

1

3,391,049

SMOOTH, MOISTURE-PERMEABLE SHOE UPPER MATERIAL

William F. Manwaring, Madison, Tenn., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

No Drawing. Continuation-in-part of abandoned application Ser. No. 355,435, Mar. 27, 1964. This application Oct. 9, 1967, Ser. No. 674,011

2 Claims. (Cl. 161-84)

ABSTRACT OF THE DISCLOSURE

A moisture-permeable sheet material is provided which (1) is useful as a shoe-upper material, (2) has unusually good surface smoothness when under tension as well as when relaxed, and (3) is made up of (a) a nonwoven fabric, (b) a very specific type of woven cotton fabric in superposed adherence with the nonwoven fabric, and (c) a mass of microporous moisture-permeable flexible polymeric composition which not only forms a smooth coating on fabric (b) but also penetrates the pores of fabrics (a) and (b) whereby the coating and the fabrics are integrally bonded together.

Cross-reference to related application

This is a continuation-in-part of my patent application Ser. No. 355,435, filed Mar. 27, 1964, now abandoned.

Background of the invention

This invention concerns moisture-permeable composite sheet materials useful for the manufacture of shoe-uppers and having good smoothness characteristics.

One of the problems encountered during the lasting operation when forming shoes from material prepared by impregnating and coating fibrous webs with polymeric materials is the development of roughness in those areas which require some stretching over the last, such as in the toe and quarter areas of the shoe. Even when a nonwoven web is used, this roughening is usually present and is associated with the pattern on the surface of the nonwoven web prior to impregnation. It is known that moisture-permeable man-made leather-like sheet materials are sometimes referred to in the art as poromeric materials.

It is a particular object of this invention to produce a poromeric material for shoe uppers from a fibrous web having a pattern on its surface prior to impregnating and surface coating, which poromeric material is "non-roughening" in the sense that after the fibrous web is impregnated, coated and then stretched, as during toe and quarter lasting during shoe manufacture, a surface pattern is not visually apparent in any significant amount.

Summary of the invention

In a broad sense, the novel product of this invention is a moisture-permeable composite sheet material having a good surface smoothness when relaxed and when under tension, and adapted for use as a breathable shoe-upper material, containing as essential components

(A) A porous nonwoven fabric substrated impregnated at least on one side with a polymeric material,

(B) A porous woven cotton fabric in superposed adherence with fabric (A), and having (1) a thread count of about 80-150 in both the warp and fill, (2) a weight of about 2-3 ounces per square yard, (3) a tensile strength of at least 45 pounds per inch in both the warp and fill directions, (4) a break elongation of about 10-30% in both the warp and fill directions, (5) a modulus at 5% elongation of about 900-1700 p.s.i. in the warp

2

direction and about 500-900 p.s.i. in the fill direction, (6) a thickness of about 5-6 mils and (7) a smoothness factor of less than 20 mils, and

(C) A mass of microporous moisture-permeable flexible polymeric composition which forms a smooth coating in superposed adherence with fabric (B), penetrates the pores of fabric (B), penetrates the pores of at least the uppermost portion of fabric (A), and integrally bonds the coating and fabrics (A) and (B) together.

Description of preferred embodiments

In accordance with this invention, a non-roughening poromeric material can be prepared using the polymers and polymeric dispersions disclosed in U.S. Patent 3,100,721 issued Aug. 13, 1963 to Holden and in U.S. Patent 3,208,875 issued Sept. 28, 1965 to Holden. The disclosures of both of these patents are incorporated herein by reference.

The poromeric laminate of this invention can be prepared by utilizing the procedures of the above patents and interposing a suitable interlayer fabric between the porous substrate sheet and the polymer dispersion coating under certain conditions set forth herein below and then coagulating and drying the coating.

A useful manner of preparing the novel product can be aptly illustrated by means of a preferred embodiment wherein an impregnated nonwoven web such as utilized in Example 1 of U.S. 3,100,721 is placed beneath and in close contact with a certain cotton interlayer fabric. A woven cotton fabric is peculiarly suitable as an interlayer providing non-roughening properties in a poromeric laminate having a coating thickness of less than about 30 mils. The woven cotton interlayer should have the characteristics set forth above in the Summary of the Invention. It will be apparent from the present disclosure that the fabric properties listed therein are the properties of the fabric before being combined with the other components of the sheet material. According to a preferred embodiment, a cotton fabric which has been desized and slack-mercerized to reduce the fabric face area at least 8% based on greige is used. The fabric preferably has a residual shrinkage of less than 1% as measured by ASTM CCT-191A. Preferably the cotton fabric is also bleached and double singed on each side before use herein.

The polymeric dispersion utilized in Example 1 of U.S. 3,100,721 is then coated on the upper surface of the interlayer fabric in sufficient amount to provide a uniform smooth coating over the surface. The polymeric dispersion has a viscosity low enough to permit it to penetrate the interlayer fabric and to enter at least a portion of the substrate fabric. The quantity of polymeric dispersion applied to the interlayer is usually large enough so that even after such penetration and filling of the interstices of the interlayer fabric and those of the substrate fabric, there still remains a coating on the upper surface of the interlayer fabric of sufficient thickness so that after coagulation of the polymer therein there is a surface coating of polymeric material at least 18 mils thick. If the viscosity of the polymeric dispersion is low enough, it will penetrate the interlayer and substrate merely by force of gravity and without assistance. Where higher viscosities are utilized, suction may be applied to the under side of the substrate, or to the under side of the interlayer before the interlayer is contacted with the substrate; or the polymeric dispersion may be forced into the interstices of the interlayer and substrate fabrics by any other convenient means. The manner of causing penetration of the interlayer and the substrate fabric by the polymer dispersion is not critical, but it has been found that the application of suction beneath the substrate or the interlayer serves to provide more uniform penetration with least disturbance of interlayer characteristics, and produce poromeric laminates

having the best combination of non-roughening properties and delamination tensile strength. In any event laminates thus produced have a smooth coating of microporous polymeric material over the surface of the interlayer and this coating is contiguous with a matrix of the polymeric dispersion extending within and connecting the interstices of the interlayer fabric and the substrate, thereby providing a sturdy bond between the polymer coating and the substrate.

Any of the polymer dispersions (including solutions) disclosed in the above-mentioned U.S. Patents 3,100,721 and 3,208,875 may be utilized in this invention. Following coating of the interlayer material as described above, the coated structure is then bathed to coagulate the polymer and dried as described in these patents.

It is not essential that the interlayer fabric be the particular 5.00 x 40 cotton lawn fabric described below in the example because any woven fabric of cotton or the like having the above-described characteristics can be utilized to advantage as an interlayer in practicing this invention.

Smoothness factor as used herein refers to the thickness in mils of the coating of polymeric composition after coagulation and drying which hides the surface pattern of fabric (B) so that said pattern is rendered substantially invisible to the unaided eye. For purposes of this invention the polymer dispersion and procedure utilized in the example is taken as a standard polymer dispersion for determining smoothness factor.

Roughness values of poromeric materials are conventionally determined by Machine Model 1004-50B made by Columbia Vise and Manufacturing Company, Cleveland, Ohio. Using this machine the roughness value of a poromeric material is determined by clamping a twelve-inch-square sample tightly between ring clamps, coating side up, and distending the material upwards by a plano-convex deformation head to a maximum of one inch above the original plane. The head is moved by hydraulic pressure over a period of about 15 seconds. If there is no apparent roughness at the high point the roughness value is zero; if discernible but insignificant roughness is present the roughness value is one; if the roughness is visible to the naked eye and significant in amount the roughness value is proportionally greater than one.

The strength of the adhesive bond between the interlayer and substrate is determined by taking a 1" x 6" sample and cutting it across the width sufficiently deep so that the interlayer can be separated from the substrate for a length of about 2 inches. The sample is then placed in an Instron tensile strength tester and the strength of the adhesive bond measured using a cross head speed of 10 inches per minute, a chart speed of 2 inches per minute and a jaw gap of 2 inches. Strength of the bond between the coagulated, dried surface coating and interlayer fabric is measured similarly.

The example which follows is given for the purpose of illustrating the invention. All quantities shown are on a weight basis unless otherwise indicated.

A substrate consisting of a porous impregnated needle punched nonwoven mat of 0.25 denier heat shrunk poly-(ethylene terephthalate) staple fiber having a needled pattern on its surface is placed beneath and in close contact with an interlayer sheet consisting of a woven (5.00 x 40) cotton lawn fabric. The nonwoven substrate had been previously impregnated with a polyurethane dispersion composition corresponding to that utilized below and then dried so that the impregnated substrate contained 50% dispersion solids based on the weight of fibers. The interlayer fabric had been desized and then slack mercerized in 23% sodium hydroxide solution to reduce the fabric surface area 12% below the greige fabric surface area (one side) and then dried to reduce its moisture content to less than 4% by weight. The resulting fabric had the following characteristics: count 123/118; weight 2.6

oz./yd.², tensile strength 50 x 50 lbs./in., break elongation 15% x 15%, modulus 1200 x 720 (warp x filling) lbs./in.² at 5% elongation, thickness 5 mils and smoothness factor less than 20 mils. Thickness is determined by ASTM D-1813-60T.

After the interlayer fabric is placed on top of the impregnated substrate, a polymer dispersion in a dimethyl formamide/water mixture, prepared in accordance with Example 1 of U.S. 3,100,721 to Holden, is coated on the upper surface of the interlayer sheet in the amount of 3.75 pounds dispersion per square yard of surface coated. The coated structure is subjected to suction (5 inches of mercury vacuum) from the under side of the substrate layer for a few seconds, which is sufficient to draw the polymer dispersion through the interlayer material and partially into the substrate layer whereby there is formed a continuous matrix connecting the two layers and terminating in a polymer dispersion coating on the upper surface of the interlayer. The amount of suction and the length of time it is applied is regulated so that sufficient polymer dispersion remains on the upper side of the interlayer fabric to provide a coating about 18 mils thick after coagulation. About one-half minute after suction is released, during which time the polymeric dispersion "flows out" and forms a smooth coating on the upper surface of the interlayer material, the laminated structure is immersed in a tank which contains water at room temperature and is bathed in this water for about 3 minutes. Finally the product is immersed in another water bath at 35° C. until the polymer is completely coagulated. Residual solvent is leached from the product by further bathing in water, and then the coated substrate is subjected to hot air at 250° F. for 7 minutes followed by drying at about 50° C. temperature.

The polymer coating is 18 mils thick, and the resulting poromeric product is 60 mils thick and has a roughness value of zero. The strength of the adhesive bond between fabric layers is 4.5 pounds/inch, and between the coating and interlayer is 4.5 pounds/inch. Leather permeability value is about 7000 (gms./hr./100 m.² at 21° C., 90% R.H., 3 hrs.; general method of Kanagy and Vickers, Journal of Leather Chemists Association, 45, 211-242, Apr. 19, 1950).

Poromeric products prepared in accordance with this invention generally have roughness values not exceeding one, a minimum delamination bond strength (between coating and interlayer and also between interlayer and substrate) of about 3 lbs./in. and a leather permeability value of about 3000 or more.

I claim:

1. A moisture-permeable composite sheet material having good surface smoothness when relaxed and when under tension, and adapted for use as a breathable shoe-upper material, containing as essential components

(A) a porous nonwoven fabric substrate impregnated at least on one side with a polymeric material,

(B) a porous woven cotton fabric in superposed adherence with fabric (A), and having (1) a thread count of about 80-150 in both the warp and fill,

(2) a weight of about 2-3 ounces per square yard,

(3) a tensile strength of at least 45 pounds per inch

in both the warp and fill directions, (4) a break elongation of about 10-30% in both the warp and fill

directions, (5) a modulus at 5% elongation of about

900-1700 p.s.i. in the warp direction and about 500-

900 p.s.i. in the fill direction, (6) a thickness of

about 5-6 mils and (7) a smoothness factor of less

than 20 mils, and

(C) a mass of microporous moisture-permeable flexible polymeric composition which forms a smooth

coating in superposed adherence with fabric (B),

penetrates the pores of fabric (B), penetrates the

pores of at least the uppermost portion of fabric

(A), and integrally bonds the coating and fabrics

(A) and (B) together.

5

2. A sheet material according to claim 1 wherein fabric (B) is a cotton fabric which has been bleached, desized, slack-mercerized and singed on both sides, the coating in superposed adherence with (B) has a thickness of less than 20 mils and a roughness value of about 0-1, and fabric (A) is a nonwoven fabric of synthetic polymer fibers which has been impregnated throughout its thickness with a moisture-permeable flexible poly-
meric composition.

6

References Cited

UNITED STATES PATENTS

1,408,061	2/1922	Arnold.	
1,875,735	9/1932	Jackson	161—84
2,949,394	8/1960	Rodman.	

FOREIGN PATENTS

842,492	7/1960	Great Britain.
---------	--------	----------------

ROBERT E. BURNETT, *Primary Examiner*.
R. H. CRISS, *Assistant Examiner*.