United States Patent

[11] 3,620,806

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[21] Appl. No. **729,920**
[22] Filed **May 17, 1968**
[45] Patented **Nov. 16, 1971**

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[54] **BLUSHED POLYSTYRENE COATING ON PAPER**
2 Claims, No Drawings

[52] **U.S. Cl.** ..... **117/63,** 117/36.7, 117/155 VA
[51] **Int. Cl.** **B44d 1/44**
[50] **Field of Search** 117/36.7, 63, 144.5; 161/164

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ABSTRACT: Method of coating a substrate with polystyrene, and after drying the coated substrate, blushing part of the coating to produce either a very glossy or a mat finish on the coated surface, leaving unblushed polystyrene separating the blushed portion of the polystyrene and the substrate. Coated products, suitable for printing, are produced and comprise a substrate bearing on at least one surface a coating of polystyrene, the surface of the coating being microporous and opaque, the substrate and blushed portion of the coating being bridged by unblushed polystyrene.

BLUSHED POLYSTYRENE COATING ON PAPER

BRIEF SUMMARY OF THE INVENTION

This invention relates to the coating of substrates, particularly paper, paperboard and the like, with polystyrene in solution and then blushing a portion of the polystyrene coating to produce an opaque polystyrene coating which adheres to the substrate even under printing conditions.

Completely blushed coatings of some thermoplastic materials on substrates are known, but they have little or no pick strength when printed. This is so because the coating is not bonded to the substrate due to poor adhesion between the blushed coating and the substrate. One approach to solve the pick problem has been to include other ingredients in the coating formulation for the purpose of bonding the coating, after blushing, to the substrate.

In the present invention, blushed polystyrene coatings of high opacity are produced on various substrates, and the coatings adhere to the substrate and have sufficient strength to withstand a printing operation without the use of additional bonding materials. A clear solution of polystyrene is applied to paper, paperboard or other substrates or films, and by blushing a portion of the clear polystyrene coating, an opaque coating, which is printable on conventional presses, is produced on the substrate. The opacity derived is not the result of pigmentation of the polystyrene but is the result of creating a microporous structure at least in the top-most portion of the polystyrene coating. While the surface of the coating is blushed, a portion of the coating below the surface is left unblushed and is transparent. This unblushed portion of the coating is between and serves to bridge the blushed portion of the coating and the substrate. It has been found that by leaving unblushed a portion of the coating adjacent to the substrate, the pick strength of the coating is greatly increased over a completely blushed polystyrene coating.

The blushed coatings of this invention can exhibit an opaque surface which is very glossy, or an opaque surface having a mat finish of low gloss, depending on the blushing technique employed. However, in all cases, the blushing is the result of treating the solvent-wet surface of the coating with a diluent or nonsolvent which is miscible with the solvent but in which the polystyrene is insoluble.

Polystyrene is dissolved in a suitable solvent and is applied to a substrate in any conventional manner, such as by dipping the substrate into a polystyrene solution or applying the polystyrene solution to the substrate by a conventional coating apparatus. After a wet film of the polystyrene is applied to the substrate, the coated substrate is dried in any conventional manner. In one embodiment of the invention, the dried, coated substrate is then treated with a solvent for the polystyrene, and then immediately treated with a nonsolvent to blush the surface of the polystyrene and render it opaque. The nonsolvent or diluent is then removed from the coated substrate by air drying or by use of conventional paper dryers such as dryer drums or radiant dryers. The final product has an opaque, coated surface which has a mat finish and is suitable for printing.

In another embodiment of the invention, after the substrate is coated with the polystyrene solution and dried for the first time, the coated surface is treated with additional polystyrene solution, then immediately treated with a nonsolvent, and finally dried. The dried final product has an opaque, coated surface which has a high gloss and is suitable for printing.

In each of the above embodiments of the invention, the initial coating is dried, then softened or rewet with solvent or with a solution of solvent and additional polymer, and then the softened or wet coating is immobilized by "phase separating" the polymer with a diluent, a phenomenon described in U.S. Pat. No. 3,377,191. The solvent treatment can be accomplished by dipping the coated substrate into a solvent bath or by spraying or coating solvent onto the coated surface of the substrate. After softening or rewetting the coated surface, the wet coating can be immobilized by dipping the coated substrate into the diluent, a nonsolvent for the polymer, or by spraying the diluent onto the coated surface. The immobilization treatment should be carried out as soon as convenient after application of the solvent to wet and soften the coated substrate.

Polystyrene can be dissolved in various solvents, and those particularly useful in practicing this invention are ketones, esters, and ethers such as methyl ethyl ketone, methyl isobutyl ketone, ethyl acetate, isoamyl acetate, bis(2–ethoxyl–ethyl)ether, and methylal. Other solvents used have been hydrocarbons such as carbon tetrachloride, gasoline, toluene, trichloroethane, and dioxane. Various nonsolvents may be employed, such as methanol, ethanol, pentane, hexane, and heptane. The preferred solvent-non-solvent system is methyl isobutyl ketone and methanol. One skilled in the art will appreciate that other solvents and nonsolvents can be used.

Various substrates may be employed in this invention. The preferred substrates are paper and paperboard which when carrying the opaque polystyrene coatings of this invention, on one or both sides, find great utility as printing papers.

The optical properties of the coated papers produced according to the present invention further enhance their utility as printing papers. It is believed that the high opacities obtained are a direct result of treating a dried polystyrene surface with solvent and then non-solvent, in separate steps.

DETAILED DESCRIPTION

The invention will be described in greater detail with the aid of the following examples.

EXAMPLE 1

Fifteen parts polystyrene (Dow Styron G78–27–7) were dissolved in 85 parts methyl isobutyl ketone, all parts being by weight. A sheet of uncoated kraft basestock paper, having a basis weight of about 40 pounds per ream, was vertically dipped into the clear polystyrene solution, and the sheet was dried at 105° C. to leave a clear or translucent coating of polystyrene on the paper. The amount of coating pickup was about 10 pounds per ream per side of paper. After the sheet was dried, it was dipped into a solvent bath of methyl isobutyl ketone, removed, and then dipped immediately into a second bath containing methanol. The surface portion of the polystyrene coating was softened by the solvent, and the methanol caused the softened polymer to blush. The sheet was removed from the methanol and dried at 105° C. The dwell time in each bath was about 1 second. The final coated paper had an opaque polystyrene coating on both surfaces, and each surface had a mat finish. The following data were collected on the basestock before coating and on the final polystyrene coated paper:

Condition	LRL brightness	B & L opacity	LRL gloss
Basestock	75.3	88.3	
Coated	85.3	95.4	15

The above paper was suitable for printing on a multilith press. It was ink receptive and did not pick on the press. Upon sectioning the coated paper, it was found that a portion of the polystyrene coating adjacent to the paper substrate was not blushed, and the unblushed polystyrene bridged the paper substrate and the blushed portion of the coating.

EXAMPLES 2–3

In example 2, 4 parts polystyrene were dissolved in 96 parts methyl isobutyl ketone, all parts being by weight. Sheets of uncoated kraft basestock paper were given a basecoat of polystyrene by dipping the sheets into one of the solutions. The coating pickup in example 2 was about 2½ pounds per ream per side of paper, whereas in example 3, the coating pickup was about 10 pounds per ream per side. The sheets were dried at 105° C. Each sheet was then dipped into a second polystyrene solution comprising 4 parts polystyrene

dissolved in 96 parts methyl isobutyl ketone, removed, and then dipped immediately in a methanol bath. The sheets were removed from the methanol bath and dried at 105° C. The dwell time in the second polystyrene solution and the methanol was about 1 second. The optical data for the final products are shown below.

Example	LRL brightness	B & L opacity	LRL gloss
Basestock	75.3	88.3	
2	84.4	96.9	60
3	90.5	99.5	75

It is to be noted that the opacities of the products of examples 2 and 3 were very high, and the opaque surfaces exhibited much higher glosses than the product of example 1 with its mat finish.

The basecoat of polystyrene was about four times heavier in example 3 as compared to example 2. The basecoat in example 3 remained substantially unblushed whereas the basecoat in example 2 was blushed substantially throughout its thickness. Upon printing the products of examples 2 and 3 by multilith, the product of example 2 picked. However, the product of example 3 showed no tendency to pick since the unblushed portion of the coating served as a tie coat between the blushed polystyrene and the substrate.

Runs similar to those in examples 2 and 3 were made, except that the basecoat was deleted. In one run, paper was dipped into the solution comprising 4 parts polystyrene, and in another run paper was dipped into the solution comprising 15 parts polystyrene. In each of these runs, the paper after being dipped in the polystyrene solution, was then immediately dipped into the nonsolvent methanol bath, removed, and then dried. The total coating pickup was about 5 pounds per ream in the first instance, and about 20 pounds per ream in the other instance. The polystyrene coating in each instance was blushed throughout its entirety, but the blushed film did not adhere to the paper substrate and could be peeled from the paper as a continuous film. Regardless of the coat weight, a coated substrate prepared in this manner picked during a printing operation, thus showing the advantage in having unblushed polystyrene bridging the substrate and the blushed coating.

From the above examples, it can be seen that paper coated with blushed polystyrene, which is suitable for printing, can be produced. The coated products comprise a base sheet bearing on at least one surface a coating of polystyrene, the surface portion of the coating being microporous and opaque as the result of being blushed, the base sheet and blushed portion of the coating being separated by unblushed or transparent polystyrene.

Throughout the examples, polystyrene in solution has been applied to the substrate. However, the polystyrene basecoat can be applied as a hot melt by extruding the polystyrene onto the substrate, and then the coated substrate can be blushed in the manner of the present invention.

As one skilled in the art will readily appreciate, various modifications may be made in the examples and descriptions set out above without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. An article of manufacture, such as printing paper having a surface with high pick strength, comprising a porous substrate such as paper in adherent contact therewith a coating of polystyrene having a coat weight of at least 10 lbs. per ream, which is ink receptive to withstand a printing operation without the use of additional bonding, the surface portion only of the coating being blushed to render it microporous and opaque to yield a B & L opacity of at least 95.4, the porous substrate and the blushed surface portion of the coating which is microporous and opaque being separated by unblushed polystyrene which adheres the blushed surface of the polystyrene coating to the porous substrate, said article of manufacture being produced by the process comprising the steps of:

a. applying a basecoat to the substrate with a wet film of polystyrene in solution,

b. substantially drying the substrate and polystyrene coating,

c. exposing the coated substrate to a solvent for polystyrene such as methyl isobutyl ketone which contains additional polystyrene dissolved therein for about one second to soften only the surface portion of the polystyrene coating thereby leaving the basecoat unaffected,

d. immediately applying a nonsolvent for polystyrene such as methanol to the softened surface portion of the polystyrene coating for about one second, said nonsolvent being miscible with the polystyrene solvent but in which the polystyrene is insoluble, to blush and render microporous and opaque only the softened surface portion of the polystyrene coating and leave the basecoat of unblushed polystyrene between the blushed surface and the substrate to adhere the blushed surface to the substrate.

2. An article of manufacture, such as printing paper having a surface with high pick strength, comprising a porous substrate such as paper and in adherent contact therewith a coating of polystyrene having a coat weight of at least 10 lbs. per ream, which is ink receptive to withstand a printing operation without the use of additional bonding, the surface portion only of the coating being blushed to render it microporous and opaque and yield a high opacity, the porous substrate and the blushed surface portion of the coating which is microporous and opaque being separated by unblushed polystyrene which adheres the blushed surface of the polystyrene coating to the porous substrate, said article of manufacture being produced by the process comprising the steps of:

a. applying a basecoat to the substrate with a wet film of polystyrene in solution,

b. substantially drying the substrate and polystyrene coating,

c. exposing the coated substrate to a solvent for polystyrene such as methyl isobutyl ketone which contains additional polystyrene dissolved therein for about one second to soften only the surface portion of the polystyrene coating thereby leaving the base coat unaffected,

d. immediately applying a nonsolvent for polystyrene such as methanol to the softened surface portion of the polystyrene coating for about one second, said nonsolvent being miscible with the polystyrene solvent but in which the polystyrene is insoluble, to blush and render microporous and opaque only the softened surface portion of the polystyrene coating and leave the basecoat of unblushed polystyrene between the blushed surface and the substrate to adhere the blushed surface to the substrate.

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