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(11) **EP 1 138 518 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **04.10.2001 Bulletin 2001/40** (51) Int Cl.7: **B41M 7/00, B41M 5/00**

(21) Application number: **01104145.6**

(22) Date of filing: **21.02.2001**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **30.03.2000 US 538770**

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(54) **Ink jet receptor sheets and transfer elements**

(57) A printing system and process are disclosed for producing durable, high quality, typically, right reading ink jet printed images. An ink jet receptor sheet and a transfer element containing a substantially transparent

hydrophobic layer, e.g., mixture of acrylic polymer, poly (n-butyl methacrylate) and 2-ethylhexyl-2-cyano-3,3-diphenyl acrylate; polyurethane elastomer or styrene copolymer is disclosed.

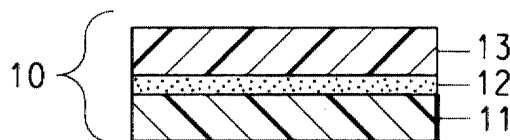


FIG. 1

Description**FIELD OF THE INVENTION**

[0001] This invention relates to ink jet receptor sheets and transfer elements useful in forming images on a permanent substrate.

BACKGROUND OF THE INVENTION

[0002] Ink-jet printing is a non-impact method for recording information in response to an electronic signal, such as that generated by a computer. In the printer, the electronic signal produces droplets of ink that are deposited on a media, such as paper or transparent film. Ink-jet printers have found broad commercial acceptance due to their reliability, relatively quiet operation, graphic capability, print quality, and low cost.

[0003] In current ink-jet printing applications, several inks (typically having colors of black, cyan, magenta and yellow) are used to print textual and graphic information on a printing media, typically ordinary paper. The inks primarily are composed of water, and contain a colorant that may be a dye or pigment dispersion. The inks generally also contain a polyhydric alcohol to prevent nozzle clogging, and may contain various adjuvants. Such inks and ordinary paper are well suited for desk-top publishing, as currently practiced, wherein only a small portion of the paper receives printed text and graphic information.

[0004] It is desired to reproduce high quality colored pictorial information (such as photographs and the like) using ink-jet technologies for applications such as commercial printing color proofing and desk-top publishing which, typically, require the use of more ink than normally used in printing text. In these applications the printing media will receive substantially more of the black and colored inks in order to accurately reproduce the various hues, tints, and colors contained in a typical colored picture. For example, the printing media will be expected to receive two or more times the total ink coverage than media used in conventional commercial printing. This, the total ink coverage for an area may exceed two separate overprint applications of ink.

[0005] Ordinary paper stock is usually not suitable for such high quality applications for a number of reasons. Water in the larger proportions associated with higher quality printing processes disrupts the paper structure, causing "cockle" that affects appearance of the paper and, in extreme cases, may actually cause the paper to distort to the extent that it contacts the ink-jet pen, disrupting the printing process. Also, paper may not absorb water sufficiently quickly to achieve the desired printing speed, or may cause flooding of the paper surface, which adversely affects image quality. Moreover, wicking of ink into the paper may cause the paper to "show through" into the printed image, detracting from image quality. There is a need for a transfer process and system that provide printed text and pictures having high quality on the final substrate.

SUMMARY OF THE INVENTION

[0006] The present invention provides a transfer element and an ink jet receptor sheet particularly adapted to receive printed images involving an ink, particularly an aqueous ink-jet ink containing a dye. The printed image which is sandwiched between the ink receiving layer and the hydrophobic layer transferred to a permanent substrate, which may be paper, plastic, glass, aluminum foil, etc. lacks problems previously encountered with higher quality printing processes employing these substrates.

[0007] The invention has a special utility in applications involving printing of pictorial information particularly in demanding ink-jet printing applications which require more ink than normally used in printing text. Applications for the invention include desktop publishing, wide format printing (e.g., for signage, banners and the like). Additionally, the invention may be used in applying ink jet images to objects having non-planar topography.

[0008] The invention has a special utility in applications involving printing of pictorial information particularly in demanding ink-jet printing applications which require more ink than normally used in printing text. Applications for the invention include desktop publishing, wide format printing (e.g., for signage, banners and the like). Additionally, the invention may be used in applying ink jet images to objects having non-planar topography.

[0009] Accordingly, in a first aspect, the invention relates to a printing process for printing an ink jet image on a receptor comprising the steps of:

(a) printing an image on an ink receptor using an ink jet printer, the ink receptor comprising:

- (1) a first temporary carrier having a first release surface,
- (2) a first adhesive layer on the first release surface, and
- (3) an ink receiving layer on the first adhesive layer, the image being printed on the ink receiving layer;

(b) laminating the printed ink receptor to a transfer element comprising:

- (1) a second temporary carrier having a second release surface, and
- (2) a substantially transparent hydrophobic layer on the second release surface, the image being laminated between the ink receiving layer and the hydrophobic layer;

(c) removing the first temporary carrier to reveal the first adhesive layer;
 (d) laminating the image to a final receptor by laminating the first adhesive layer to the final receptor; and
 (e) removing the second temporary carrier, thereby revealing the substantially transparent hydrophobic layer and the image beneath the hydrophobic layer. Alternately, a second adhesive layer may be provided on the hydrophobic layer of the transfer element to form a three layer structure comprising a second temporary carrier having a second release surface, a substantially transparent hydrophobic layer and a second adhesive layer.

[0010] In a second aspect the invention relates to an ink jet printing system comprising in combination:

(a) an ink receptor sheet comprising:

- (1) a first temporary carrier having a first release surface,
- (2) a first adhesive layer on the first release surface, and
- (3) an ink receiving layer on the first adhesive layer, the ink receiving layer being adapted to receive an image from the ink jet printer; and

(b) a transfer element comprising:

- (1) a second temporary carrier having a second release surface, and
- (2) a substantially transparent hydrophobic layer on the second release surface.

[0011] Optionally, a second adhesive layer may be present adjacent to the substantially transparent hydrophobic layer in the transfer element.

[0012] In a third aspect the invention relates to a printed article comprising in sequence:

- (a) a final receptor;
- (b) a first adhesive layer on the final receptor;
- (c) an ink receiving layer on the first adhesive layer;
- (d) an ink jet image on the ink receiving layer; and
- (e) a substantially transparent hydrophobic layer on the second release surface.

[0013] Optionally, there may be a second adhesive layer between the hydrophobic layer and the printed image.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Figure 1 is a simplified schematic diagram showing a cross-section of the ink receptor.
 Figure 2 is a simplified schematic diagram showing a cross-section of the transfer element.
 Figure 2a is a simplified schematic diagram showing a cross section of the transfer element containing a second adhesive layer.
 Figures 3 to 7 are simplified schematic diagrams showing in cross section the subsequent processing steps employing the ink receptor and the transfer element.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The present invention provides a process and a system for using an ink jet receptor and a transfer element which result in right-reading printed images having improved quality and durability.

[0016] In a typical application, as shown in Figure 1, the ink jet receptor **10** has, in order, a first temporary carrier having a first release surface **11**, a first adhesive layer **12** on the first release surface, and an ink receiving layer **13** on the first adhesive layer. As shown in Figures 2 and 2a, the transfer element **20** has, in order, a second temporary carrier having a second release surface **21**, and a substantially transparent hydrophobic layer **22** on the second release

surface. Optionally, a second adhesive layer **23** is present on the hydrophobic layer **22**.

INK JET RECEPTOR SHEET

First Temporary Carrier Having A First Release Surface:

[0017] The first temporary carrier having a first release surface **11** is a material having sufficient stiffness and dimensional stability to support the a first adhesive layer **12**, the ink receiving layer **13** and a printed image without having the image distort or misalign. Typically, it should have sufficient water resistance that it can be exposed to an aqueous ink without warping or shrinkage. The material also should withstand heat and pressure applied during the lamination steps described below. The first temporary carrier typically has a thickness of about 25 to about 250 microns (1.0 to 10 mils), preferably about 50 to 200 microns (2 to 8 mils). Suitable materials include polymeric films, such as polyethylene terephthalate and polyethylene naphthanate, polyamides, polycarbonates, fluoropolymers, polyacetals, and polyolefins. Thin metal sheets may be selected, as well as natural or synthetic paper treated to be water resistant. The substrate may be transparent, translucent, or opaque. It may be colored and can have components, such as antihalation dyes, incorporated therein to meet the needs of specific applications. Polyethylene terephthalate films are a preferred support material.

[0018] The first release surface on the first temporary carrier may be integral with the first temporary carrier. Some suitable examples of films having release surfaces include polyethylene or a fluoropolymer. Alternately, the release surface may be a separately applied release layer (not shown) on the first temporary carrier. The release surface may be applied by known techniques including coating, spraying or dipping the temporary carrier material with the release material. Another technique might be to releasably apply it with another multilayer film structure.

[0019] The first release surface facilitates removal of the first temporary carrier **11** from the rest of the ink receptor sheet in step (c) of the process.

[0020] The first release surface includes a release agent selected from cellulose ethers; polyethylene oxides; polyacrylates or polymethacrylates; blends of water-soluble polymers with polyethylene oxide; silicones, thermoplastic polyamides and copolymers thereof such as Ultramid® 1C; and dispersions of polyolefins or polyfluorocarbons in water-soluble polymers. An example of a silicone is a crosslinked silicone coating Furon® 8721 commercially available from Furon of Worcester, MA. Examples of water soluble polymers include polyvinyl alcohol, polyvinyl pyrrolidone, polysaccharides, cellulosic compounds like hydroxy methyl cellulose, starch and gum. An example of cellulose ether is ethyl cellulose.

[0021] It has been found that matting agents added to the material of the first release surface can be used to adjust the gloss characteristics of the layer adjacent to the first release surface. Types and uses of matting agents are well known in the coatings industry. The choices of matting particle size and concentration are dictated by the thickness of the layer to be matted and the degree of matting desired.

[0022] The matting agent used should be chemically inert and may be either inorganic or organic. Some suitable matting agents for use in making the first release surface include inorganic fillers such as silica or silicates, zeolites, calcined kaolin, diatomaceous earth, barium sulfate, aluminum hydroxide or calcium carbonate, glass beads, mica, tin oxide and titanium dioxide and organic matting agents such as polymeric particles, for example, particles of homo- or copolymers of styrene or styrene derivatives such as divinyl benzene, fluorocarbon polymers, and crosslinked polyacrylates and other materials that would be readily apparent to one skilled in the art. The preferred matting agent is silica. The level of matting would be obtained from very different weight amounts of matting agent depending upon the choice of matting agent, e.g., whether the matting agent is a polystyrene or a dense metal compound, or matting agent density, particle size, layer thickness and coating technique. Thus, the amounts of any given matting agent could vary by severalfold to yield a given matte surface. Nonetheless, it is contemplated that in typical applications, the matting agent may be present in the amount of about 0.1 to about 50% by weight, based on the total weight of the layer.

[0023] The other components that may be including when making the first release surface are antistatic agents, colorants, antihalation dyes, surfactants, plasticizers, coating aids, and the like.

[0024] The first release surface may be a layer which generally has a thickness in the range of from about 0.1 to about 20 microns, and more typically from about 0.1 to about 3 microns. In other words, the dry coating weight of the layer ranges from about 1 to about 200 mg/dm², and more typically from about 1 to about 30 mg/dm².

[0025] Conventional antistatic coatings may be present on one or both sides of the first temporary carrier having a first release surface **11** to reduce static if the first temporary carrier having a first release surface **11** is later separated by "peeling", as discussed below. The antistatic coatings may also contain minor additive amounts of materials such as colorants, antihalation dyes, optical brighteners, surfactants, plasticizers, coating aids, and the like.

[0026] Conventional back-coatings may be applied to the first temporary carrier having a first release surface **11** in order to reduce curl. Additionally, the first temporary carrier having a first release surface **11** may have a backing layer, to improve transport properties of the ink receptor in the ink-jet printer, if the material selected as the first temporary

carrier does not possess the desired handling properties. The backing layer may have antistatic agents, matting agents, and the like that are commonly employed in the art. For example, the first temporary carrier having a first release surface **11** may have an abrasion resistant coating as disclosed in U.S. Patent No. 5,069,942.

First adhesive layer:

[0027] A first adhesive layer **12** present on the first temporary carrier having a first release surface **11** may be used to ensure adequate adhesion of the inked or imaged ink receptor sheet **10** to the final receptor **40** in step (d) of the process. Adhesive materials for bonding different types of materials are well known in the art and are discussed in Handbook of Adhesives, 2nd Edition, Irving Skeist, Ed. (Van Nostrand Reinhold Co., New York, 1977). Typically, the adhesive layer may be thermoplastic. Any conventional thermoplastic adhesive material can be used so long as it is not adversely affected by the printing step. Representative materials include ethylene/vinyl acetate copolymers, vinyl chloride/vinyl acetate copolymers, vinyl chloride/vinylidene chloride copolymers, acrylate or methacrylate copolymers, and terpolymers. A specifically contemplated material is a mixture of a polymer containing one or more monomers of methacrylate, methyl methacrylate, ethyl acrylate and acrylic acid with a polymers containing one or more monomers of ethyl acrylate and acrylic acid, thermoplastic polyamides, and the like and mixtures thereof. A specific example of a useful adhesive material is a 50:50 mixture of acrylic copolymers. Useful commercially available compositions include acrylic resins, e.g., Carboset® sold by B. F. Goodrich of Leominster, MA; or crystalline polymers such as polycaprolactone. The choice of adhesive will depend on the compositions of the release layer and the support. The adhesive layer **12** may contain materials such as antistats, colorants, antihalation dyes, optical brighteners, surfactants, plasticizers, coating aids, and the like. The first adhesive layer generally has a thickness in the range of 0.01 to 100 microns, preferably 3 to 15 microns. The thickness of the first adhesive layer is dependant on the roughness or smoothness of the final substrate.

Ink Receiving Layer:

[0028] The ink receiving layer is constructed of a composition having a balance of properties. The ink receiving layer is affixed to the first adhesive layer such that it will remain with the imaged element during the process steps. It is desirable that the ink receiving layer not be so tacky at ambient temperatures that it presents a handling problem.

[0029] The ink receiving layer typically has a thickness of from about 3 to about 40 microns, more typically from about 5 to about 20 microns. It contains at least about 10 % by weight, typically 10 to 90% by weight, of a water soluble binder, typically selected from the group consisting of homo- and copolymers of vinyl alcohol and vinyl acetate, homo- and copolymers of vinyl pyrrolidone, methyl vinyl ether, cellulose compounds such as polyhydroxymethyl cellulose, polyhydroxyethyl cellulose, polyhydroxypropyl cellulose, polyhydroxypropyl methyl cellulose; homo- and copolymers of acrylic acid, methacrylic acid, maleic acid, and their metal or amine salts; starch, gelatin, gum arabic, and combinations thereof.

[0030] The ink receiving layer may contain conventional ingredients such as inorganic fillers, humectants, UV absorbers, polymeric dispersants, defoamers, mold inhibitors, antioxidants, latex, dye mordants, optical brighteners, etc.

[0031] The ink receiving layer generally has a thickness in the range of about 3 to about 40 microns, more typically about 10 to about 20 microns.

Preparation

[0032] The first adhesive layer and the ink receiving layer are sequentially applied to the first temporary carrier having thereon a first release layer. For high coverage images, the ink receiving layer has a dry coating weight of about 30 mg/dm² (milligram per square decimeter) to about 600 mg/dm²; similarly, the first adhesive layer has a coating weight from about 30 mg/dm² to about 1000 mg/dm². Appropriate coating weight of the ink receiving layer is needed to provide sufficient ink vehicle absorbing capacity to prevent ink spread and/or puddling and to minimize cockle with porous substrates. The first adhesive and ink receiving layers are applied to the first temporary carrier by conventional coating methods such as roller coating or knife coating methods (e.g., air knife, trailing blade). All the ingredients can be premixed to form the compositions that are applied to the first release surface of the first temporary carrier at the dry coating weights set out above.

[0033] In a different embodiment, the ink receiving layer and the first adhesive layer may be laminated, in order, to a first release layer that is coated on a first temporary carrier.

TRANSFER ELEMENT

[0034] As shown in Figure 2, the transfer element comprises a second temporary carrier having a second release

surface **21** and a substantially transparent hydrophobic layer **22**. Alternately, as shown in Figure 2a, a second adhesive layer **23** may be present adjacent the hydrophobic layer.

Second Temporary Carrier having a Release Surface:

[0035] The second temporary carrier having a second release surface **21** may be any material having sufficient stiffness and dimensional stability to support the hydrophobic layer **22**, and if present, the second adhesive layer **23**. It has to be capable of assisting with the transfer of the image without having the image distort or misalign. The material of the second temporary carrier also should withstand heat and pressure applied during the lamination steps described below. The second temporary carrier typically has a thickness of about 25 to about 250 microns (1.0 to 10 mils), preferably about 50 to 200 microns (2 to 8 mils). Suitable materials include polymeric films, such as those disclosed earlier for the first temporary carrier having a first release surface. Polyethylene terephthalate films are a preferred support material.

[0036] The second release surface on the second temporary carrier **21** is similar to that described earlier for the first temporary carrier having a first release surface **11**, but it must adhere slightly more strongly to substantially transparent hydrophobic layer **22** than the first release layer of the first temporary carrier **11** adheres to the first adhesive layer **12**, in order for the process to work efficiently.

[0037] Conventional coatings for the side of the second temporary carrier opposite to the side having the second release surface may be applied to the second temporary carrier having a second release surface **21** in order to reduce curl. Examples of such "back coatings" include layers duplicating the layers on the opposite side of the second temporary carrier to balance stresses caused by temperature, humidity or degree of molecular crosslinking in said layers. Anticurl backcoating are also disclosed in U.S. Patent Nos. 4,503,111, U.S. 4,578,285, U.S. 5,068,140, U.S. 5,118,570, U.S. 5,277,965, and U.S. 5,302,437. Additionally, the second temporary carrier having a second release surface **21** may have a backing layer, to improve transport properties of the ink receptor in the ink-jet printer, if the material selected as the second temporary carrier does not possess the desired handling properties. The backing layer may have anti-static agents, matting agents, and the like that are commonly employed in the art. For example, the second temporary carrier having a second release surface **21** may have an abrasion resistant coating as disclosed in U.S. Patent No. 5,069,942.

Hydrophobic Layer:

[0038] Since the printed image is viewed through the hydrophobic layer **22**, the layer is substantially transparent and preferably has no yellowness that might shift color balance of the printed image.

[0039] The hydrophobic layer **22** includes at least one compound selected from acrylate or methacrylate polymers and copolymers such as butyl methacrylate; epoxy resin, diene rubber such as polyisoprene, polybutadiene, styrene-butadiene rubber, chloroprene rubber; polyolefin elastomers; polyurethane elastomers; polyvinyl chloride; polyvinyl butyral; polycarbonates; cellulose esters or copolymers of the corresponding monomeric units. Preferred compounds include butyl methacrylate, e.g., poly(n-butyl methacrylate), having glass transition temperatures (T_gs.) of between about 15°C and about 35°C, acrylate and methacrylate copolymers, or mixtures thereof. A particularly useful mixture is a blend of a predominant amount of butyl methacrylate polymer and acrylic copolymers, such as those acrylic polymers described as useful for the first adhesive layer. The functionality of the acrylic polymer determines useful mixture proportions; for example, it has been found that the poly(butyl methacrylate) added to certain acrylic resins (e.g., CARBOSET® resins) controls the hydrophilicity of those acrylic resins. A less hydrophilic acrylic resin might not require poly(butyl methacrylate).

[0040] Typically, the hydrophobic layer may also contain UV absorbers. Suitable UV absorbers often contain groups such as, for example, benzoates, benzophenones, salicylates, cinnamates, dithiocarbamates, benzotriazoles, propenoic esters, diphenylacrylates and combinations thereof. Examples of suitable UV absorbers include the following: propoxylated ethyl para-aminobenzoate; propoxylated ethyl para-aminobenzoate; dipropylene glycol salicylate; 2-ethylhexyl para-dimethylaminobenzoate; 2-ethylhexyl-p-methoxycinnamate; 2-hydroxy-4-methoxybenzophenone; 2-hydroxy-4-n-octoxybenzophenone; hydroxybenzoate type; nickel dibutyl dithiocarbamate; N-(p-ethoxycarbonylphenyl)-N'-ethyl-N'-phenylformamidine; blends of benzophenone and 1-hydroxycyclohexyl phenyl ketone; 2-methyl-1-(4-methylthio)phenyl)-2-morpholinopropanone-1; 2-ethylhexyl-p-methoxy cinnamate; 2-hydroxy-4-methoxybenzophenone; dihydroxybenzo-phenone; 2-hydroxy-4-methoxybenzophenone-5-sulfonic acid; 2-hydroxy-4-n-octoxybenzophenone; 2-(2'-hydroxy-5-'-methyl-phenyl)benzotriazole; 2,2',4,4'-tetrahydroxy benzophenone; sodium 2,2'-dihydroxy-4,4' dimethoxy-5-sulfobenzophenone; 2-hydroxy-4-methoxy benzophenone; 2-hydroxy-4-methoxy benzophenone-5-sulfonic acid; ethyl-2-cyano-3,3-diphenylacrylate; ethylhexyl-2-cyano-3,3-diphenylacrylate; 2,4-dihydroxy benzophenone; 2-propenoic acid, 2-cyano-3,3-diphenyl-2-ethyl hexyl ester. A useful amount of uv absorber depends on the uv absorption properties of the uv absorber, its molecular weight, and any objectionable yellow color produced by

it in the layer. Typical amounts range, from about 0.01 to about 5%.

[0041] Since the printed image is viewed through the hydrophobic layer **22**, the layer is substantially transparent and preferably has no yellowness that might shift color balance of the printed image. Because of the process of use, matting agents tend to be ineffective in the hydrophobic layer **22**, and such agents may cause unwanted haze over the printed image.

[0042] The hydrophobic layer **22** generally has a thickness in the range of from about 3 to about 40 microns, more typically from about 7 to about 20 microns.

Second Adhesive Layer:

[0043] As shown in Figure 2a, an adhesive layer **23** may optionally be present on the hydrophobic layer **22**. The composition of the second adhesive layer **23** may be the same as or different from the first adhesive layer **12**. Some useful compositions include thermoplastic resins such as acrylic resins, e.g., Carboset®; or crystalline polymers such as polycaprolactone. The layer may contain fillers such as silica particles to control tack, the presence or absence of fillers would be determined by the inherent tack of the polymer binder(s) employed as adhesive. It is important that the adhesive layer used be substantially transparent because the final image will be viewed through this layer if it is present in the transfer element.

Preparation

[0044] The hydrophobic layer and the second adhesive layer, if present, are sequentially applied to a second temporary carrier having thereon a release layer. For high coverage images, the hydrophobic layer has a dry coating weight of about 30 mg/dm² (milligram per square decimeter) to about 600 mg/dm²; similarly, the adhesive layer has a coating weight from about 30 mg/dm² to about 400 mg/dm². The hydrophobic layer and the optional second adhesive layer should be as thin as possible to minimize unwanted visual effects on the printed image, while still performing their design functions. The layers are applied to the carrier support by conventional coating methods such as roller coating or knife coating methods (e.g., air knife, trailing blade). All the ingredients can be premixed to form the compositions that are applied to the surface of the release layer at the dry coating weights set out above.

[0045] In a different embodiment the hydrophobic layer and the second adhesive layer may be laminated, in order, to a release layer that is coated on the second temporary carrier.

ADHESION BALANCES

[0046] The adhesion balance between the various layers of the ink receiving sheet and the transfer element is important if these elements are to function effectively to transfer an ink jet applied image on to a final receptor. The adhesion force at the point of separation should be lower than the adhesion forces between all other layers remaining at separation. Anchor layers may be present between layers, other than at the point of separation, to increase the adhesion force between layers.

FINAL RECEPTOR

[0047] The final receptor for the colored image can be chosen from almost any material desired. For most applications a paper final receptor is used. Other materials which can be used as the final receptor include cloth; wood; glass; china; polymeric films such as poly(ethylene terephthalate), polyethylene, polypropylene, etc.; synthetic papers; thin metal sheets or foils; cardboard, etc. The first adhesive layer provides the desired bonding strength between the ink receiving layer and the final receptor.

APPLICATIONS

[0048] The transfer media provided by this invention may receive ink printed by conventional ink-jet printers, such as thermal or bubble jet printers, piezoelectric printers, continuous flow printers, or valve jet printers.

TRANSFER PROCESSES

[0049] A transfer process may be used to produce a single or multi-colored image on a final receptor. For example, as shown in Figure 3, a ink receptor sheet **10** may be printed with one or more colored inks to form an image **30**. Some useful inks are disclosed in U.S. 5,085,698 issued February 4, 1992. As shown in Figure 4, a transfer element **20** is brought in contact with the ink image containing ink receptor sheet resulting in the image being sandwiched between

the ink receiving layer **13** and the hydrophobic layer **22**. In the embodiment, wherein the transfer sheet shown in Figure 2a is used, the image is sandwiched between the ink receiving layer **13** and the second adhesive layer **23**. Typically, contact is achieved by lamination of the transfer element to the image containing ink receptor sheet with the hydrophobic layer of the transfer element shown in Figure 2 adjacent the ink receiving layer of the ink receptor sheet carrying the ink image **30**. Next, as shown in Figure 5, the first temporary carrier having a first release surface **11** is removed, typically by peeling, revealing the first adhesive layer **12**. As shown in Figure 6, the revealed first adhesive layer **12** of the resulting element is then contacted with the final receptor **40**. The second temporary carrier is then removed, typically peeled off, leaving the ink jet applied image **30** on the final receptor sandwiched between the ink receiving layer **13** and the hydrophobic layer **22** or the second adhesive layer **23**, if present. This final element is shown in Figure 7.

EXAMPLES

[0050]

GLOSSARY:

Name	Available From	Chemical description
Carboset® 515	B. F. Goodrich, Leominster, MA	Acrylic copolymer
Carboset® 526	B. F. Goodrich, Leominster, MA	Acrylic copolymer
Carboset® 527	B. F. Goodrich, Leominster, MA	Acrylic copolymer
Elvanol® 52-22	E. I. du Pont de Nemours and Company, Wilmington, DE	Poly(vinyl alcohol)
Gantrez® S97BF	ISP, Wayne, NJ	Methyl vinyl ether/maleic acid copolymer
Elvacite® 2044	ICI Acrylics, St. Louis, MO	Poly(n-butyl methacrylate)
Uvinul® 3039	BASF, Rensselaer, NY	2-ethylhexyl-2-cyano-3,3-diphenyl acrylate
Furon® 8721	Furon, Worcester, MA	Cross-linked silicone release coating
Furon® 8785	Furon, Worcester, MA	Matte acrylic release coating
Furon® 8787	Furon, Worcester, MA	Glossy acrylic release coating
Kraton® G1657	Shell Chemical Co., Houston, TX	Styrene copolymer
Sancure® 815	B. F. Goodrich, Leominster, MA	Polyurethane resin

Printing And Lamination:

[0051] Unless otherwise stated, each of the transfer media in the Examples was printed using an AX4 ink jet printer (E. I. du Pont de Nemours and Company, Wilmington, DE). The printed medium was subsequently transferred to a permanent substrate by lamination. The lamination equipment was either a WaterProof® Laminator (E. I. du Pont de Nemours and Company), at a temperature setting of about 100 to 135°C, preferably about 115°C; or an EasySprint® Laminator (E. I. du Pont de Nemours and Company) at a lamination temperature setting of about 115°C. It is expected that EasySprint® Laminator temperature settings in the range of about 105 to 135°C would be useful for this invention, but a setting of about 115°C is preferred because optimal operations of this multi-use equipment in a commercial print shop usually dictate constant laminator conditions.

[0052] It is helpful, when transferring an image to a wrinkle-prone substrate such as polyethylene film or metal foil, to sandwich the [image-bearing transfer sheet]-[final substrate] combination between sheets of 5 mil (127 micron) polyester film (possibly recycled ink receiving layer substrate) during the final lamination. To produce the final image with any substrate, it is necessary to peel the transfer sheet substrate (and its corresponding release layer) away from the rest of the final laminated structure.

[0053] Unless otherwise stated, the amounts for ingredients in the various component layers are listed in parts by weight, based upon the weight of the component layer.

EXAMPLE 1

[0054] A solution of 15% of Carboset® 515 and 15% of Carboset® 527 in ethyl acetate was coated and dried to give an approximately 12 micron thick layer over a cross-linked silicone release layer (Furon® 8721, applied by Furon

Company, Worcester, MA) borne by a 5 mil (127 micron) thick polyester film (500 gauge Melinex® 377 film from E. I. du Pont de Nemours and Company, Wilmington, DE).

[0055] A solution of 6.6% of Elvanol® 52-22, 2.2% of Gantrez® S97BF, and 2.2% of triethanolamine in water was coated and dried to give an approximately 12 micron thick layer over the Carboset® polymer layer. The resulting structure is structure X.

[0056] A solution of 17.6% of Elvacite® 2044, 8.2% of Carboset® 526, 3.6% of Carboset® 527, and 0.6% of Uvinul® 3039 in ethyl acetate was coated and dried to give an approximately 12 micron thick layer over a polyacrylate release layer, (Furon® 8785, applied by the Furon Company, Worcester, MA) borne by a 3 mil (76 micron) thick polyester film (300S Melinex® film from E. I. du Pont de Nemours and Company). This structure is structure Y.

[0057] A color image was printed onto structure X with an AX4 ink jet printer (E. I. du Pont de Nemours and Company, Wilmington, DE). Structure Y was laminated over the image with a WaterProof® Laminator (E. I. du Pont de Nemours and Company) at 110°C and the "film" setting (transport speed about 857 mm/min and total load of about 150 pounds (68 kg) on the rollers). The 5 mil (127 micron) polyester film was peeled away, carrying with it the Furon® 8721 release layer, and discarded. The remaining XY structure was laminated to a sheet of Reflections® paper (Consolidated Papers, Inc., Wisconsin Rapids, WI) with the WaterProof® Laminator set at 110°C and the "paper" setting (transport speed about 652 mm/min and a total load of 450 pounds (204 kg) on the rollers). The 3 mil (76 micron) polyester film was peeled away, carrying with it the Furon® 8785 release layer, and discarded. The result of this process was a durable, right-reading (positive), high-quality image on a final substrate.

[0058] Durable, right-reading, high-quality images were also obtained with other final substrates such as corona-treated polyethylene film, cardboard, Cromalin® CRS-1 Receptor (E. I. du Pont de Nemours and Company), and aluminum foil, using the preceding process with structures X and Y.

EXAMPLE 2

[0059] A 20% (by weight) solution of styrene copolymer (Kraton® G1657 from Shell Chemical Company) in cyclohexane is coated over a release layer (Furon® 8721) on 5 mil (127 micron) thick polyester film and dried to give about a 12 micron thick overlayer.

[0060] A solution of 6.6% of ethyl cellulose (K-100 from Dow Chemical, Midland, MI), 2.2% of a copolymer of methyl vinyl ether and maleic acid (Gantrez® S97BF from ISP, Wayne, NJ), and 2.2% of triethanolamine in water is coated over the preceding layer of styrene copolymer and dried to give about a 12 micron overcoat. The resulting structure is structure U.

[0061] A 35% aqueous dispersion of polyurethane resin (Sancure® 815 from B. F. Goodrich Company, Leominster, MA) is coated over a release layer (Furon® 8785 on 3 mil (76 micron) thick polyester film) and dried to give about a 12 micron overlayer.

[0062] A 30% solution of poly (vinyl acetate) (AYAF from Union Carbide) in ethyl acetate is coated over the preceding polyurethane layer and dried to give about a 3 micron overlayer. The resulting structure is structure V.

[0063] A color image is printed onto structure U with an AX4 ink jet printer. Structure V is laminated over the image to give structure UV. The polyester film base of structure U is peeled and discarded, carrying with it the corresponding release layer. The remainder of structure UV is laminated to a paper substrate. The polyester film base of structure V is peeled and discarded, carrying with it the corresponding release layer. The result expected is a durable, right-reading, high-quality image on a final substrate.

EXAMPLE 3

[0064] A 30% solution of poly(vinyl acetate) (AYAF from Union Carbide) in ethyl acetate was coated over a release layer (Furon® 8721) on 5 mil (127 micron) polyester film and dried to give about a 12 micron thick overlayer.

[0065] A solution of 6.6% of polyvinylpyrrolidone (PVP K-90 from ISP, Wayne, NJ), 2.2% of copolymer of methyl vinyl ether and maleic acid (Gantrez® S97BF from ISP), and 2.2% of triethanolamine in water was coated over the preceding poly(vinyl acetate) layer and dried to give about a 12 micron thick overcoat. This resulted in structure S.

[0066] A 20% solution of thermoplastic styrene copolymer (Kraton® D1118 from Shell Chemical Co.) in cyclohexane was coated over a release layer (Furon® 8787 applied by Furon Company, Worcester, MA) on 3 mil (76 micron) thick polyester film and dried to give about a 12 micron thick overlayer.

[0067] A suspension containing 9.6% of polycaprolactone (CAPA 650 from Union Carbide), 0.4% of finely divided amorphous silica (Acematt® OK-607 from Degussa Corp., Ridgefield Park, NJ), 81% of toluene, and 9% of methanol was coated over the preceding layer of styrene copolymer and dried to give about a 3 microns thick overcoat. This resulted in structure T.

[0068] A color image was printed onto structure S with an AX4 ink jet printer. Structure T was laminated onto the image to give structure ST. The polyester film base of structure S was peeled and discarded, carrying with it the cor-

responding release layer. The remainder of structure ST was laminated to paper. The polyester film base of structure T was peeled and discarded, carrying with it the corresponding release layer. The result of this process was a durable, right-reading, high-quality image on a final substrate.

[0069] Durable, right-reading, high-quality images were also obtained, using this process and structures S and T with other final substrates such as corona-treated polyethylene, cardboard, Cromalin® CRS-1 Receptor, and aluminum foil.

EXAMPLE 4

[0070] A solution of 17% of Elvacite® 2044, 8.2% of Carboaset® 526, 3.6% of Carboaset® 527, and 0.6% of Uvinul® 3039 in ethyl acetate was coated and dried to give about a 12 micron thick layer over a polyacrylate release layer (Furon® 8785) present over a 3 mil (76 micron) thick polyester film.

[0071] A suspension containing 9.6% of polycaprolactone (CAPA 650), 0.4% of finely divided amorphous silica (Ace-matt® 607), 81% of toluene, and 9% of methanol was coated over the preceding polymer layer and dried to give about a 3 micron thick overcoat. This resulted in structure N.

[0072] A color image was printed onto structure X (from Example 1) with an AX4 ink jet printer. The printed image was placed face up on a Waterproof® carrier plate. Structure N was laid face down over the image. The resulting composite was passed through a Waterproof® Laminator set at 115°C, using the "film" setting. The 5 mil (127 micron) polyester film of structure X was peeled away, carrying with it the corresponding release layer, and discarded. The exposed first adhesive layer of the remaining NX structure was laid face down over a sheet of Reflections® paper. This composite was passed through the Waterproof® Laminator at 115°C, using the "paper" setting. The 3 mil (76 micron) polyester of structure N was peeled (from the rest of the laminate), carrying with it the corresponding release layer, and discarded. The result of this process was a durable, right-reading, high-quality image on a final substrate.

EXAMPLE 5

[0073] A color image was printed onto structure X (from Example 1) with an AX4 ink jet printer. Structure N (from Example 4) was laid over the image, so that its (second) adhesive layer contacted the ink receiving layer. The resulting NX composite was passed through an EasySprint® Laminator set at 115°C. The 5 mil (127 micron) polyester film of structure X was peeled away, carrying with it the corresponding release layer, and discarded.

[0074] A sheet of 5 mil (127 micron) polyester (recycled substrate from structure X) was placed on a Waterproof® carrier plate and smoothed with a Waterproof® static brush. A sheet of corona treated polyethylene was placed, treated side up, on the 5 mil (127 micron) polyester sheet and smoothed with the brush. The peeled NX laminate was placed face down over the polyethylene, so that its (first) adhesive layer contacted the polyethylene, and brushed smooth. Two sheets of 5 mil (127 micron) polyester were laid over the NX laminate and brushed smooth. The resulting stack was passed through an EasySprint® Laminator set at 115°C. The 3 mil (76 micron) polyester film of structure N (with its corresponding release layer) was peeled from the rest of the final laminate to yield a durable, right-reading, high quality image on polyethylene film.

Claims

1. An ink jet printing system comprising in combination:

(a) an ink receptor sheet comprising:

- (1) a first temporary carrier having a first release surface,
- (2) a first adhesive layer on the first release surface, and
- (3) an ink receiving layer on the first adhesive layer, the ink receiving layer being adapted to receive an image from the ink jet printer; and

(b) a transfer element comprising:

- (1) a second temporary carrier having a second release surface, and
- (2) a substantially transparent hydrophobic layer on the second release surface.

2. The ink jet printing system of Claim 1 in which the transfer element further comprises a second adhesive layer adjacent to the hydrophobic layer.

3. The ink jet printing system of Claim 1 in which the first adhesive layer comprises an acrylic copolymer; the ink receiving layer comprises poly(vinyl alcohol), methylvinyl ether/maleic acid copolymer and triethanolamine; and the hydrophobic layer comprises poly(n-butyl methacrylate), acrylic copolymer, and 2-ethylhexyl-2-cyano-3,3-diphenyl acrylate.

4. The ink jet printing system of Claim 2 in which the first adhesive layer comprises styrene copolymer; the ink receiving layer comprises ethyl cellulose, copolymer of methyl vinyl ether and maleic acid and triethanolamine; the hydrophobic layer comprises polyurethane resin and the second adhesive layer comprises poly(vinyl acetate).

5. The ink jet printing system of Claim 2 in which the first adhesive layer comprises poly(vinyl acetate) the ink receiving layer comprises polyvinylpyrrolidone, copolymer of methyl vinyl ether and maleic acid and triethanolamine; the hydrophobic layer comprises styrene copolymer; and the second adhesive layer comprises polycaprolactone.

6. The ink jet printing system of Claim 2 in which the first adhesive layer comprises an acrylic copolymer; the ink receiving layer comprises poly(vinyl alcohol), methylvinyl ether/maleic acid copolymer and triethanolamine; the hydrophobic layer comprises poly(n-butyl methacrylate), acrylic copolymer and 2-ethylhexyl-2-cyano-3,3-diphenyl acrylate; and the second adhesive layer comprises polycaprolactone.

7. The ink jet printing system of any of the preceding claims in which the adhesive layer, the ink receiving layer or the hydrophobic layer further comprises silica particles.

8. The ink jet printing system of Claims 3 and 6 in which the acrylic copolymer comprises an acrylate or methacrylate copolymer.

9. The ink jet printing system of Claim 1 wherein the first adhesive layer comprises polycaprolactone, copolymer of ethylene and vinyl acetate, copolymer of vinyl chloride and vinyl acetate, copolymer of vinyl chloride and vinylidene chloride, acrylate copolymer, methacrylate copolymer or polyamide; the ink receiving layer comprises a homo- or copolymer of vinyl alcohol, homo- or copolymer of vinyl pyrrolidone, a cellulose compound; homo- or copolymer of acrylic acid, methacrylic acid, maleic acid, or a metal salt thereof; homo- or copolymer of acrylic acid, methacrylic acid, maleic acid, or an amine salt thereof; starch, gelatin, gum arabic, or any combination of the foregoing; and the hydrophobic layer comprises an acrylate or methacrylate polymer or copolymer, epoxy resin, diene rubber, styrene-butadiene rubber, chloroprene rubber; polyolefin elastomer; polyurethane elastomer; polyvinyl chloride; polyvinyl butyral; polycarbonate; cellulose ester or copolymer of a monomeric unit of the foregoing.

10. A printing process for printing an ink jet image on a receptor comprising the steps of:

(a) printing an image on an ink receptor using an ink jet printer, the ink receptor comprising:

- (1) a first temporary carrier having a first release surface,
- (2) a first adhesive layer on the first release surface, and
- (3) an ink receiving layer on the first adhesive layer, the image being printed on the ink receiving layer;

(b) laminating the printed ink receptor to a transfer element comprising:

- (1) a second temporary carrier having a second release surface, and
- (2) a substantially transparent hydrophobic layer on the second release surface, the image being laminated between the ink receiving layer and the hydrophobic layer;

(c) removing the first temporary carrier and first release layer to reveal the first adhesive layer;

(d) laminating the image to a final receptor by laminating the first adhesive layer to the final receptor; and

(e) removing the second temporary carrier and second release layer, thereby revealing the substantially transparent hydrophobic layer and the image beneath the hydrophobic layer.

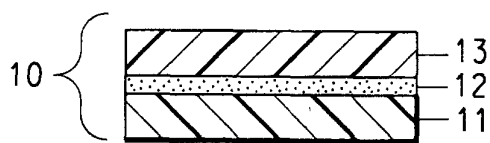


FIG. 1

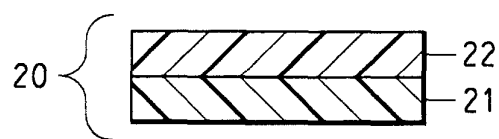


FIG. 2

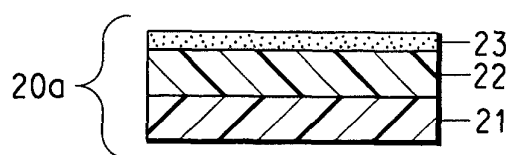


FIG. 2A

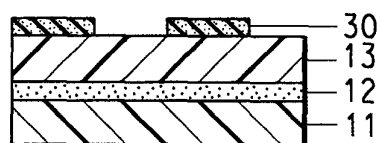


FIG. 3

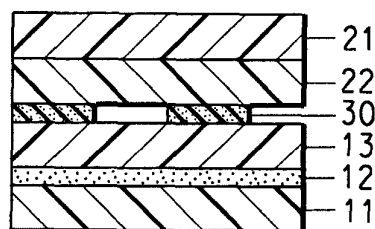


FIG. 4

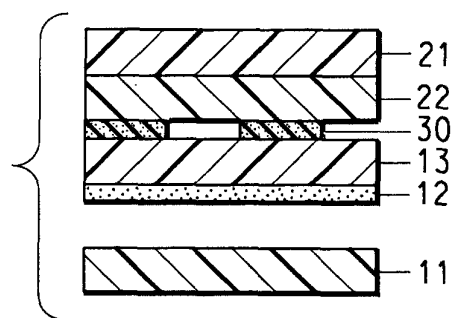


FIG. 5

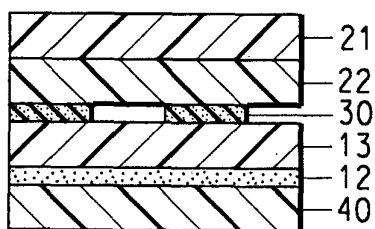


FIG. 6

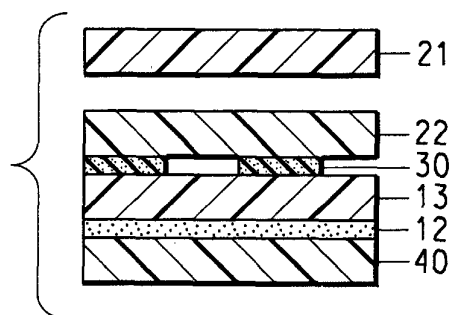


FIG. 7