A method for preparing carpet by using polyurethane to anneal secondary backing to a greige, comprising fibers attached to a primary backing. The polyurethane monomers are mixed just prior to application to the greige primary backing allowing the relatively low viscosity polyurethane to penetrate the fibers of the primary backing to aid in fiber lock. The polyurethane coated greige is then contacted with the secondary backing before complete polymerization to insure sufficient tack to hold thebackings together.
POLYURETHANE COATING PROCESS FOR CARPET BACKING

RELATED APPLICATION DATA

[0001] The present application claims priority from U.S. Provisional Application Ser. No. 60/245,966 entitled POLYURETHANE COATING PROCESS FOR CARPET filed on Nov. 3, 2000, the entire specification of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to improved methods for adhering secondary backing to tufted or woven carpeting employing polyurethane adhesive systems.

BACKGROUND OF THE INVENTION

[0003] It is customary in the carpet and rug industry to use various forms of filled and unfilled latex or polyurethane to coat the back of carpet. The coating is used to bond the face fibers to the primary backing and to bond secondary backings to the greige (fibers/primary backing). For example, carpets having attached polyurethane foam layers as backing are described in U.S. Pat. Nos. 3,755,212; 3,821,130; 3,862,879; 4,022,941; 4,515,646; 5,604,267; 5,908,701; and 6,299,715. A key property of the carpet produced by these methods is annealing strength, the force required to separate the secondary backing from the carpet. In order to achieve suitable annealing strength, the secondary backing must be in direct contact with the greige, and a sufficient amount of adhesive must be interagent the greige and the secondary backing to ensure complete wet out of the fibers. Another key property is, the fiber lock, which measures the force necessary to pull face fibers from the carpet.

[0004] The most widely used annealing adhesive is latex. Latex is typically applied by methods involving roll over flattened or roll over roll processes. Regardless, of the method used, the greige is coated with an adhesive precoat of latex, and the secondary backing, also coated with latex, is married to the greige and cured.

[0005] Although, latex is a popular adhesive, carpet prepared from latex displays numerous shortcomings. For example, the strength and hydrolytic stability of latex is less than desired, and latex is less durable over time than alternative polymer systems such as PVC plastisol or polyurethane. Moreover, latex curing requires the evaporation of large amounts of water during cure, a process that is both expensive and energy intensive. The use of latex also hinders the effective recycling of manufacturing remnants and used carpet at the end of its life cycle. Alternatively, polyurethane adhesives are capable of forming carpet with superior annealing strength as well as other desirable physical properties. However, despite the advantages of polyurethane, technical problems have kept it from widespread use in the industry.

[0006] Attempts to replace latex with polyurethane have faced a variety of problems, requiring numerous process modifications. One striking example is the difficulty associated with placing polyurethane onto a backing in single applications, while maintaining the necessary adhesiveness to attach a second backing. After the pre-polymers have been mixed and polymerization begins polyurethane soon begins to lose its adhesive properties. Loss of adhesiveness is generally not a problem with the use of latex. Conventional latex maintains its adhesiveness and viscosity during processing, even in the curing oven. Following application of latex adhesive to both the greige and the secondary backing the two components are married and as a result of the latex properties, good temporary adherence of the secondary backing to the greige is observed. In the curing oven, the latex viscosity does not drop significantly as water is evaporated. Thus, the secondary backing satisfactorily adheres to the greige, and little dripping of latex from the bottom of the carpet to the oven is observed.

[0007] On the other hand, polyurethane application from bulk troughs, common in latex systems, is made very difficult due to premature polymerization in the delivery line. Typically, polyurethane is applied as “foam,” polymerized prior to application and sprayed onto the primary or secondary backing before the upstream edge of a doctor blade. However, unless the manufacturer guards against premature polymerization the delivery line becomes clogged retarding the flow of polyurethane to the spray apparatus. In addition polyurethane begins to lose its adhesiveness soon after polymerization begins unless the manufacturer controls the polymerization rate by using heat sensitive catalysts or other chemical agents designed to maintain the viscosity of the polyurethane. Regardless of the manufacturer’s attempts at controlling premature polymerization the manufacturer has only a finite amount of time after the prepolymers (polyl and isocyanate) have been mixed in which to apply the polyurethane to the backing before the polymer begins to lose its adhesive properties. In an attempt to combat the rapid loss of adhesiveness manufacturers have applied one coating of polyurethane to the greige as fiber lock and a second coating of polyurethane just prior to contacting the secondary backing to insures sufficient adhesion between the backings. Even with the additional polyurethane, the slow advancement of most commercial carpet lines, and the inherent lack of adhesiveness associated with polyurethane, does not allow for the desired adherence between the greige and the secondary backing.

[0008] Curing the backing to the greige is also complicated because of the considerable decrease in viscosity of the polyurethane prior to cure. The viscosity of the polyurethane, and likewise its adhesiveness, may decrease to only 10% of its initial value prior to application as the catalyzed polyurethane-forming reaction begins to exert its effect. The greatest decrease in viscosity is often exhibited over the temperature range of ambient to 70° C., where the polyurethane catalysts are not optimally active. As a result, if the initial adherence of the secondary backing to the greige is insufficient the secondary backing may separate during this period of low viscosity.

[0009] In an attempt to address the problems associated with the use of polyurethane several changes to the underlying process have been disclosed. For example, U.S. Pat. No. 6,264,775 offers the addition of various chemical thickening agents to the polyurethane to maintain viscosity and adhesiveness. Another process provides for the use of multiple applications of polyurethane to the primary backing prior to joining the secondary backing. See e.g., U.S. Pat. No. 6,299,715. Still another technique disclosed in U.S. Pat. No. 6,299,715, is the application of both polyurethane to the primary backing and another tacky composition to the
secondary backing prior to joining the two backings. None of these techniques have been favored over standard latex based carpet laminates, primarily due to the increased cost and complexity associated with building and using separate manufacturing lines to implement the new technologies.

[0010] It would therefore be desirable to provide a polyurethane carpet annealing process requiring only a single application of the polyurethane, while providing acceptable fiber lock and annealing strength. It would also be desirable to provide a polyurethane annealing system which does not require excessive quantities of polyurethane to provide sufficient annealing strength. It would be beneficial to provide a polyurethane annealing system which does not require an oven for curing.

SUMMARY OF INVENTION

[0011] The present invention pertains to a polyurethane carpet annealing system which discloses two unique advantages over the prior art. First it requires only a single application of polyurethane. The lower amount of polyurethane employed in a single application significantly decreases the weight of the carpet and decreases raw material costs. Second, the polyurethane is cured at ambient temperature. The absence of an oven-curing step markedly decreases the time from application of the polyurethane to product roll-up. The carpet produced by the process exhibits acceptable fiber lock and initial secondary backing adhesion without the use of large quantities of polyurethane and without the expensive heat curing step common in other annealing systems. In combination, the two advantages significantly increase the commercial utility of the product.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 illustrates a typical prior art latex-based carpet annealing process.

[0013] FIG. 2 illustrates a prior art single application polyurethane-based carpet annealing process.

[0014] FIG. 3 illustrates a prior art dual application polyurethane-based carpet annealing process.

[0015] FIG. 4 illustrates a prior art polyurethane-based process that coats primary backing with polyurethane and the secondary backing with a skip-coat adhesive.

[0016] FIG. 5 illustrates one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0017] The present invention is designed to improve the annealing of secondary backing to tufted or woven carpeting utilizing a polyurethane adhesive system. Referring now to the drawings in more detail, FIG. 1 illustrates a typical prior art commercial latex-based carpet annealing process. The greige 5, with top carpet face 10 and bottom primary backing side 15 to which fiber lock adhesive is applied, is directed by rollers 20 to place the primary backing side 15 of the greige under trough 25, which is supplied with latex through line 30. The downstream edge of trough 25 serves as a doctor blade 35, in conjunction with plate 40. Adjusting the amount of latex applied also serves to force the latex through the primary backing 15 into the fibers. Further penetration is provided by pressure roller 45. The carpet is then redirected by roller 50. Secondary backing 55 is supplied from roll 60 and directed by rollers 65 across wheel roll 70, which rotates in trough 75 filled with additional latex which coats the secondary backing 55. The coated secondary backing 77 is pressed onto the latex-coated greige 80 by their travel through ligation rolls 85. The carpet then passes through oven 90 where water is removed from the latex, and the latex cures, adhering fibers and secondary backing to form a lamellar carpet.

[0018] FIG. 2 illustrates a single application polyurethane-based carpet annealing process. The greige 5 with carpet face 10 downward is fed onto a metering plate 95. Here polyurethane “froth” 100 is placed on the backing side 15 using a mixing head 105. After the polyurethane 100 is applied, its thickness may be adjusted by doctor blade 35 and metering plate 95. A secondary backing 55 is then applied to the surface of the uncured polyurethane 100 using a ligation roller 85. The coated and backed greige 78 is then passed through oven 90 to cure the polyurethane layer 100. After the carpet has been cured, it may then be advanced through a trimmer 115 and finally to an accumulator 120 or roll-up area.

[0019] FIG. 3 illustrates a dual application polyurethane-based carpet annealing process. To the primary backing side 15 of the greige 5, polyurethane 100 is applied from first line 30. Doctor blade 35, in cooperation with plate 40, limits the applied weight of polyurethane 100 and forces it into the greige 5. Following the first line 30 is second line 32, which supplies additional frothed polyurethane 100. Doctor blade 36, in conjunction with plate 41, adjusts the thickness of the deposited polyurethane 100. While the first doctor blade 35 substantially contacts the primary backing 15, the second doctor blade 36 is spaced a distance away to allow enough polyurethane 100 to be deposited to temporarily bind the secondary backing 55 before curing. The secondary backing 55, supplied from roll 60, contacts the coated greige 80 below ligation roller 85. Prior to entry into the oven 90 for curing, press rollers 125 assist in maintaining stable contact between the secondary backing 55 and the greige 5.

[0020] FIG. 4 illustrates a polyurethane-based process that coats the primary backing with polyurethane and the secondary backing with a polyurethane adhesive. Following application of the polyurethane 100 from line 30 and its impregnation onto and into the primary backing side 15 of the greige 5 between doctor blade 35 and plate 40, the carpet is contacted with a wheel-coated secondary backing 55. The secondary backing 55, supplied from roll 60, has been directed by rollers 65 past wheel roll 130 which rotates in trough 135 filled with wheel coating agent. Rotation of wheel roll 130 in the trough 135 coats the roll with wheel coating agent which is then transferred to the secondary backing 55 to form a wheel-coated secondary backing 140. Wheel roll 130, supplies a tacky polyurethane based coating agent which is not “self-curing” and therefore does not substantially increase in viscosity over the life of the composition in the trough 135. Wheel-coated secondary backing 140 mates with the polyurethane adhesive coated greige below roller 85, which may be tamp-conjwted with a roller directly below, or a plate, to form a pair of ligation rollers or equivalent devices. The carpet then passes between press rollers 125 into oven 90 for curing.
FIG. 5 illustrates the carpet manufacturing process according to the present invention. The greige 5 with carpet face 10 downward is fed onto a tenter roll 12 that directs the greige 5 to metering plate 95, the carpet face 10 is advanced over the metering plate 95 using pulling rollers 21.

In FIG. 5, a layer 100 of polyurethane polymer is deposited onto the primary backing side 15 as it passes over metering plate 95 using a mixing head 105. Preferably, the polyurethane is applied to the primary backing 15 at an area concentration of about 1.0 g/m² to about 30 g/m² or in a more preferred concentration of about 5.0 g/m² to about 12 g/m². In an even more preferred embodiment of the present invention, the polyol and isocyanate pre-polymer components are mechanically blown through a mixing head 105 to form the polyurethane layer 100. This prevents the pre-polymer from contact until just prior to application to the primary backing 15. According to this method, the polymerization process does not begin to occur until just prior to the exit of the polyurethane components from the mixing head 105. This process allows the relatively low viscosity polyurethane to deeply penetrate the fibers in the primary backing, resulting in excellent fiber lock characteristics. A preferred method of blowing the polyurethane layer is by feeding separate lines of polyol and isocyanate components and a stream of air into a Gusmer Corporation spray attachment (model GX7-400). If the need arises a third line is available for the introduction of catalyst. The spray attachment combined with the air stream provides sufficient turbulence to provide a homogenous solution of the urethane-forming components.

After the polyurethane components are applied polymerization accelerates and foaming begins. The thickness of the polyurethane foam may be adjusted by various means known in the art such as a doctor blade 35 or air knife. The polyurethane coated greige 79 is then optionally passed across a steam box 150. Steam box 150 adds water to the reaction, to aid in accelerating the polymerization rate. In addition the steam serves to enhance blooming of the yarns passing through the primary backing for deeper penetration and assures a more level coverage of polyurethane. A furnace hood 155 is placed above the steam box 150 to capture escaping volatiles released with the steam. Conspicuously absent at this stage of the process is an oven curing step. An oven is not necessary in the process because the polyurethane components are essentially kept separate until they are applied to the primary backing 15, therefore there is no need to dope the polyurethane components in order to control the rate of polymerization. In a preferred embodiment of the present process temperatures are generally maintained within 30°F of ambient temperature or in a more preferred embodiment within 15°F of ambient temperature during the carpet manufacturing process. In contrast, prior art polyurethane curing processes are required to utilize heat sensitive catalysts and other chemical additives to maintain sufficient viscosities to apply the polyurethane, from various holding lines and troughs, to the backing surface. These additives necessitate a heat curing stage.

The independence gained by controlling the mixing of polyol and isocyanate has lead to the removal of a formal curing stage. The excision of this step has dramatically improved the processing speed of laminated carpets, cutting manufacturing time by as much as 50-60% without sacrificing the annealing strength or fiber lock properties of the carpet.

After applying the polyurethane coating, and steaming the coated greige 79, the coated greige 79 is rapidly pulled to merge roll 160 where the secondary backing 55, supplied from roll 60, contacts the coated greige 79 downstream from roller 87. Due to the short time that elapses between the initial application of polyurethane and the merger of the secondary backing 55 with the coated greige 79, the polyurethane possesses sufficient tackiness to anneal the secondary backing in place. The annealed carpet can then be cooled briefly 190 and rolled for storage and transport.

In all of the foregoing embodiments, the Figures have been simplified for clarity and to ease viewing and understanding. In commercial embodiments, additional devices, e.g. drive motors, tension devices, etc. will be required.

Polyurethane prepolymers useful in the practice of the present invention are prepared by the reaction of active hydrogen compounds with any amount of isocyanate in a stoichiometric excess relative to active hydrogen material.

The prepolymer formulations of the present invention include a polyol component. Active hydrogen containing compounds most commonly used in polyurethane production are those compounds having at least two hydroxyl groups or amine groups. However, any active hydrogen containing compound can be used with the present invention.

In the practice of the present invention, preferably at least 50 weight percent of the active hydrogen compounds used to prepare the polyurethane is a polyol having molecular weight of from about 100-400.

The polyisocyanate component of the formulations of the present invention can be prepared using any organic polyisocyanates, modified polyisocyanates, isocyanate based prepolymers and mixtures thereof. These can include aliphatic or aromatic isocyanates. Preferably the isocyanate used to prepare the prepolymer formulation of the present invention is methyl diisocyanates such as Bayer’s 142L or Dow 901 or blends of equal type.

Catalysts suitable for use in preparing the polyurethanes of the present invention include tertiary amines, and organometallic compounds and mixtures thereof. For example, suitable catalysts include stannous octoate, triethylene diamine, N-methyl morpholine, like compounds and mixtures thereof. The catalysts do not necessarily need elevated activation temperatures or other promoters to initiate polymerization.

Surfactants can be useful for preparing a stable dispersion or froth of the present invention. Surfactants useful for preparing a stable dispersion can be cationic, anionic, or non-ionic surfactants. Preferably the surfactants used to prepare the prepolymer formulation of the present invention are silicone surfactants such as Dow Corning DC-194 or Union Carbide’s L-540. A surfactant can be included in a formulation of the present invention in an amount ranging from about 0.01 to about 7 parts per 100 parts by weight of polyurethane component.
[0033] A compound of the present invention optionally includes a filler material. The filler material can include conventional fillers such as milled glass, calcium carbonate, aluminum trihydrate, barium sulfate, fly ash, dyes and pigments or fire retardants (aluminum trihydrate and Tris polyolefin glycol). Preferably the filler can be present in an amount ranging from 0 to 300 parts per 100 parts of the polyurethane component.

[0034] Generally, any method known to one skilled in the art of preparing polyurethane froths can be used in the practice of the present invention to prepare a polyurethane froth suitable for preparing, for example, a carpet of the present invention.

[0035] Although a preferred embodiment of the present invention has been disclosed herein, it will be understood that various substitutions and modifications may be made to the disclosed embodiment described herein without departing from the scope and spirit of the present invention as recited in the appended claims.

What is claimed is:

1. A method for preparing carpet by annealing a secondary backing to a greige, having fibers attached to a primary backing, said process comprising:
   a) preparing polyurethane by introducing polyol from a first dedicated line and an isocyanate from a second dedicated line into a mixing head for spray application;
   b) applying said polyurethane to the primary backing side of said greige to form a tacky polyurethane-coated greige; and
   c) contacting said secondary backing with the polyurethane-coated greige to form a carpet.

2. The process of claim 1 wherein said greige is subjected to steam after coating with polyurethane and prior to contact with the secondary backing.

3. The process of claim 1 wherein said polyurethane is applied to said primary backing at an area concentration of about 1.0 g/m² to about 30 g/m².

4. The process of claim 1 wherein filler is present in the polyurethane in a concentration of from 0 to about 300 parts per 100 parts of polyol.

5. The process of claim 1 wherein metallic or organic amine catalysts or a mixture thereof are introduced through a third dedicated line into said mixing head for spray application.

6. The process of claim 1 wherein a thermal rise of less than 30° F. is observed.

7. The process of claim 1 wherein said polyurethane applied to said primary backing is flame retardant.

8. The process of claim 1 wherein said polyurethane applied to said primary backing contains 0.5 to 5 parts water per 100 parts of polyol.

9. A method for preparing carpet by annealing a secondary backing to a greige, having face fibers extending from a first side of a primary backing, said process comprising:
   a) preparing polyurethane by introducing polyol from a first dedicated line and an isocyanate from a second dedicated line into a mixing head for spray application;
   b) applying said polyurethane to a second opposed side of the primary backing of said greige to form a tacky polyurethane-coated greige;
   c) applying steam to the polyurethane coated primary backing; and
   d) contacting said secondary backing with the polyurethane-coated greige to form a carpet.

10. The process of claim 9 wherein said polyurethane is applied to said primary backing at an area concentration of about 1.0 g/m² to about 30 g/m².

11. The process of claim 9 wherein the filler is present in said polyurethane at a concentration of from about 0 to about 300 parts per 100 parts of polyol.

12. The process of claim 9 wherein metallic or amine catalysts or a mixture thereof are introduced through a third dedicated line into said mixing head for spray application.

13. The process of claim 9 wherein a thermal rise of less than 30° F. is observed.

14. The process of claim 9 wherein said polyurethane applied to said primary backing is flame retardant.

15. The process of claim 9 wherein said polyurethane applied to said primary backing contains 0.5 to 5 parts water per 100 parts of polyol.

16. A method for preparing carpet by annealing a secondary backing to a greige, having fibers attached to a primary backing, said process comprising:
   a) preparing polyurethane by mixing a polyol component and an isocyanate component at about the same time the components are introduced into a mixing head for spray application;
   b) applying said polyurethane at ambient temperature to the primary backing side of said greige to form a tacky polyurethane-coated greige;
   c) applying steam to the polyurethane coated primary backing; and
   d) contacting said secondary backing with the polyurethane-coated greige to form a carpet.

17. The process of claim 16 wherein said polyurethane is applied to said primary backing at a areal concentration of about 1.0 g/m² to about 30 g/m².

18. The process of claim 16 wherein the filler is present at a concentration of from about 0 to about 300 parts per 100 parts of polyurethane.

19. The process of claim 16 wherein metallic or amine catalysts or a mixture thereof are introduced into said mixing head for spray application.

20. The process of claim 1 wherein a thermal rise of less than 30° F. is observed.

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