

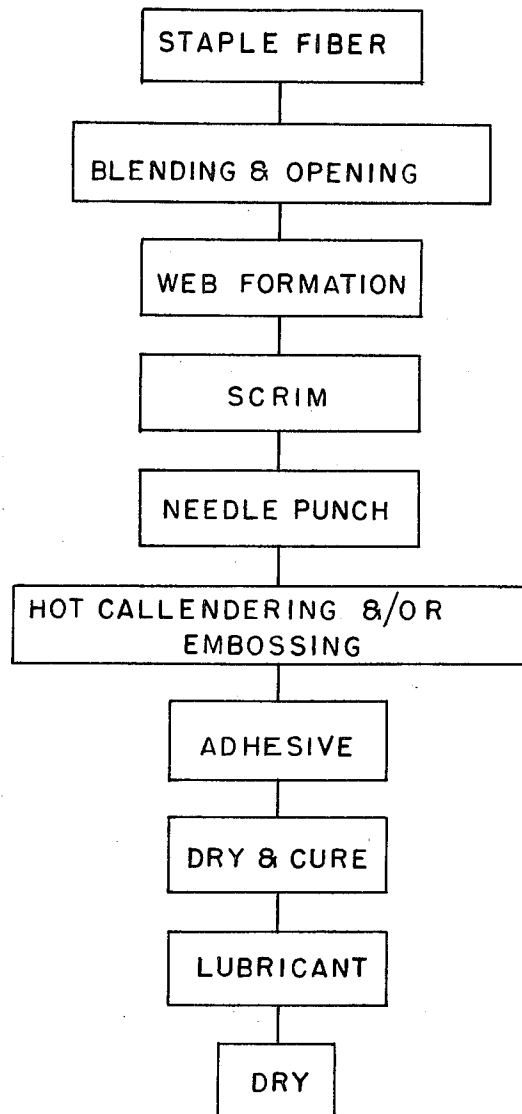
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NON-WOVEN PROCESS

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3,704,191

NON-WOVEN PROCESS

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ABSTRACT OF THE DISCLOSURE

A process for making non-woven nylon carpet backing for either tufted or needle-punched carpets, comprising the steps of forming nylon web and bonding the same together with an open filament yarn base, by a combination of mechanical entanglement, selective heat treatment, and a binder, as described hereinafter.

BACKGROUND AND PRIOR ART

The field of non-wovens is now replete with publications on all aspects of product, product usage, and manufacture. The principles on which production of non-wovens is based are relatively simple, but their application in practice is an extremely complex art, one in fact which has become highly developed in a relatively few years. The background and prior art publications relative to this invention generally deal with disclosures concerning variations in web production, as by use of carding equipment, cross-laying or overlapping several web layers thus formed, continuous filament lay-down on a moving conveyor, random deposition by the well known Rando-Webber machine, application of liquid binder systems, lubrication, etc. Similarly, much is published concerning various bonding processes by chemical and/or heat means, binders, fillers, and other non-woven development is set out in "The Development of Non-Woven Fabrics" by A. R. Smith, Chemistry and Industry, Dec. 28, 1968, which includes some 77 references to articles and patents.

Previously known carpet backings constructed primarily of polypropylene have met with relatively good success. The nylon articles produced by the method of this invention embody certain improvements thereover. Some of the polypropylene backings are "Locktuff" and "Prime Bak," disclosed in U.S. Pats. 3,394,043 and 3,286,007 respectively. These and similar polypropylene products have been used considerably, due primarily to economic reasons although lacking certain physical property attributes due to the nature of polypropylene. For example, polypropylene, although relatively inexpensive, is physically incapable of taking many of the more inexpensive dyes and the commonly used cheaper lubricants. Therefore it is necessary to utilize costly polysiloxane or silicone base lubricants; and even when these materials are used the lubricated web will not be compatible with a continuous dyebath operation and has a low receptivity for most adhesives. The polypropylene webs are also incompatibly heat sensitive with hot-melt backing systems of today.

SUMMARY AND OBJECTS

The present invention is concerned with a method of making improved carpet backings, particularly with respect to heat sensitivity, receptivity to adhesives and dyeing characteristics and to weight, strength, durability, and the like. This is accomplished by employing nylon in a novel combination of materials and by combining the

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materials in a particular, novel manner. More specifically, this invention provides a method of making an economical carpet backing comprised entirely or almost entirely of nylon, which method also creates open discrete areas in the backing which are in a relatively free state, thereby allowing for greater ease in handling and flexibility in carpet manufacturing procedures. Further, the nylon backing is much less heat sensitive and can therefore be tufted at higher needle speeds, will readily accept a wide range of adhesives and inexpensive lubricants such as alkylated fatty acids, related soaps and/or surfactants, and has excellent dyeing characteristics as well as other advantages over previously known carpet backings, with or without nylon included therein.

The method of this invention involves a series of steps which, when taken together, have the advantage of producing a unique carpet backing having the improved properties mentioned. These steps include production of one or more non-woven webs from nylon staple, joining the web or webs together with an open filament yarn base such as a woven scrim by a combination of needle-punching selective heat treatment in certain areas and an adhesive, and final curing, lubricating and drying. The base material is fed independently from the one or more non-woven webs which are fed to the needle-punching zone at a slower rate than the base material to avoid bunching or buckling at the needling zone. The combined web and yarn base is consolidated by needle-punching and heat setting under critically selected conditions. The heat setting may be accomplished by calendering and/or embossing between opposed pressure rolls or platens, or by other types of heat sources. The open filament base yarn preferably is composed of nylon, however, other high temperature melting fibers such as polyester may also be employed.

The advantages mentioned are achieved in part by the ability of the process of this invention to incorporate and effectively use economic materials which may include, for example, the use of garnetted nylon fibers to a certain extent, within certain appropriate size, weight, and denier ranges. The materials are combined in a strong, yet light weight and flexible unit which itself affords advantages, and which has further advantages in alleviating or solving problems of backing and carpet manufacture inherent with prior art backings.

A further object of the invention is to provide a similar method of making carpet backing comprised in part of matrix fibers blended with the other substrate materials, matrix fibers referring to filamentary material containing at least two different fiber forming polymeric materials having differing melting points, the lower melting component thereof forming a matrix in which the other is dispersed in microfibrillar form. Still another object is to provide a method of making a non-woven web for a carpet backing, comprised of nylon fibers blended with virgin staple fibers as will be described.

Other objects and advantages will be described and will become apparent to those skilled in this art from the appended claims and following description of the best mode of carrying out the invention, and examples thereof, made in connection with the accompanying flow diagram drawing.

DESCRIPTION

In accordance with the preferred embodiment of the present invention, nylon 6 staple fibers having a denier of 3 to 15 are collected and placed in a carding machine and formed into web. Next the web is reinforced by either a parallel layer of continuous filament nylon of 100 to 200

denier or a woven scrim. The non-woven substrate may be mechanically entangled by needle-punching both before and after the reinforcement elements are added to the construction thereof. Where a heavier mat (herein referred to as one or more non-woven webs in combination with the yarn base) is desired it is preferable to cross-lap parallel webs and interpose the yarn base therebetween.

The non-woven web may also be produced by random air laid staple fibers, or garnetted and lapped web or webs to form a substrate.

The reinforcement component is advanced to the needle-punching zone at a faster rate than the webs. This results from the fact that the staple fibers in the webs are more readily displaced than the continuous reinforcement component. Previously, a severe problem has not been encountered because of the slower conventional needling processes. It has therefore been discovered that in a high speed process as described herein the reinforcement base material must be advanced from a separate supply source so it may be withdrawn under low tension at a faster linear speed than the non-woven web components. After needle-punch bonding together, the mat is then heat treated by calendering on an embossing calender, or otherwise subjected to point fusion, to further bond certain discrete areas while leaving a large proportion of the fibers in a relatively free state. The mat product thus produced has a finished weight of 2.5 to 4.5 oz./sq. yd., preferably 3.2 to 4.0 which is considerably lighter than the above-mentioned polypropylene backings. Finally, the product is strengthened and stabilized with a small proportionate amount of synthetic adhesive by spray bonding, drying and heat setting under controlled conditions.

The nylon web-nylon scrim combinations and the combination of needle-punching and calendering result in a product which is relatively insensitive to heat (350° F.), as compared to the polypropylene backing (230° F.) and thus can be utilized with the new hot-melt backing systems. In dyeing operations the nylon backing readily accepts the commonly used dyes and thereby avoids "grinning" problems frequently encountered with other natural or synthetic materials of different colors that resist dyes or take on different shades than the tufted material. Also, its heat sensitivity permits the backing to be subjected to higher drying temperatures and the porosity at the same time permits air to pass through the web (after tufting or needling) thereby allowing faster drying. In addition to the normal advantages of non-wovens over the available wovens, the carpet backing of this invention will not ravel at the edges and will have a more dimensionally stabilized construction than available wovens or non-wovens.

The low weight web material, being produced at high speeds of approximately 30 feet per minute or more, for example, may be composed of staple fibers, or blends thereof, staple fibers plus producer textured waste yarns, or merely blends of producer textured waste yarns reprocessed by garnetting. The nylon staple fibers should be within the range of 3 to 15 denier, although it is preferred that a major portion be in the range of 5 to 8. The preferred staple fiber length is from 2¾ to 4½ inches with the higher denier staple being of longer length generally.

Tests have proven that the most critical factors involved in producing the carpet backing of this invention reside in the appropriate selection of denier and staple. Thus, the denier employed for the nylon web should be such that at least 50% by weight of the web be of 5 to 8 denier, and more specifically, in the following approximate ranges:

Denier:	Percentage
3-4 -----	0-25
5-8 -----	50-100
8-15 -----	0-25

The reinforcing scrim may be woven or parallel laid nylon filament (in the machine direction), preferably ranging from 90 to 120 denier, 10 ends per inch of width.

The following specific example of the preferred embodiment hereof is illustrative of the invention. Nylon 6 (polycapromide) staple fiber of 2¾ inches length, 50% 15 denier/ filament and 50% 6 denier/filament were blended and opened. A tandem weighing device was utilized to balance out fiber weight for the web.

Webs produced by a carding machine were cross-lapped at approximately 90° to give a 2.5 oz./sq.yd. mat and a nylon scrim was inserted between upper and lower webs.

Actually, in the preferred embodiment the scrim was a continuous yarn laid into the center of the material in the machine direction and weighed 0.15 oz./sq. yd., a total of 100 denier-10 ends/inch, giving a total mat and scrim weight of 2.65 oz./sq.yd. The continuous yarns forming the reinforcement base were withdrawn from individual supply packages on the creel and the webs were fed from a carding machine. Because of the continuous nature of base yarns they are advanced to the cross-laying and needle-punching machines at linear rates up to 15 percent faster than the webs in order to prevent bunching of the webs and/or breaking out of the continuous yarns. Upon completion of web laying and scrim insertion, the material is lightly compressed to reduce its loftiness. As an alternative of equal quality, a woven nylon scrim, weighing between 0.12 and 0.35 oz./sq. yd. as, for example, 5 by 5 or 6 by 6 count, or 6 warp by 2 to 3 fill, may be used.

To avoid setting up lines of stress in the final product it is preferable to employ a random, non-uniform needle pattern. The mat fed through the needle loom under low tension at 27 feet per minute was penetrated ¾ inch, 200 punches/min., needle 15 by 18 by 36 by 3½ round barb. The penetration count for each of two passes was 200 per square inch.

The embossing is performed on both sides of the needed mat preferably, but not necessarily, but at least two different patterns. Suitable patterns are, for example, pigskin, scroll, bubble, alligator and the like. Thus a broad scroll pattern was used on the face or upper side of the mat to assure fusion and heat bonding on limited surface areas and within the mat, while the small pigskin pattern promoted surface bonding only on the back side, the net result being an intermittent discontinuous bonding of the needed webs and scrim. A four roll calender was used, with two pairs of steel engraved rolls running against two firm fiber rolls. The embossed patterns will therefore appear predominately on one side of the mat, and the other being composed of freer fibers resulting in an article that can be very easily tufted, dyed and dried. The temperature range for calendering nylon 6 is preferably about 400° to 420° F.; 405° F. ±4° (face side) and 410° F. ±4° (back side) producing the best fusion bonding while operating at 400 to 700 lbs./sq. inch, preferably 600. For nylon 6,6 (polyhexamethylene adipamide) the calendering temperatures should be approximately 45° F. higher.

As a final bonding step, it is preferable to apply a limited amount of adhesive synthetic binder (0.5 oz./sq. yd.). The latter is applied by spray to the more highly bonded back side of the mat to preserve the advantages of the freer fiber side, yet contribute the bonding properties desired, i.e., the binder will penetrate into the mat and promote dimensional stability and strength of the final product. It is then dried in an infra-red oven and cured in a festoon type air convection oven at 350° F. for five minutes to completely cure the binder.

Immediately after the adhesive is applied to the heat fused mat, the latter is passed through a heating zone (about 150° F.) for about 45 seconds to drive off excess moisture and produce preliminary heat setting of the adhesive. Thereafter, the mat is exposed to the curing zone above mentioned. Next a lubricant spray is applied to reduced the metal-to-fiber friction during later carpet manufacturing procedures such as tufting and needle-punching. The lubricant constitutes an addition of ap-

proximately 1% more weight to the carpet backing, and must be of a type compatible with the carpet dye bath. Lubricants of this type are known to the art.

As mentioned above, the advantages of the described non-woven carpet backing are derived from its nylon composition and the manner in which it is assembled. It is, of course, contemplated that minor amounts of other synthetic or naturally occurring fiber and fiber-like materials can be introduced into the web or scrim without departing from the essence of this invention. Similarly, additives such as alkalis or other synthetic stabilizers, wetting agents, dispersing agents, antioxidants, plasticizers, pest repellents and the like may be added. More particularly, as another embodiment of this invention the inclusion of a small proportion (3 to 15% by weight) of a matrix staple fiber 2¾ to 4 inches long is contemplated and within approximately the same denier ranges as given above, but preferably slightly higher, as, for example, 5 to 10 denier.

As used herein, matrix-type fibers or filaments means filaments made by inclusion of at least one polymeric material in the form of discontinuous fibrils in a matrix of another, the two materials having substantially different melt temperatures such that fibrous constructions composed thereof can be bonded preferably, but not necessarily, by application of heat below the melt temperature of one and equal to or above that of the other, the entire filament composition or any component thereof optionally including any secondary material compatible with the bonding process and end utility of the product as a whole, such as antioxidant and other stabilizing agents, reinforcing particles, filler, adhesion promoting agents, fluorescent materials, dispersing agents, and others useful in polymerization, extruding spinning, fabric forming and shaping, heat-setting and product finishing techniques. If desired, inorganic materials such as metal whiskers, Fiberglas fibrils, asbestos particles and the like may be incorporated in very small amounts for conductive and/or reinforcement purposes.

The preferred matrix fibers useful herein are comprised of a homogeneous mixture of two different polymeric materials, the lower melting material being nylon 6 and forming a matrix in which the higher melting material, preferably polyethylene terephthalate, is dispersed throughout in the form of discontinuous microfibrils. Although various polymeric materials are mixed together, they need not be entirely intermiscible due to their physical properties and/or the mixing technique employed to disperse the higher melting component in the matrix material for forming microfibrils. Thus micro-sized globules or fibrils are usually initially produced in the matrix, which when spun or drawn produce the desired microfibrillar dispersion in the lower melting matrix material. As in the case with any of the above-mentioned fibers, the component filaments may be round, trilobal, elliptical, or any other cross-sectional shape.

The principal advantages offered by employing matrix filaments is their ability to bond by heating, or as a nylon fiber in the carpet backing, yet contribute improved strength, tear and durability.

Matrix-constituent filaments have the ability to bond to each other, and to other filaments, in a manner which does not cause significant flow or cross-sectional disfiguration, thereby setting up conditions for bonding systems that promote fiber orientation and strength and yet which admit controllable physical properties such as porosity, permeability, appearance, texture, etc.

Further, the matrix fibers effectively bond under the heat binder conditions preferred for this invention, such bonding being by localized fusion partial or complete, of individual portions of the fibers. Such fusion may be brought about by spark discharge through the web or the application of heat to highly localized, mechanically isolated portions of the web as by embossing described above.

As to chemical make-up, the multi-constituent filaments pertinent to this invention are prepared from a polyester-polyamide combination. The compositions contain 50-90 parts by weight nylon 6 and 50-10 parts by weight of a polyester microfibrillar dispersion.

The following example is illustrative of the use of matrix fiber in this invention. The matrix fibers were produced in accordance with the polyamide-polyester (70/30) formulation of Example 1 in U.S. Patent 3,369,057.

The polymer blend fiber thus produced is hereafter referred to as a nylon/polyester matrix fiber. The latter is formed into a 10 denier fiber and cut into 3½ inch staple. A mixture of 10 percent by weight nylon/polyester matrix fiber, 90 percent nylon 6, 3 inch, 6 denier staple was carded, deposited in cross lapped webs to produce a 3.0 oz./sq. yd. mat in the manner described above and combined with a 0.2 oz./sq. yd. parallel laid scrim. The mat scrim is then fed through a needle loom under low tension again in the manner described above. Thereafter, embossing is carried out by calendaring with a broad scroll pattern on the upper surface and a pigskin pattern on the bottom surface, at slightly higher temperatures than with only nylon 6, i.e., at 410° F. to 430° F., preferably 422° F. The matrix fiber being present in a significant amount, up to 15 percent, and the higher embossing, will result in point fusion of the matrix material, setting up a relatively firm, dimensionally stable network of fibers bonded to each other and to the companion nylon fibers and scrim within the mat.

After the needle-punch and embossing steps synthetic latex is applied by spraying the bottom side and the backing dried and cured, all in the manner described above.

In another embodiment a 5 x 5 nylon scrim is used, interposed between layers of a mat comprised of 8 percent nylon/polyester matrix fiber staple 10 denier 3½ inches long, and 92 percent nylon 6, 3 inches long, 6 denier, the mat being 2.8 oz./sq. yd. and the scrim being 0.2 oz./sq. yd. All other process conditions and materials employed were the same as described above.

We claim:

1. A method of making a synthetic carpet backing suitable for use in tufted and needle punched carpets, comprising the steps of forming a matted fibrous substrate by

(a) feeding a plurality of separate non-woven webs comprised of nylon staple into a needle punching machine while simultaneously feeding a single layer open filament yarn base between said webs into said needle punching machine at a higher linear rate of speed than said webs to allow the nylon staple to be more readily displaced than the single layer open filament yarn base; and

(b) bonding the same together by mechanically needle punching the webs and yarn base and subsequently applying heat and pressure to discrete discontinuous areas of the same to produce a discontinuous network of fusion bonding thereby the matted fibrous substrate is formed.

2. A method as defined in claim 1 wherein the fibrous substrate consists essentially of nylon 6 fibers and said bonding by heat is applied by pressure embossed calendar step on one surface of the substrate in discrete, patterned areas at a temperature between 401 and 409° F., and the other surface thereof is fusion bonded at a temperature between 406 and 414° F.

3. A method as defined in claim 2 wherein said non-woven web is formed from at least 50 percent by weight of nylon staple from 2¾ to 4½ inches long and from 5 to 8 denier.

4. The method as defined in claim 3 further comprising the step of bonding said substrate by application of a latex adhesive only to said other surface.

5. A method as defined in claim 3 wherein said staple is comprised of up to 50 percent 6 denier approximately

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2¾ to 3½ inches long and the remainder 8 to 15 denier of approximately 3½ to 4½ inches long.

6. A method as defined in claim 5 wherein the interposed yarn base is comprised of a single layer of continuous yarn withdrawn from a creel individually at linear speeds of 5 to 15 percent faster than the webs.

7. A method as defined in claim 1 wherein the non-woven webs are comprised of non-woven mat from 3 to 15 percent by weight of matrix fiber staple of 5-15 denier, 2¾ to 4 inches length, said matrix fiber staple itself being comprised of 50-90 parts by weight of a nylon 6 matrix and 50-10 parts by weight of a polyester microfibrillar dispersion in said matrix, the remainder of said mat being comprised of nylon staple of from 5 to 8 denier, 2¾ to 4½ inches length.

8. A method as defined in claim 7 wherein said open yarn base is interposed between upper and lower non-woven web sections of said mat.

9. A method as defined in claim 8 wherein said open yarn base is bonded to the bottom surface of said non-woven mat.

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