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(54) Title: COATING MATERIAL FOR POROUS SUBSTRATES

(57) Abrégé/Abstract:
A substrate coating is provided for application in association with ink jet ink imaging on the substrate. The coating enhances permanence of black and specialty non-black color ink jet prints. The coating material of the present invention can be applied to the porous substrate as a pre-print coating or a post-print coating. The coating comprises a polymer, a surfactant and an electrolyte, with water.

# COATING MATERIAL FOR POROUS SUBSTRATES


## Abstract of the Disclosure

A substrate coating is provided for application in association with ink jet ink imaging on the substrate. The coating enhances permanence of black and specialty non-black color ink jet prints. The coating material of the present invention can be applied to the porous substrate as a pre-print coating or a post-print coating. The coating comprises a polymer, a surfactant and an electrolyte, with water.

# COATING MATERIAL FOR POROUS SUBSTRATES

## Technical Field

The present invention relates to ink jet printing and, more particularly, to the application of black and color inks to a specialty coated substrate for achieving enhancement in permanence and image quality.

## Background Art

In continuous ink jet printing, ink is supplied under pressure to a manifold region that distributes the ink to a plurality of orifices, typically arranged in a linear array(s). The ink discharges from the orifices in filaments which break into droplet streams. The approach for printing with these droplet streams is to selectively charge and deflect certain drops from their normal trajectories. Graphic reproduction is accomplished by selectively charging and deflecting drops from the drop streams and depositing at least some of the drops on a print receiving medium while other of the drops strike a drop catcher device. The continuous stream ink jet printing process is described, for example, in U.S. Pat. Nos. 4,255,754; 4,698,123 and 4,751,517.

Achieving improvement in permanence and darkness of ink jet print remains a top priority in the printing business. For ink jet business to grow in the graphic arts, textiles, lottery, business forms and publishing industries, significant improvement in water resistance and darkness of the image must be demonstrated.

Substrate manufacturers produce many

ink-jet grade substrates using coated components. Coated components, such as amorphous and precipitated silicas, vary in particle sizes and their distribution. Multivalent cross linking, often cationic, components include specialty treated high-bulk oxides of metals such as aluminum, titanium, zirconium, lanthanum, magnesium; modified starches; water soluble polymeric binders, such as hydrolyzed PVA; and resins. Depending on the composition and methods of coating, such substrates yield varying degrees of dot gain, brightness, optical density, rate of absorption or drying, and water resistance of the ink-jetted image.

The use of hydroxyalkylated polyethyleneimine (EPI) in ink jet inks has been shown to significantly improve waterfastness of the inks. However, polymeric inks, used to improve permanence of an image, do not run in the printer as well as non-polymeric inks, and require more frequent system maintenance. Furthermore, non-black inks achieve only modest improvement in water resistance with EPI, probably due to extreme solubility of the non-black color dyes.

Waterfastness of printed images may be achieved through ink formulation. The use of pigments, for example, versus soluble dyes, may produce permanent images due to their insolubility in water. Pigments, however, have very poor redispersability once the ink dries on the orifice plate or charge leads. This is detrimental to good runnability in a continuous ink jet printer. Another approach is to use water soluble dyes in the presence of polymers. However, viscosity limitations on ink jet inks (1.0 - 1.5 centipoise) do not permit adding enough polymer to obtain near

100% permanence without exceeding the viscosity limitation. This becomes very critical in the case of very water soluble dyes which require exceedingly more polymer for fixation.

It is seen then that there is a need for an improved method of optimizing waterfastness in an aqueous, black or non-black, dye-base ink.

## Summary of the Invention

This need is met by the coating material according to the present invention, wherein enhancement in permanence of black and specialty non-black color ink jet prints is achieved. Rather than applying the polymer solution to the ink, the polymer solution is applied to the substrate as a pre- or post-coating. This has the advantage of allowing enough polymer to be used without adversely affecting the runnability of the ink. Furthermore, the ink formulations will remain simple and have a better chance of running well in ink jet systems. The coating material of the present invention can be applied to the porous substrate as a pre-print coating or a post-print coating.

In accordance with one aspect of the present invention, a coating material for application on a porous substrate for use with an ink jet printing system comprises an ethoxylated polyethyleneimine polymer, a surfactant and an electrolyte. When the coating material is applied to the porous substrate, waterfast prints are produced which are resistant to smudging or bleeding when subjected to moisture.

Other objects and advantages of the invention will be apparent from the following description and the appended claims.

## Detailed Description of the Invention

The present invention proposes a coating material for application on a porous substrate. The application may occur before or after printing, using any suitable application means such as spraying. The coating material is particularly advantageous for use on a porous substrate, including a textile-, paper- or pulp-based substrate. The substrate coating enhances the permanence of ink jet imaging on the substrate to produce waterfast prints resistant to smudging or bleeding even when subjected to moisture.

In accordance with the present invention, the coating composition comprises an aqueous solution of a polymer, a surfactant and an electrolyte. The polymer cross-links to the dye in the ink jet ink. The surfactant enhances the wetting of the coating to the substrate. The electrolyte lowers the solubility of the ink into the coating.

The following examples illustrate various formulations for the pre- or post-coating solution of the present invention, and the resultant effectiveness of each embodiment.

### Example 1

| | |
|---|---|
| Ethoxylated Polyethyleneimine (20% solution) | 5.0% |
| SURFYNOL™ 465 | 0.3% |
| Deionized water | 94.7% |

### Example 2

| | |
|---|---|
| Ethoxylated Polyethyleneimine (20% solution) | 5.0% |
| SURFYNOL™ 104E | 0.05% |
| Sodium Sulfate | 1.0% |
| Deionized Water | 93.95% |

Example 3

| | |
|---|---|
| Ethoxylated Polyethyleneimine (20% solution) | 5.0% |
| Surfynol TGE | 0.1% |
| Ammonium Sulfate | 1.0% |
| Deionized Water | 93.9% |

Example 4

| | |
|---|---|
| Ethoxylated Polyethyleneimine (20% solution) | 5.0% |
| Surfynol 440 | 0.1% |
| Ammonium Sulfate | 1.0% |
| Isopropyl Alcohol | 2.0% |
| Deionized Water | 91.9% |

To determine the effectiveness of the solutions in each example above, three different types of substrate boards (Kraft, white top and chemi) were sprayed with solutions of Examples 1, 2, 3 and 4, then dried with a heat gun. The sprayed boards were then imaged and the prints were evaluated for waterfastness, bleed, and print intensity. Solutions of the above examples were also evaluated on a pre-imaged substrate by spraying the printed substrates followed by drying.

The following table illustrates results obtained with the different coating solutions:

I. Pre-Coating

| | Waterfastness | Bleed | Print Intensity |
|---|---|---|---|
| Ex.1 | 85-90% | Some | Enhanced |
| Ex.2 | 85-90% | Less Bleed | Enhanced |

| | | | |
|---|---|---|---|
| Ex.3 | 95-100% | No Bleed | Enhanced |
| Ex.4 | 95-100% | No Bleed | Enhanced |
| | | II. Post-Coating | |
| Ex.1 | 85-90% | Yes | No Change |
| Ex.2 | 85-90% | Less Bleed | No Change |
| Ex.3 | 95-100% | Min. Bleed | No Change |
| Ex.4 | 95-100% | Min. Bleed | No Change |

From these results, it is seen that ammonium sulfate has the additional advantage of reducing the pH, thus increasing the cationic character of EPI. This, in turn, enhances interaction with anionic dyes.

Therefore, in a preferred embodiment of the present invention, the aqueous coating solution comprises 0.5 to 10% (on 100% basis) of EPI, 0.05 to 0.5% of a surfactant, 0.5 to 5% of an electrolyte, and water.

The surfactant can be any nonionic, anionic, or cationic surfactant such as, for example, Surfynol 465, Surfynol TGE and Surfynol 104E. The surfactant in the coating fluid enhances wetting of highly hydrophobic substrates. Also, the electrolyte can be any water soluble inorganic salt, such as, for example, sodium sulfate or ammonium sulfate. The addition of salt to the coating solution decreases the solubility of the dye in the aqueous solution to allow an effective polymer/dye interaction to occur. Ammonium sulfate has the added advantage of lowering the pH, thus enhancing polymer/dye interaction. Other additives that are optionally included in the vehicle of the invention are a lower aliphatic alcohol from 0-10% such as ethanol or IPA, and a biocide such as 1,2 -

Benzoisothiazolin-2 one from 0-0.3%.

The coating solution may be applied by any suitable means, such as, for example, by spraying, roller arrangement, or application by a printhead positioned inline with the ink-applying printheads. When a printhead is used to apply the coating solution, the option exists of covering only the printed image area with the coating material, rather than the entire area of the substrate. After a post-coating application, the print can be dried, such as with a heat gun, to set the image.

Alternatively, the coating composition can be applied to the substrate prior to imaging, as a precoat material. Pre-coat application can provide the advantage of eliminating color-to-color bleed during imaging, since the dyes are fixed instantaneously as the ink contacts the pre-coated substrate. Furthermore, with pre-coating, images appear darker and have sharper edge definition, since the coating minimizes ink penetration and allows more fixed dyes on the surface. Finally, complete drying of the pre-coated substrate may not be necessary. Therefore, drying can be applied once after imaging, resulting in considerable savings in energy.

Imaging can be done on a continuous web of paper, wherein the paper is subjected to the coating material of the present invention. The various color heads are positioned behind each other so that they image sequentially on the paper as it passes underneath the head. In order to obtain high quality color images, multiple drops of each color ink are printed at each pixel location. The jet spacing is 240-300 dpi with an orifice diameter of 0.7 to 0.9 mil. The stimulation frequency is 100 kHz and all heads are synchronized. The web speed is typically 200-500 feet per minute accurately controlled.

When the images are printed prior to application of the coating material, application of moisture to the print causes extreme bleed, to the point of almost complete color removal. However, when the coating material of the present invention is applied to the ink jet prints, and then dried, the images are close to 100% permanent even when sprayed with water. Alternatively, the coating material may be applied as a pre-print coat to the substrate, i.e., prior to imaging, with substantially equivalent results.

As will be obvious to anyone skilled in the art, the components that comprise the coating are commercially available. It is also understood and known in the art that waterfastness is dye specific, resulting in variations in the amount of waterfastness achieved, particularly when varying the inks being applied to the substrate. Almost all ink jet inks applied on a variety of commodity substrates give vastly varying image quality. Differences occur in optical density, brilliance, permanence, drying and dot resolution. The substrate coating composition of the present invention is particularly adaptable for printing permanent images on cardboards which are used to build boxes. Another application is to treat textile materials printed with direct dyes. Direct dyes have very poor waterfastness on cellulosic fabrics. Treatment of the fabric with the coating solution of the present invention can produce fabrics with excellent waterfastness.

The invention has been described in

detail with particular reference to certain preferred embodiments thereof, but it will be understood that modifications and variations can be effected within the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A substrate coating applied before or after printing for enhancing permanence of ink jet imaging on the substrate, the coating comprising a liquid vehicle, an ethoxylated polyethyleneimine polymer, a surfactant and an electrolyte, wherein

the ethoxylated polyethyleneimine polymer comprises from about 0.5% to 10% by weight, based on a 100% weight basis;

the surfactant is present in an amount of about 0.05% to 0.5% by weight and is selected from the group consisting of nonionic, anionic and cationic surfactants; and

the electrolyte comprises a water soluble inorganic salt and is present in an amount of about 1.0% to 5% by weight; and wherein

the liquid vehicle is an aqueous solution.

2. A substrate coating as claimed in claim 1 further comprising a lower aliphatic alcohol.

3. A substrate coating as claimed in claim 1 further comprising a biocide.

4. A coating substrate as claimed in claim 1 wherein waterfastness of the ink jet ink is improved to greater than 95%.