an electrical resistivity less than about 10^{10} ohm-centimeters and preferably less than about 10^5 ohm-centimeters in order to dissipate charge from the photoconductor in illuminated areas.

Carrier liquids may be used to provide for layer **8**. Any suitable carrier liquid capable of having graphite in finely powdered, flaked or other particulate form dispersed therein for example in a dispersion and which are capable of being coated or layered on a pre-formed belt base to form an adhesive coating for an overcoating of a photoconductor as described may be used.

Graphite may be incorporated in the liquid carrier by any suitable means such as strong shear agitation preferably with simultaneous grinding. These methods also include ball milling, roll milling, sand milling, ultrasonic agitation, high speed blending, and any desirable combination of these methods.

Almost any typical fugitive carrier liquid may be used, depending on plate fabricating parameters, including isopropanol, ethyl alcohol, trichloroethylene, naphtha, other volatile organic liquids, water and so on. Mixtures of from about 10% to about 20% by weight graphite have been found to be generally suitable for coating.

Non-fugitive carrier liquids found to be useful herein include mineral oil, petroleum oil, castor oil, polyglycols and mixtures thereof. On a graphite/liquid carrier dry weight basis the useful range of pigmentation extends from about 50% to about 80%.

The interfacial layer of this invention may have any suitable thickness but in order to achieve the dual properties preferred of electrical conductivity yet electronic charge carrier blocking to prevent excessive dark, decay when conductive support bases are used, the interfacial layer should preferably have a thickness substantially uniform over the effective surface of the xerographic plate to assure uniform xerographic characteristics, desirably of from about 1 to about 20 microns with a preferred range being from about 1 to about 5 microns.

The graphite-liquid carrier slurry may be applied to the belt base by any of the well known painting or coating methods including spraying, flow coating, knife coating, electrostatic coating, dip coating, reverse roll coating and so on. After or during the drying of this interfacial layer the photoconductor may be applied thereover by any suitable method such as vacuum evaporation for amorphous selenium or any of the above coating methods for the resin based phthalocyanine binder system.

In addition, methods of depositing a thin layer of graphite other than using a carrier liquid may be used such as doctor blading or draw down bar coating particulate graphite itself onto a belt base optionally rendered tacky to adhesively receive the particles.

Layer **7** may comprise any suitable photoconductive insulating material. Amorphous selenium alone or alloyed with arsenic, tellurium, antimony, bismuth, etc., or amorphous selenium or its alloys doped with halogens, for example, is found to be a preferred photoconductive insulating material for use herein because of a surprisingly and completely unexpected increased adherence to substrates when deposited on the graphite interfaces of this invention. Amorphous selenium is, of course, also preferred because of its excellent photoconductive insulating properties including its extremely high quality image making capability, low fatigue, high light response and capability to receive and retain charge areas at different potentials and of different polarities. Phthalocyanine pigmented organic binder photoconductors, for example, as described in copending application Ser. No. 375,191, filed June 13, 1964, are also preferred for use herein, generally, for the same reasons. An especially preferred phthalocyanine pigment is *x*-form metal-free as described in copending application Ser. No. 505,723, filed Oct. 29, 1965, now U.S. Pat. 3,357,989.

Generally, the thickness of the photoconductor will depend upon the particular photoconductor and on the desired xerographic properties of the resultant plate. However, for thicker amorphous selenium photoconductor layers, for example, much greater than 40 microns used in flexible plate, i.e., belt configurations it is found that the beam like flexing forces induced in the photoconductive layer itself, as a result of extreme bending, tend to fracture the photoconductor regardless of the type of substrate or interface used. But it is found that in a flexible plate configuration amorphous selenium layers up to about 35 microns in thickness deposited onto the interfacial layer of this invention show superb adhesion. For rigid backed plate configurations the thickness of the amorphous selenium will primarily depend on the desired xerographic properties of the resultant plate with a preferred thickness range of from about 20 to about 80 microns. The thickness of the phthalocyanine binder photoconductor for rigid and flexible plates is desirably between about one to about 100 microns and preferably in about the five 30 micron range.

However any suitable photoconductive insulating material may be used in carrying out the invention. Typical photoconductors include: alloys of sulfur with selenium, selenium doped with materials such as thallium, cadmium sulfide, cadmium selenide, etc., particulate photoconductive materials such as zinc sulfide, zinc cadmium sulfide, French process zinc oxide, phthalocyanine, cadmium sulfide, cadmium selenide, zinc silicate, cadmium sulfoselenide, linear quinacridones, etc. dispersed in an insulating inorganic film forming binder such as a glass or an insulating organic film forming binder such as an epoxy resin, a silicone resin, an alkyd resin, a styrene-butadiene resin, a wax or the like. Other typical photoconductive insulating materials include: blends, copolymers, terpolymers, etc. of photoconductors and non-photoconductive materials which are either copolymerizable or miscible together to form solid solutions and organic photoconductive materials of this type include: anthracene, polyvinyl-anthracene, anthraquinone, oxidiazole derivatives such as 2,5 - bis - (p-aminophenyl-1), 1,3,4-oxidiazole; 2-phenylbenzoxazole; and charge transfer complexes made by complexing resins such as polyvinylcarbazole, phenolaldehydes, epoxies, phenoxies, polycarbonates, etc., with Lewis acid such as phthalic anhydride; 2,4,7-trinitrofluorenone; metallic chlorides such as aluminum, zinc or ferric chlorides; 4,4-bis(dimethylamino) benzophenone; chloranil; picric acid; 1,3,5-trinitrobenzene; 1-chloroanthraquinone; bromal; 4-nitro-benzaldehyde; 4-nitrophenol; acetic anhydride; maleic anhydride; boron trichloride; maleic acid, cinnamic acid; benzoic acid; tartaric acid; malonic acid and mixtures thereof.

Referring now to the figure, in operation, xerographic plate **12** in the form of a flexible endless belt is advanced in a clockwise direction by drive roller **10** powered by motor **13** around guide and tension roller **11**, the belt advanced sequentially past corona charging device **15**, exposure station **17**, developing station **19** to be transferred to support surface **25** in the region of corona discharge device **26**, and finally past rotating brush **27** to clean and ready the surface of the xerographic plate for a new cycle of operation.

The corona discharge device **15** is a preferred mechanism for sensitizing the xerographic plate before exposure which sensitization consists of imparting a uniform charge to the surface of the photoconductor. Two examples of corona discharge devices are disclosed in Vyverberg Pat. 2,836,725 and Walkup Pat. 2,777,957. The plate **12** is preferably charged when it is at its highest insulating value, i.e., in the absence of actinic radiation or in the dark. After charging, the plate advances to exposure station **17** where light rays **21** from an original, preferably synchronized to the movement of the xerographic plate by conventional apparatus not shown, selectively discharges the xerographic plate in accordance with the intensity of the actinic radiation reaching the plate, thereby leaving on the plate as it advances towards roller **10** a latent electrostatic image corresponding to the image of the original.

Other methods of forming a latent image are available in the art and include latent image transfer techniques for example see Carlson Pats. 2,982,647 and 2,825,814 and by the use of shaped electrodes or pin matrices, for example see Schwertz Pats. 3,023,731 and 2,919,967 and by electron beam techniques, for example see Glenn Pat. 3,113,179.

The latent electrostatic images may be rendered visible by any suitable developing means known to those skilled in the art and illustratively by the form of cascade development as illustrated which generally consists of gravitationally flowing developer material **33** consisting of a two component material of the type disclosed for example in Walkup et al. Pat. 2,638,416 over the xerographic plate bearing the latent image. The two components consist of an electroscopic powder termed toner and a granular material called carrier and which by mixing acquire triboelectric charges of opposite polarities. In development the toner component usually oppositely charged to the latent image is deposited on the latent electrostatic image to render that image visible. In operation developer material **33** is carried by a conveyor **34** to chute **32** with gate **30** to regulate the flow of developer down the chute to cascade in contact with the latent electrostatic image. The developer after passing over the latent electrostatic image passes into developer reservoir **36** where it may be used over again with allowance made to replenish the amount of toner left behind on the xerographic plate.

The loosely adhering xerographic powder image **37** formed on the surface of plate **12** during development is then advanced contiguous to transfer web **25** where the loose powder image is transferred to the web and affixed thereto by any suitable means such as solvent vapor or heat fusing. The permanitized image is then rolled onto takeup roll **35** where it is stored until ready for use.

By using interface **8**, the resistance of the plate to cracking and spalling of the photoconductor caused by flexing and other strains is found to be greatly enhanced. Although the theory of operation explaining why layer **8** provides for this improved result is not completely understood, it is thought that the thin graphite interface acts as an excellent and outstanding tie coat because slippage in the graphite interlayer permits the selenium or other photoconductive insulating material to be bent without excessive strain on the interface. It is thought that the effect is almost surely due to the graphite pigment, and not the relatively trivial proportion or binder which may be found in some of the preferred embodiments of the inventive interlayers hereof.

The following examples further specifically define the inventive interfacial layer and the novel xerographic plate one embodiment of which is shown in the figure as plate **12**. The parts and percentages are by weight unless otherwise indicated. The examples below are intended to illustrate various preferred embodiments of the inventive interfacial layer and xerographic plate and process of making and using same of this invention. In each example a qualitative tape test is performed by applying pressure sensitive adhesive tape such as Scotch brand pressure sensitive Magic transparent tape No. 810 to the bonded photoconductor surface for testing the adherence of the photoconductive insulator to the underlying belt. The strip of tape is snapped off the photoconductor by a quick movement of the hand to give a quick but rather severe test of adhesion, since insufficiently bonded material will be pulled off either in part or in total. Also, in each example a qualitative flex test is performed by bending the specimen once over a 1 inch diameter steel bar and carefully observing for any spalling of or microcracks in the photoconductor surface.

Xerographic prints are made using the sample specimens in the example by taping the test specimens on a rigid xerographic drum and performing the sequential xerographic operations generally described herein.

Except where otherwise provided, the test specimen is xerographically processed with positive charging, the exposure being from a tungsten filament lamp operating at a filament temperature of about 2950° K., at an exposure level at the photoconductor surface in illuminated areas of about 3.2 f.c.s. to form a latent electrostatic image which is then cascade developed. The clean, sharp image thus produced is transferred to a receiving sheet and fused to produce a high quality xerographic image.

Each test specimen holds up under the tape and flex tests better than a control plate constructed according to the example but absent the inventive graphite interlayer. Also the control plate exhibits inferior xerographic properties, especially lacking the ability to effectively dissipate charge in illuminated areas in Examples I and III where electrically insulating substrates are used.

Example I

About a 3 mil thick Mylar film is dip coated into a colloidal graphite dispersion in mineral spirits with a solid content of about 10 percent available under the designation "dag" Dispersion No. 2404 from the Acheson Colloids Co. The Mylar film is removed and dried for about 1 hour at about 100° C. to form about a 5 micron layer on top of the Mylar. The surface resistivity of the coated film is measured laterally to be about $4\frac{1}{2}\times10^5$ ohms/sq.

An epoxy-phenolic electrically insulating organic binder resin is then prepared by mixing together about 35½ parts of a solid synthetic epoxy resin possessing terminal epoxide groups available under the trademark Epon 1007 from Shell Chemical Corp., about 20 parts of a phenolic baking type coating intermediate containing about 75 percent non-volatile matter and available under the trademark Methylon 75201 from the General Electric Co., about 4½ parts of a urea-melamine formaldehyde resin in an organic solvent available under the trademark Uformite F-240 from the Rohm & Haas Co. containing about 60 percent non-volatile matter, about 40 parts of the organic solvent ethylene glycol monoethyl ether available under the trademark Cellosolve from the Union Carbide Corp. to form a mixture of about 53 percent non-volatile solids.

About 11½ parts of the epoxy-phenolic mixture of about 53 percent non-volatile solids, about 1 part of X-form metal-free phthalocyanine prepared as described in copending application Ser. No. 505,723, filed Oct. 29, 1965 and about 10 parts of ethylene glycol monoethyl ether available under the trademark Cellosolve from the Union Carbide Corp. are put together and ball milled in about a 4 fluid ounce glass jar containing about 70 parts of ⅛ inch steel shot and milled for about 1 hour. The resulting dispersion is then coated over the interfacial layer on the Mylar film and dried to a thickness of about 20 microns.

Example II

A colloidal graphite conductive pigmented dispersion containing about 20 percent solids in an organic fugitive carrier of isopropanol available under the designation "dag" Dispersion No. 154 from Acheson Colloids Corp. is coated onto about an 8 mil thick flexible brass foil substrate and allowed to dry in air to form a layer of graphite about 1 to 2 microns thick.

About a 20 micron layer of amorphous selenium is then vacuum evaporated over the thin layer of graphite as more fully described in Bixby Pat. 2,970,906.

The plate holds a 20 volt/micron positive charge indicating the fine blocking characteristics of the graphite layer and shows a typical selenium photoresponse during xerographic processing. This plate exhibits outstanding adhesion and flexing properties. This plate shows such exceptional adhesion to the substrate that even when flexed around a pipe of ¾ inch diameter, no microcracks are observed.

Example III

Example II is followed except that about an 8 mil polycarbonate film substrate is used in place of the flexible brass foil substrate.

This plate also exhibits excellent adhesion, flexing and xerographic properties.

Example IV

Example II is followed except that about a 45 micron layer of amorphous selenium is vacuum evaporated over the graphite.

A control plate absent the graphite interlayer is prepared and both plates are xerographically cycled on a drum reveloving at about 13.3 r.p.m. Exposures are at about 30 f.c.s. from a white fluorescent lamp. Both plates are charged positively to an initial value of about 800 volts. Both plates are sequentially charged and discharged for 150 cycles and then percentage dark discharge of both plates is measured 30 seconds after charging and no exposure. The control plate has a fatigued dark discharge 30 seconds after charging, after 150 rapid cycles of charge and discharge of about 8 percent and the inventive plate, although not as low as the control, compares favorably with a dark discharge of about 15 percent which is certainly not excessive. However, a tremendous advantage in lower residual build up is found for inventive plate. The control plate after about 60 cycles, built up and maintained for further cycles a residual potential of about 120 volts while the inventive plate more slowly built up and maintained for further cycles a residual potential of about only 30 volts. This marked advantage of lower residual potential for the inventive plate manifested itself in lower background, higher contrast copies than those produced on the control plate.

Selenium adhesion to the graphite interlayer of the above plate is excellent, i.e., no selenium is removed by the tape. The plate is successfully flexed around a three inch diameter roll without any evidence of cracking or spalling in the selenium layer. The inventive plate exhibits a photosensitivity comparable to the control plate.

The adhesion of selenium coated directly on brass is poor, particularly under flexing conditions. Considerable cracking and spalling occurs when the control selenium plate is flexed around a three inch diameter roll.

Thus, the graphite interlayer of this invention confers unexpectedly excellent adhesion, flexing, and physical blocking conditions to the selenium-brass interface with a dramatically lower residual potential.

Example V

Example II is followed except that about a 5 mil flexible aluminum substrate is used.

Although specific components and proportions have been stated in the above description of preferred embodiments of the interfacial layer as used in the fabrication of a xerographic plate and its use, there are, as disclosed herein, other suitable materials which may be used with similar results. In addition, other materials may be added to the mixture or variations made in the various fabrication and processing steps to synergize, enhance or otherwise modify the properties of the resultant xerographic plate. For example various plasticizers and moisture and other "proofing" agents may be added to the various polymeric substrates mentioned herein.

It will be understood that various other changes in the details, materials, steps and arrangements of parts which have been herein described and illustrated in order to explain the nature of the invention will occur to and may be made by those skilled in the art upon a reading of this disclosure and such changes are intended to be included within the principle and scope of this invention.

What is claimed is:

1. A flexible photoconductive member resistant to spalling, cracking, and micro-cracking upon curvature in a substantially circular configuration having a diameter of at least ¾ inches, comprising:

(a) a flexible electrically conductive metallic support base;

(b) an interface comprising predominantly graphite overlying said support base; and

(c) an amorphous photoconductive insulating layer comprising amorphous selenium overlying said interface opposite said support base.

2. A photoconductive member according to claim 1 wherein said interface is between 1 and 20 microns thick.

3. A photoconductive member according to claim 2 wherein said interface is between about 1 and about 5 microns thick.

4. A photoconductive member according to claim 2 wherein the electrical resistivity of said interface is less than about 10^5 ohm-centimeters.

5. A photoconductive member according to claim 1 wherein said interface consists essentially of free graphite.

6. A photoconductive member according to claim 1 wherein said interface comprises, by weight, from about 50% to about 80% graphite.

7. An electrophotographic process wherein the photoconductive member of claim 1 is provided with a latent electrostatic image and developed with electrically attractable marking particles.

8. An electrophotographic process according to claim 7 wherein the latent electrostatic image is provided by electrically charging said member and then exposing the charged member to a light image pattern to be reproduced.

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