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[54] **PRESSURE SENSITIVE ELECTROPHOTOGRAPHIC REPRODUCTION SHEETS**

[75] Inventor: **Ghazi Zaki Ibrahim,** North Reading, Mass.

[73] Assignee: **Dennison Manufacturing Company,** Farmingham, Mass.

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[58] **Field of Search** 96/1.5, 1.8; 117/215, 218, 117/201; 162/138

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Primary Examiner—David Klein
Assistant Examiner—John R. Miller
Attorney, Agent, or Firm—Dike, Bronstein, Roberts, Cushman & Pfund

[57] **ABSTRACT**

An electrophotographic reproduction sheet or label having adhered to the surface of the backing sheet thereof opposite from the electrophotographic layer, a layer of electrically conductive pressure sensitive adhesive for adhesively sticking the label to a receiving surface, in which improved print quality and pressure sensitive adhesiveness are achieved by the presence in the adhesive of nitrocellulose or other nitrated hydroxy polymer; the pressure sensitive adhesive resin is an acrylic polymer.

The protective release sheet or liner for the pressure sensitive adhesive may be rendered conductive by the inclusion of electrically conductive material therein.

11 Claims, No Drawings

PRESSURE SENSITIVE ELECTROPHOTOGRAPHIC REPRODUCTION SHEETS

BACKGROUND OF INVENTION

Conventional electrophotographic reproduction sheets comprise an electrophotographic layer, made up of photoconductive particles, usually zinc oxide, embedded in an insulating resin (usually a dye sensitizer is also included), applied to an electrically conductive backing sheet, which is usually an electrically conductive paper, made electrically conductive by coating or impregnating with an electrically conductive material. In most cases, a thin hold-out coating, such as starch or casein together with an adhesive promoting resin, is applied to the backing sheet before application of the electrophotographic layer or coating.

It has been proposed to provide pressure sensitive electrophotographic labels by applying a layer of pressure sensitive adhesive to the side of the backing sheet opposite the electrophotographic layer with a peelable protective release sheet or liner releasably applied over the pressure sensitive adhesive layer to protect it. The surface of the liner in contact with the pressure sensitive adhesive is made of a material having low adhesion to such adhesive so that the liner can be easily peeled off the pressure sensitive adhesive. By peeling the liner off the electrophotographic sheet (the adhesive bond between the pressure sensitive adhesive layer and the backing sheet is strong compared to that between the adhesive layer and the liner and is substantially permanent), it, the electrophotographic sheet (the electrophotographic layer-backing sheet — pressure sensitive adhesive layer laminate), can be adhesively stuck to a receiving surface in the manner of conventional pressure sensitive adhesive labels.

Accordingly, these sheets are useful as pressure sensitive labels which can be printed electrophotographically in conventional electrophotographic machines. Thus, a pressure sensitive label is provided, the printing surface of which is supplied with an electrophotographic layer for electrophotographic printing, thereby providing a fast, inexpensive and novel method of printing pressure sensitive labels.

However, a serious problem in achieving satisfactory electrophotographic reproduction with such a composite sheet was that in conventional electrophotography it is necessary for the substrate supporting the electrophotographic layer to be sufficiently conductive throughout its thickness (through conductivity) for the charge to leak through the thickness of the substrate at a sufficiently rapid rate during reasonable exposure times, whereas the pressure sensitive adhesive layer, which becomes a part of such substrate, is nonconductive and, in the minimum thickness required for good pressure sensitive adhesion, functions as an electrical insulating barrier or dielectric to thereby prevent the required through leakage of charge.

It has been suggested to solve this problem by either (1) incorporating a highly conductive, electrically unipotential layer or surface, preferably a flexible, thin, highly conductive continuous metal layer or foil, between the electrophotographic layer and the pressure sensitive adhesive layer and/or (2) incorporating in the non-conductive pressure sensitive layer a sufficient amount of conductive material, such as a conductive

resin or conductive particles, to render the layer adequately conductive to pass the charge therethrough at a rate, which will permit reasonable exposure times and which is commensurate with or greater than the rate achieved in conventional, ionically conductive electrophotographic papers.

With the use of a conductive pressure sensitive adhesive layer it has also been suggested that improved results can be achieved by also incorporating in the protective release sheet or liner, sufficient conductive material to increase its through conductivity also. However, since conventional release liners are quite thin, they do not ordinarily present an absolute insulating barrier to through conductivity. Accordingly, it has been suggested electrophotographic reproduction can be achieved without incorporating in the liner conductive material to make it conductive, although quality of reproduction is decreased.

The conductive materials or medium which have been suggested to be incorporated in the pressure sensitive adhesive layer to make it conductive comprise,

1. finely divided, highly electrically conductive particles, such as electrically conductive metal particles, electrically conductive carbon particles, i.e., carbon black, or particles of electrically conductive zinc oxide, electrically conductive tin oxide or other electrically conductive metal oxides, embedded in and distributed uniformly throughout the pressure sensitive adhesive layer in sufficient quantity to achieve particle-to-particle contact throughout such layer to thereby provide electrically conductive paths therethrough for leakage of the charge from the electrophotographic layer during exposure. (The finely divided conductive metal particles may be of silver (e.g., milled precipitated silver particles), gold, copper, aluminum, platinum, etc. and may be in the form of flakes, spheres, powders, etc.),
2. conductive resins, such as the polyquarternary ammonium resins, e.g., those sold under the name DOW QX resins (polyvinyl benzyl trimethyl ammonium chloride) by Dow Chemical Company, and under the name Calgon 261 by Calgonite Corporation and under the names DeSoto 104 and C112 by the DeSoto Chemical Company, mixed with the pressure sensitive adhesive, and
3. highly ionizable, water soluble salts, preferably ammonium and alkali metal salts, of the strong mineral acids, such as potassium chloride, mixed with the pressure sensitive adhesive. The conductive resins and inorganic salts provide ionic conductivity by virtue of their ionizability and, when admixed with the pressure sensitive adhesive, render it ionically conductive.

The minimum amount of electrically conductive medium added to the pressure sensitive adhesive is that which gives it sufficient through conductivity to permit leakage of charge through the thickness thereof during the exposure time desired. The maximum amount is that beyond which the cohesiveness and pressure sensitive adhesiveness of the adhesive is unduly decreased since these electrically conductive materials do not themselves have pressure sensitive adhesiveness and, accordingly, when added to the pressure sensitive adhesive, they reduce the cohesiveness and adhesiveness thereof.

The use of a conductive pressure sensitive layer is more attractive than the use of metal foil backing sheets in certain respects, e.g., because it permits the use of conventional, inexpensive conductive base paper, i.e., conventional electrophotographic sheets with an electrophotoconductive coating on conductive base paper rather than metal foil sheets.

However, rendering the pressure sensitive layers sufficiently conductive has presented certain problems, namely, the achievement of good print quality without excess background over an adequate latitude while still achieving optimum pressure sensitive adhesiveness. For example, it is difficult to add a sufficient amount of solid conductive particles to the pressure sensitive adhesive without deleteriously affecting pressure sensitive adhesiveness and print quality. Also, the use of solid conductive particles have other disadvantages as compared to the use of conductive resins and inorganic salts. On the other hand, in the case of adding conductive resins and inorganic salts to the pressure sensitive adhesive, there is the problem that these materials are hydrophillic in nature, whereas the pressure sensitive adhesives are relatively hydrophobic in nature so that their compatibility is limited. This is particularly so with respect to the inorganic salts but is also a problem to some extent with respect to the conductive resins. Also, since the conductive resins and inorganic salts are non-pressure sensitive adhesive in nature they reduce the pressure sensitive adhesiveness, i.e., they reduce the tackiness of the pressure sensitive adhesives, which not only reduces the usefulness of the resulting electrophotostatic label as a pressure sensitive label but also presents problems during the electrophotographing, e.g., because of the lowered adhesion to the conductive base paper and lowered cohesiveness of the pressure sensitive adhesive layer, the adhesive layer is apt to be removed during the toner development step, particularly where a liquid toner is used wherein the electrophotographic sheet is immersed in the liquid toner bath, which not only further deleteriously affects the pressure sensitive adhesiveness of such layer but also contaminates the toner bath. Again these problems are more acute with respect to the inorganic salts but still represent impediments in the development of a marketable pressure sensitive electrophotostatic label utilizing a conductive pressure sensitive adhesive.

In order to compensate for the reduced pressure sensitive adhesiveness of the pressure sensitive adhesive, e.g., plasticized polybutadiene-styrene, rubber, polyvinyl ether, polyvinyl alcohol, acrylic-vinyl acetate copolymers, etc., due to the conductive resin and/or inorganic salts, it has been suggested to add tackifying agents, e.g., hydrogenated wood rosin or coumarone indene resin. However, there is a limit to the amount of tackifying agent which can be added, after which the addition of more tackifying agent will decrease the pressure sensitive adhesive tack.

BRIEF DESCRIPTION OF INVENTION

It has been discovered that the aforesaid problems with respect to pressure sensitive electrophotostatic labels utilizing a conductive pressure sensitive adhesive layer can be eliminated or reduced substantially by the presence in the pressure sensitive adhesive layer of nitrocellulose, or other nitrated polyhydroxy resin, such as the polymers of glucose or dextrose or maltose or the dextrins. It appears that the nitrocellulose not only increases the through conductivity of the pressure sensitive layer without deleteriously affecting the pressure sensitive adhesiveness, i.e., it acts as a conductor, but for some reason, increases the compatibility of the conductive resins with the pressure sensitive adhesive to thereby reduce the deleterious effect of the conductive resins on the adhesiveness of the pressure sensitive adhesive. It is also believed that the nitrocellulose provides superior results because it or the nitro group in it in some way prevents or inhibits secondary capacitance which seems to be caused by the pressure sensitive adhesive and which deleteriously affects the residual charge in the background areas of the electrophotographic label.

It has also been discovered that improved print quality with good pressure sensitive adhesiveness can be achieved by selecting as the pressure sensitive adhesive component an acrylic resin, e.g., acrylate-vinyl acetate copolymers or polyacrylates cross linked with epoxy monomers or a homopolymer acrylate, e.g., methyl or ethyl methacrylate. This improvement may be due to the presence of the ester groups in the acrylic resin. In fact, it has been discovered that substantially increased conductivity can be achieved by use of the acrylic resins as the pressure sensitive adhesive (as compared to other pressure sensitive adhesive resins) without the presence of the nitrocellulose but the presence of the nitrocellulose with the acrylic ester provides vastly improved results.

Although the best results have been achieved with nitrocellulose in combination with polyacrylic pressure sensitive adhesive, nevertheless the nitrocellulose provides a marked improvement with other pressure sensitive adhesives.

Also, although optimum results have been achieved with nitrocellulose together with conductive resin (inorganic salts can be used instead but do not give as good results as conductive resin) in the pressure sensitive adhesive layer, nevertheless the presence of nitrocellulose even without any conductive resin or inorganic salt provides fairly good results, particularly when used with a polyacrylic pressure sensitive adhesive.

In some cases the nitrocellulose together with the conductive resin tends to dry out the polyacrylic or other resinous pressure sensitive adhesive in which case a tackifying agent is added. It has been found that excellent pressure sensitive adhesive tack can be achieved in this way although adequate tack can be achieved in some cases without the tackifying agent.

It is also desirable in most but not all instances to use a plasticized resin, e.g., plasticized (conventional plasticizers can be used) acrylic resins to achieve the softness desired.

Where a conductive material such as conductive resin or inorganic salt is used in addition to the nitrocellulose, the conductive resins are highly preferred because the inorganic salts are more hydrophyllic than the conductive resins and tend to absorb substantial amounts of moisture to reduce the efficiency of the pressure sensitive adhesive.

Conventional protective release sheets or liners for pressure sensitive adhesive labels are either themselves made of a material which has low adhesion to the pressure sensitive adhesive, e.g. glassine, silicone, etc., or they are coated with such a material, e.g., a silicone coated paper or plastic, such as a vinyl sheet, so that

they can be readily peeled off from the adhesive to expose it without removing the adhesive from the backing sheet of the label. Such release sheets can be used in the present invention. Although they are generally nonconductive they are so thin they do not present an absolute barrier to leakage of charge through the thickness thereof and, accordingly, can be used in the present invention without modification.

However, they do interfere with through flow of charge to some extent and, accordingly, when a conductive pressure sensitive adhesive layer is used without a unipotential layer, better electrophotographic reproduction is achieved by incorporating in the release sheet the aforesaid electrically conductive materials to increase the conductive rate of flow of charge therethrough, a preferred amount being that which will provide a rate of flow of charge through the thickness thereof commensurate to the rate of flow through the thickness of the pressure sensitive adhesive layer. For example, where a silicone coated release paper is used the paper may be impregnated with the inorganic salt or conductive resin or conductive particles. Even better results are achieved, if, in addition, such resin or salt is added to the silicone coating. However, in such case the amount added should not be so great as to unduly interfere with the release properties of the silicone.

In this way, the entire thickness of the substrate for the electrophotographic layer from the inner electrophotographic surface to the outer release paper surface is conductive.

Some conventional release sheets are more conductive than others, e.g., glassine is more conductive for some reason, which might be the amount of water of hydration contained therein.

The amount of nitrocellulose may range from ½ to 15 or 20 percent, more preferably 1–10 percent and still more preferably 2 or 4 to 8 or 8.8 percent, by weight of the dry pressure sensitive adhesive mix (based on total dry solids).

The amount will vary depending on the other ingredients in the pressure sensitive adhesive and the amounts thereof, e.g., the pressure sensitive adhesive resin used, whether the resin is plasticized and, if so, on the amount of plasticizer, whether a tackifier is used and, if so, the amount thereof, etc. It will also vary depending on the tackiness desired for the intended use and also on the characteristics of the base sheet to which the pressure sensitive adhesive layer is adhered.

Although fairly good results can be achieved with the acrylic resins combined with a conductive resin even without the nitrocellulose, the nitrocellulose greatly improves the results.

DETAILED DESCRIPTION

EXAMPLES

An electrophotographic coating composition is made up by adding 44.04 grams of a 45 percent by weight toluene solution of a modified acrylic polymer, which solution is sold by DeSoto Chemical Company, Chicago, Illinois, under the trade name DeSoto E–O 41 resin, to 114.6 grams of toluene and admixing therewith 120 grams of photoconductive zinc oxide, sold by the New Jersey Zinc Co. under the name, Florence Green Seal No. 8 (ultimate particles size of 0.3 – 0.4 microns), and 1.5 ml of a 1 percent methanol solution of sensitizing dye (0.29 grams bromophenol blue, 0.59 grams uranine (USP) plus 0.135 grams methylene blue dissolved in 99 grams methanol).

The aforesaid coating composition is coated onto an Electrofax conductive base paper sold by Weyerhauser Paper Company under the designation CCA, which has a hold-out and conductive layer of clay, protein and quarternary ammonium polymer, to which the electrophotographic coating composition is applied with a meier rod in an amount equal to twenty pounds per 24 × 36 500 sheet ream followed by drying to provide an electrophotographic coating layer having an average thickness of 0.6–1.0 mil or 15–25 microns.

A number of pressure sensitive adhesive solutions are prepared by adding the ingredients in the amounts set forth in the following TABLE I (all numerical amounts being in percent or parts dry weight) to a solvent mixture to be described more fully hereinafter.

TABLE I

Ingredients	EX. 1	EX. 2	EX. 3	EX. 4	EX. 5	EX. 6	EX. 7	EX. 8	EX. 9	EX. 10	EX. 11	EX. 12
Acrylic resin[1] (pressure sensitive adhesive)	54	38	40	37	36	40	34	48	38	39	43	100
polyvinyl ethyl pyridinium chloride[2] (a quarternary ammonium resin) (conductive resin)	1	7	10	12	15	18	20	0	3	5	10	0
R.S. Nitrocellulose[3] (¼ sec)	4	8	6	4	2	1	1	10	0	0	0	0
phenolic-formaldehyde tackifying agent[4]	5	15	9	15	20	6	9	6	25	35	9	0
low molecular weight polyvinyl ethyl ether[5] (plasticizer for the acrylic resin)	36	32	35	32	31	35	26	36	33	28	38	0

[1] Sold by Monsanto under the name MPS 263.
[2] Sold by Desoto Incorporated under the name DeSoto C112.
[3] Sold by duPont under that name.
[4] Sold by Rohm & Haas under the name ST 149 Amberol.
[5] Sold by Union Carbide under the name EHBC as an 80% solids solution in heptane.

In each example the pressure sensitive adhesive solution is prepared by adding the ingredients of each example to the following solvent mixture:

Xylene — (high boiling solvent to adjust for rate of evaporation of the wet coating after application). 30 percent by weight

ethyl acetate — (low boiling solvent for the acrylic resin) 40 percent by weight

isopropyl alcohol — (low boiling solvent for conductive resin) — 30 percent by weight

with stirring to dissolve the plasticized acrylic resin, conductive resin, tackifying agent and nitrocellulose. The per cent by weight of solids in the solution is in each case 35 percent.

Each solution is coated on the glassine surface of a 40 lb. Glassine Release Paper in the amount of 9–10 lbs. of adhesive resin solution per 24 × 36 500 sheet ream and dried to provide a highly pressure sensitive adhesive layer about one mil thick.

The paper surface of the electrophotographic layer - conductive paper base sheet laminate is then pressed against the exposed pressure sensitive adhesive surface of the pressure sensitive adhesive — release sheet laminate of each example to adhere the two laminates together by virtue of the adhesiveness of the pressure sensitive adhesive and to thereby form the composite electrophotographic pressure sensitive sheet.

The composite electrophotographic pressure sensitive sheet, the upper surface of which comprises the electrophotographic layer and the lower surface of which comprises the release paper, is then cut or perforated by a dye into labels with the cut or perforation lines extending through the electrophotographic coating, the conductive base paper and the pressure sensitive adhesive layer but not through the release sheet so that the release sheet comprises a backing sheet to which the electrophotographic pressure sensitive labels are adhered but from which they can be individually peeled and stuck to a receiving surface.

Electrophotographic copies are made on such labels while applied to the release sheet from a black and white master in a Dennison Standard Electrophotographic Copier using Graphofax toner sold by Phillip A. Hunt Chemical Company and with an exposure time of seven seconds. The labels, releasably adhered to the release sheet, are charged, exposed and toner developed and fixed in the copier in conventional manner.

The following TABLE II gives for each of the aforesaid examples, the compatibility of the pressure sensitive adhesive system in terms of "good," "poor" and "fair," the comparative tackiness of such system in terms of "good" and "poor," the exposure setting of the copying machine at which optimum print quality is achieved, the latitude of exposure settings below and above such setting to achieve good print quality and the comparative print quality in terms of "poor," "fair," "good" and "very good."

TABLE II

Property	Example 1	Example 2	Example 3	Example 4	Example 5
Compatibility	good	good	good	good	good
Tack (pressure sensitive adhesiveness)	good	good	good	good	good
Optimum Exposure Setting	2½	2½	3	2½	3
Latitude (range of exposure settings above and below optimum at which optimum print quality was not adversely affected	2 below 4 above optimum	±2	±2½	±2	±2
Print Quality (Density-blackness of print in image areas)	very good	very good	very good	very good	very good

Property	Example 6	Example 7	Example 8	Example 9	Example 10	Example 11	Example 12
Compatibility	good	good	good	fair to good	fair to good	fair to good	good
Tack (pressure sensitive adhesiveness)	good	good	good	poor	fair to good	fair to good	good
Optimum Exposure Setting	3	3	2	Quest-ionable	3	3	Quest-ionable
Latitude (range of exposure settings above and below optimum at which good print quality is achieved)	±3	±2½	±2	Quest-ionable	±2½	±2½	Quest-ionable
Print Quality (Density-blackness of print in image areas)	good	good	fair to good	poor	fair	fair	poor to fair (sheet moderately conductive poor background)

It may be seen from these examples that the nitrocellulose (Examples 1–8) improves print quality and compatibility of the conductive resin with the pressure sensitive adhesive (compare with Examples 9–11).

Examples 1–8 are repeated except the release sheet is a glassine sheet impregnated with conductive Dow QX 2611.12 resin (polyvinyl benzyl trimethyl ammonium chloride), sold by Dow Chemical Company, in an amount equal to 2 pounds per 24 × 36 500 sheet ream and coated with a thin layer of silicone resin. Reproduction is slightly improved and adhesive and release properties are the same.

The ranges of relative amounts of the different materials in the pressure sensitive adhesive mix and layer of the examples are set forth in the following TABLE III, all amounts except plasticizer being based on dry weight of the pressure sensitive adhesive mix and the plasticizer being based on weight of the resin.

TABLE III

Ingredient	Broad Range	More Preferred Intermediate Range	Most Preferred Narrower Range
Plasticized Elastomeric Resin)	50 - 90%	60 - 87%	70 - 85%
Plasticizer	0–70% by wght of acrylic resin	10 - 65% by wght of acrylic resin	15 - 60% by wght of acrylic resin
Conductive Resin	0 - 25%	1 - 20%	1 - 15%
Tackifier	0 - 55%	4 - 50%	5 - 20 or 35%
Nitrocellulose	½ - 15%	1 - 10%	2 or 4 - 8 or 8.8%

The ranges of the relative amounts of the different solvents used to make the pressure sensitive adhesive solution may vary as set forth in the following TABLE IV.

TABLE IV

Solvent	Broad Range	Preferred Range	More Preferred Range
Ethyl Acetate	10 - 65%	10 - 50%	10 - 25%
Isopropanol	0 (if no conductive resin is used) -45%	10 or 15-40%	20 - 40%
Xylene	0 - 70%	20 - 60%	40 - 60%

These ranges vary depending on the dry ingredients of the pressure sensitive adhesive mix and the coating procedure used to coat the mix on the release sheet. For example, if the amount of pressure sensitive adhesive resin is increased then the amount of ethyl acetate (solvent for such resin) will be increased, and if the amount of conductive resin is increased then the amount of isopropanol (solvent for conductive resin) will increase. Also, if the method of coating is such as to make desirable a more rapid evaporation of the applied coating then the amount of xylene should be increased. It has been found that if no xylene or too little xylene is used the outer part of the applied coating tends to dry or evaporate rapidly relative to the inner part of the coating and blistering is apt to occur.

The electrophotostatic labels of the examples show generally the same print properties on six different copying machines, namely, The Apeco, Copystatic 500, Mark I, Rofax 1400, Savin and Toshiba Machines.

The percent solids in the pressure sensitive solutions may vary over a wide range, e.g., 10–60 percent by weight but more preferably 25–40 percent by weight. The maximum is dictated by the solubility of the dry ingredients (they should all be dissolved) and the method of coating application. The minimum is dictated by the economics of unduly extending the drying time and using more solvent that is required.

With respect to the amount of nitrocellulose, it should not be so great as to reduce the tackiness too much. However, even small amounts show an advantage in increasing compatibility and print quality.

With respect to the conductive resin, only fair print quality can be achieved without it (where the nitrocellulose is present). Small amounts improve the print quality and the maximum amount is dictated by the fact that if too much is added it reduces the tack too much.

The amount of tackifier depends on the amount required to compensate for the reduction in tack caused by the nitrocellulose and conductive resin. In some cases with a very tacky resin and small amounts of nitrocellulose and conductive resin, it is not required at all. As the amount is increased a threshhold amount is reached beyond which the tackiness is decreased rather than increased. This is a well known phenomenon.

The amount of plasticizer again depends on the softness desired, the plasticizer also adding to the tackiness. In some cases with a soft resin, the plasticizer can be omitted entirely. If too much is added it will reduce the tackiness and reduce conductivity.

The particular solvents used can be varied over a wide range. Any non-toxic solvent having suitable evaporation rates for conventional coating techniques can be used for each of the dry ingredients, e.g., any of the volatile alcohols (e.g., the lower alkyl alcohols such as ethyl alcohol, butyl alcohol, etc.) or ketones (e.g.,

dialkyl ketones such as dethyl ketone-acetone-or methyl ethyl ketone or methyl isobutyl ketone, etc.) or even volatile aldehydes can be used which are solvents for the plasticized resin and any of the volatile ketones and esters (e.g., propyl or amyl or isobutyl acetate) can be used which are solvents for the conductive resin so long as the two solvents are miscible and compatible with each other and so long as the mixture thereof, as such, or with the aromatic or other solvent used in the system is a solvent for the nitrocellulose and does not attack the release sheet to which it is applied or the other ingredients in the pressure sensitive adhesive mixture. In fact, in some cases hydrocarbon (paraffinic hydrocarbons such as hexane or isoparaffinic mixtures) solvents can be used either alone or in admixture with the alcohol or ketone or ester solvents. Suitable such solvents can be selected by anyone skilled in the art from any solvent handbook. Also the xylene can be replaced by any other non-toxic higher boiling aromatic solvent (e.g., naphthalene or benzene or toluene) or any other non-toxic non-aromatic solvent (including paraffin hydrocarbons) compatible with the other two solvents, and which does not attack the plasticized resin or tackifier or nitrocellulose or the surface to which the pressure sensitive adhesive coating is applied. Such solvents will be readily apparent to those skilled in the art knowing that the purpose thereof is as a higher boiling solvent to decrease the rate of evaporation to prevent blistering during the coating procedure.

RS (11.8–12.2 percent nitrogen) nitrocellulose (nitrated cellulose from cotton linters or from wood pulp made by treatment of cellulose with nitric acid to produce the ester, cellulose nitrate) is preferred. It is soluble in most of the ester solvents, e.g., ethyl, butyl and amyl acetates, and ketones, e.g., acetone, methyl isobutyl ketone, methyl propyl ketone, etc. It has good compatibility with a large variety of the pressure sensitive adhesive resins which are soluble in commercially practical solvent combinations. However, any nitrocellulose can be used, including without limitation the SS type (10.9–11.2 percent nitrogen), which is more soluble in the alcohols than the RS type. The low viscosity types of SS nitrocellulose are almost completely soluble in ethanol alone. Also, the SS type has the advantage that the lower the nitrogen content of the nitrocellulose the more thermoplastic it is. AS (11.3–11.7 percent nitrogen) nitrocellulose, has also been used successfully. In selecting the nitrocellulose, one should be used which is soluble in the solvent combinations for the plasticized elastomeric resin and the conductive resin and to reduce the rate of evaporation. In some cases, where it is desired to reduce the viscosity of the pressure sensitive adhesive coating composition, lower alkyl alcohols are used, which may not themselves be good solvents for the ingredients but which are compatible with other good solvents for such ingredients and which may be referred to as latents or cosolvents. This technique of reducing viscosity of solutions is a well known one.

It is believed that the nitrogen atoms are present in the nitrocellulose as $-NO_2$ and/or NO_3 radicals. In addition to nitrocellulose other nitrated polymers of hydroxy or cyclic hydroxy ether compounds, like glucose or dextrose or phlorose and other saccharide residues, can be used. However, nitrocellulose is by far preferred.

Any of the conventional conductive resins can be used, such as the quarternary ammonium resins (cationic electrolyte polymers), such as DeSoto C112, Dow QX 2611.12 resin, Calgon 261, Dow ECR34 (polymeric vinyl benzyl trimethyl ammonium chloride), or Bubond 60 poly [oxyethylene (dimethyl liminio) ethylene dichloride] sold by Buckman Laboratories Incorporated or Nalco 61J16 (poly cationic polymer) sold by Nalco Chemicals Company or the weakly anionic styrenemaleic anhydride resins, (Lytron 822 sold by Monsanto Chemical Company), or the ammonium salts of sulfonated polystyrenes (Lytron RP505 and Lytron 939 sold by Monsanto Chemical Company).

Although the low molecular weight elastomeric acrylic and modified acrylic resins (e.g., methyl or ethyl methacrylate or acrylic acid and vinyl acetate copolymers and epoxy cross linked acrylate resins) are by far preferred because they are themselves moderately conductive (probably because of their greater polarity), other conventional pressure sensitive adhesives such as polyvinyl ether, polyvinyl alcohol, plasticized polyisobutylene, plasticized rubber, plasticized poly esters, plasticized butadiene-styrene, etc. can be used so long as they contain the conductive resin and nitrocellulose. These resins may be plasticized with conventional nonmigrating plasticizers, such as the oleates, oil, phthalates, e.g., dioctyl phthalate, tricresyl phosphate, poly-alpha methyl styrene, polyvinyl ether, etc., to soften the resin and achieve the tackiness and strength required.

Preferred pressure sensitive adhesives are those comprising a mixture of a highly tacky resin, i.e., tackifying agent, such as a hydrogenerated wood rosin or coumaron indene resin or tacky phenol-formaldehyde prepolymers of the unreactive type such as ST–149 Amberol, and a tacky back-bone resin, such as acrylic polymer or styrene-butadiene or rubber or poly crepe, for strength and control of tackiness. In this regard it is pointed out that the nitrocellulose as well as the conductive resin tend to dry out the pressure sensitive adhesive resin which can be compensated for by the tackifying agent. Thus, the reduction in tack of the pressure sensitive adhesive caused by the addition of the nitrocellulose and conductive resins, which are tack reducers, can be compensated for by increasing the ratio of tackifying agent to the less tacky back-bone resin or by the use of a more tacky tackifying agent.

Where a liquid toner is to be used for development it is preferred to use in the pressure sensitive adhesive layer a polyacrylic resin, e.g., a cross-linkable poly acrylic-vinyl acetate copolymer, such as MPS263 sold by Monsanto Chemical Company, which is resistant to the liquid carrier of the toner, e.g., odorless mineral spirits, used in the developing step.

The thickness of the pressure sensitive adhesive layer is the same as that in conventional pressure sensitive labels, e.g., between 0.8 and 1.2 mils.

A compatible anti-oxidant, e.g., of the hindered phenol type, may be added to the pressure sensitive adhesive mix.

The amount of conductive resin with which the release paper may be impregnated may range from 1 to 5 lbs. per 24 × 36 500 sheet ream.

As has been stated, the release paper need not be rendered conductive but may be. In addition to the Glassine papers, silicone sheets or silicone coated sheets (e.g., silicone coated paper) or any other conventional release sheets for pressure sensitive adhesives can be used.

Also, any conventional conductive base sheet (to which the electrophotostatic coating and pressure sensitive adhesive layer are adhered) can be used, such as K-Savin 2200 stock (Weyerhauser International) R-Riegal High Speed Stock (Riegal Paper)), aluminum foil or aluminum foil-paper laminates, etc.

The thickness of the electrophotographic layer is conventional and may range from 0.3 - 1.0 mil.

Other conventional electrophotographic coating compositions can be used. Thus, the zinc oxide can be replaced by other photoconductive materials such as zinc cadmium sulfide, zinc sulfide, cadmium sulfide, titanium dioxide of very fine particle size, zinc cadmium selenide, selenium telluride, mercuric sulfide, selenium sulfide, stilbene, polyvinyl carbozole, imidizole derivities and anthracene; the insulator resin can be replaced by other electrophotographic insulator resinous binders such as the alkyd resins, silicone resin, vinyl resins, e.g., polyvinyl-acetate and polyvinyl chloride homopolymers and copolymers, polyurethane, styrene, acrylonitrile, butadiene-styrene; the sensitizer can be replaced by any conventional and compatible sensitizer; and the weight ratio of photoconductive particles to resin binder may range between 1/1 and 8/1 or higher.

Also the electrophotographic layer can be applied to the substrate, be it metal or paper or plastic, in any conventional manner but preferably as a dispersion of the photoconductive particles in a solution of the resin in a solvent.

The conductive pressure sensitive adhesive layers achieved in the present invention have a volume resistivity approaching that of the base paper or less.

The invention has been described in detail with respect to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A pressure sensitive electrophotographic reproduction sheet comprising an electrically conductive backing sheet, a photoconductive layer adhered to one side of said backing sheet, and a layer of electrically conductive pressure-sensitive adhesive containing from ½ to 20 percent by weight nitrocellulose adhered to the other side of said backing sheet, said adhesive layer being sufficiently pressure sensitive as to cause the electrophotographic reproduction sheet to adhere to a receiving surface when the adhesive layer is placed in contact with such surface and pressure is applied to the backing sheet.

2. A pressure sensitive electrophotographic reproduction sheet comprising an electrically conductive backing sheet, a photoconductive layer adhered to one side of said backing sheet, and a layer of electrically conductive pressure-sensitive adhesive containing from ½ to 20 percent by weight nitrocellulose adhered to the other side of said backing sheet, said conductive pressure-sensitive adhesive layer having a protective release sheet releasably adhered thereto and adapted to be pulled off said pressure-sensitive adhesive layer to expose the same for adhesion of said pressure-sensitive electrophotographic reproduction sheet to a receiving surface, and said electrophotographic sheet being conductive through its thickness from the inner surface of said photoconductive layer through the outer surface of said protective release sheet.

3. A sheet according to claim 2, said release sheet containing conductive material which increases the conductivity of said release sheet.

4. A sheet according to claim 1, said pressure sensitive adhesive layer also comprising a pressure sensitive adhesive resin and an electrically conductive resin.

5. A sheet according to claim 4, said pressure sensitive adhesive comprising an acrylic resin.

6. A sheet according to claim 4, said adhesive resin being a plasticized resin and said layer also containing a tackifying agent.

7. A sheet according to claim 4 comprising a pressure sensitive adhesive electrophotographic label which can be printed electrophotographically.

8. A plurality of the labels according to claim 7, including a protective release sheet to which said plurality of labels are pressure-sensitively adhered by said conductive pressure-sensitive adhesive layers, on which said labels are adapted to be individually printed electrophotographically and from which said plurality of labels are adapted to be removed after printing to expose said pressure-sensitive adhesive layers for pressure-sensitive adhesion of said labels to a receiving surface or surfaces, and said labels being conductive through their thickness from the inner surface of said photoconductive layer through the outer surface of said protective release sheet.

9. A sheet according to claim 4, said nitrocellulose being present in the amount of from ½ to 15 percent dry weight of said pressure sensitive adhesive layer and the amount of said conductive resin being between 1-25 percent by weight of said pressure sensitive adhesive layer.

10. A sheet according to claim 9, said pressure sensitive adhesive layer also containing a tackifying agent in the amount of from 4-50 percent dry weight of the pressure sensitive layer.

11. A sheet according to claim 9, said resin being plasticized with a plasticizer present in the amount of from 10-65 percent by weight of the resin.

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