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MULTI-DIRECTIONAL STRETCHABLE NONWOVEN FABRIC

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ABSTRACT OF THE DISCLOSURE

A nonwoven fabric having the ability to stretch in multiple directions and recover its original shape, said fabric comprising a thermoplastic bonding agent and a stable fibrous constituent having from 20 to 40 crimps per inch. Such fabrics possess utility in the manufacture of brassieres, wool jersey garments, lightweight wooden fabrics, shoes, basic fabrics for polyvinyl chloride laminations, and the like.

This invention relates to nonwoven fabrics. More particularly, the invention relates to nonwoven stretch fabrics.

Nonwoven fabrics having the ability to stretch and recover their original shape are useful in many segments of the clothing industry. For example, nonwoven stretchable interlining is useful in brassieres, wool jersey garments, light-weight woolen fabrics, shoes, base fabrics for polyvinylchloride laminations, and the like. However, one of the drawbacks of some of the presently known nonwoven fabrics resides in their inability to stretch in a number of directions at the same time and substantially completely recover their original shape.

There exists, therefore, a need for nonwoven stretch fabrics which exhibit multi-directional stretchability and substantially complete recovery of original shape. The present invention provides such a multi-directional nonwoven, stretchable fabric. In accordance with the invention, a multi-directional, nonwoven, stretchable fabric comprises (1) thermoplastic bonding agent and (2) fibrous constituent selected from the group consisting of (a) a blend of super-crimped fibrous materials and (b) a blend of a major proportion of super-crimped fibrous materials and a minor proportion of at least one component selected from uncrimped fibrous material, regular-crimped fibrous and mixtures of uncrimped and regular-crimped fibrous materials. It is to be understood that the term "blend", as employed throughout this application and in the appended claims, means a mixture of at least two different fibrous materials, that is, for example, a mixture of nylon and acetate fibers.

Super-crimped, synthetic fibrous materials, which can be utilized in the practice of the invention, include both natural and synthetic fibrous constituents. Super-crimped, synthetic fibrous materials, which are useful in the manufacture of a fabric made in accordance with the instant invention, include nylons, acetates, polyesters, acrylates, and other crimpable, synthetic filamentary or fibrous materials and blends thereof which have an average number of about 20 to about 40 crimps per inch and preferably about 25 to 35 crimps per inch. Super-crimped, natural fibrous materials include wool, which has an average number of about 20 to 40 crimps per inch. The particular blends of these super-crimped, fibrous materials can vary as much as desirable when they are utilized to prepare a fabric in accordance with the invention. However, in a fabric manufactured in accordance herewith, the total amount of fibrous material is normally in a range of about 50 to 90 percent by weight, based on the total fabric weight and preferably in a range of about 60 to 80

percent by weight. On the other hand, greater or lesser amounts of fibrous material can be utilized, since these ranges are not critical, although the fabric so manufactured will not then exhibit the most desirably preferred characteristics of stretchability. In a fabric so prepared, the remainder of the fabric normally comprises the thermoplastic bonding material generally mentioned hereinabove as well as other additives, such as anti-static agents, dyes, thermosetting resins, which impart durability and resilience to the fabric, and/or other additives and the like.

The regular-crimped component utilized in the practice of the invention can be any one or more of the synthetic or natural fibrous materials mentioned hereinabove except that it contains an average number of about 5 to 20 crimps per inch.

The uncrimped fibrous material can be any of the synthetic materials mentioned above in an uncrimped state or it can be natural fibrous material. Fibrous materials of natural origin include materials such as cellulosic fibers, i.e. cotton and rayon, and proteinaceous fibers such as wool, and the like. It is to be understood that the term "uncrimped" includes materials which contain an average number of 1 to 5 crimps per inch as well as materials which do not contain any measurable crimp.

The regular-crimped and uncrimped fibrous materials may each be utilized alone in a blend of the super-crimped fibrous material or they may be used in mixtures with each other in such a blend. However, it is preferred that the total amount of regular-crimped and/or uncrimped material be utilized in a minor amount in a range of about 2 to 40 percent by weight, based on the total weight of fibrous material in a fabric. Preferably, however, the total amount of regular-crimped and/or uncrimped material is employed in a range of 5 to 15 percent by weight. Although the numerical ranges set out are not critical, and slightly greater amounts of the uncrimped and regular-crimped material can be employed, a fabric containing greater amounts therein does not exhibit the most desirably preferred stretch characteristics. On the other hand, in a fabric which contains very small amounts of regular-crimped and/or uncrimped materials, the stretch characteristics exhibited are similar to a fabric which contains only a blend of super-crimped materials alone.

The fibrous material employed in manufacturing the multi-directional, stretchable, nonwoven fabric in accordance with this invention can vary in denier size. In general, fibrous materials employed herein, whether they be crimped or uncrimped, have a denier measurement in a range of about 1 to 15 denier per filament. Preferably, however, the fibrous materials employed herewith measure in a range of 1.5 to 8 denier per filament. Moreover, it is to be noted that, in blends, fibrous materials of different denier can be utilized. For example, an excellent multi-directional, stretchable nonwoven fabric in accordance with the invention comprises 35 percent by weight of 3 denier per filament of super-crimped nylon and 17.5 percent each of 3 and 5 denier per filament of super-crimped acetate. In addition to the denier measurement, the fibrous material employed can also vary widely in the length of individual fibers thereof. For example, the particular nonwoven fabric referred to immediately hereinabove contains individual filaments which have an average length of approximately 1½ inches. However, individual fibers having an average length of anywhere from about ½ inch to about 3 inches lend themselves very readily to utilization in the practice of this invention. Here, once more, although these figures are not of a critical nature, fabrics exhibiting the most desirable characteristics in accordance with this invention are followed in manufacturing a fabric in accordance herewith. Moreover, processing limitations necessitate the

use of fibers not exceeding about 5 inches in length with presently known machinery.

As pointed out hereinbefore, thermoplastic bonding agent is present in the new nonwoven fabrics of this invention in a range of about 10 to about 50 percent by weight, based on the total weight of the fabric, and preferably in a range of about 20 to 40 percent by weight, although these figures are not critical. The thermoplastic material or binder can vary widely and depends to some degree upon the particular blend of fibrous material being utilized to manufacture a fabric. The most particularly useful thermoplastic bonding agent for a particular blend of fibers can be determined by standard analytical methods. Suitable thermoplastic bonding agents include polymers of esters and amides of acrylates and methacrylic acids as well as polymers and copolymers of vinyl acetate and acrylic esters. Specific useful thermoplastic bonding agents are, butadiene-acrylonitrile copolymers, butadiene-styrene copolymers, carboxylated butadiene-styrene copolymers, natural rubber, carboxylated butadiene-acrylonitrile copolymers, styrene-acrylate copolymers, butyl rubber, polyurethanes, polyethylene emulsions, polyvinyl chloride emulsions, polyvinyl acetate dispersions, copolymers of polyvinyl chloride polyvinyl acetate, acrylic-vinyl acetate copolymers, homopolymeric vinylidine chloride, polyvinyl acetate stearate; terpolymers of polyvinyl acetate, vinylidine-chloride and acrylonitrile; polyvinyl butral and polyvinyl acetate dibutyl maleate. Also useful as bonding agents are terpolymers and copolymers of acrylates and acrylic acids.

The thermoplastic bonding agent is normally employed in an aqueous solution or emulsions of about 10 to 50 percent concentration. The solution or emulsion also contains thermosetting resins, such as melamine-formaldehyde resins to impart durability and resilience to the fabric. The solution or emulsion also contains a latent acid catalyst, such as ammonium chloride, or the like.

The multi-directional, stretchable, nonwoven fabrics of this invention can be manufactured by any of the known methods for making nonwoven materials and such a fabric consists primarily of a fibrous web which is produced on a card, garnett or Rando-Webber apparatus. Generally, such a process includes opening the fiber on fiber-opening machinery, preparation and formation of the web under proper temperature and conditions of humidity and, finally, bonding the web by saturating, spraying, impregnating, or other application.

The web-forming process usually begins with opening of the fibers. This operation may include a procedure of blending different fibers before loading them into a picker from where they are conveyed to a garnett or other web-forming device. The fiber-opening operation can be accomplished by equipment such as shredders, beaters, grinders, aerators, automatic blending feeders and remix blenders. After the fibrous material has been opened and blended, it is delivered directly to a web former. Although garnetts usually are regarded as web formers, they are sometimes useful in the opening operations as a pre-carding machine to achieve more thorough opening and blending before web formation.

In general, web formation can be achieved by three fundamentally different processes. Two of these are parallel and crossload web production. The other is the production of random or isotropic webs by air blowing. Currently, commercial nonwoven webs are manufactured by all three types of processes.

The parallel laid webs, in which all fibers run in approximately the same direction, are produced on carding machines such as garnetts, cards, and the like, which are devices for combing the fibers into essentially parallel arrangement. Each carding machine delivers a thin sheet of parallel fibers onto a continuous belt. Several such machines are run in series and the thin layers produced by successive machines are super-imposed on each other running in the same direction to form a multi-layer web.

The crosslaid web is a system in which the web is built up in sandwich fashion in a sequence of layers in which the fibers run in different directions. Again the fibers is first run through a carding machine to form a thin sheet of parallel fibers. However, the product of successive carding machines is delivered onto the conveyor belt in different directions. Thus, the first carding machine delivers in the direction of conveyor travel. The sheet delivered from the second carding machine is superimposed crosswise to the first layer by means of a cross lapper, also known as a Scotch Feeder. The result is a plurality of superimposed layers of fibers webs.

One process of manufacturing random laid webs includes process steps in which the fibers are opened up and are blown onto a rotating perforated drum or moving foraminous conveyor belt to which they are held by internal vacuum. A mat is formed thereby and delivered to a high-speed lickerin (a rotating drum provided with metallic teeth which breaks up the original web structure). The resulting fibrous particles are blown onto a second vacuum drum where they form a highly uniform web which is taken off and passed to a continuous conveyor.

The final operation in any of the processes is the bonding or stabilization of the fibrous mat. This is done by applying binder to the unbonded web such as by impregnation, spraying, coating and the like.

After drying the bonded nonwoven fabric, finishes can be applied thereto, if some special properties are required. Among commonly known finishes which are applied to a nonwoven fabric are water-repellency treatments, fire-retarding treatments, pigmenting treatments, softening treatments, and the like. Subsequently, any cross-linking agents which have been heretofore added to impart durability and resilience to the fabric can be activated by subjecting the fabric to elevated temperatures (about 140° C. to 160° C.) at this stage of the manufacturing process.

In order to illustrate the instant invention more fully, the following examples are set forth. In the examples all parts and percentages are by weight unless otherwise indicated.

EXAMPLE I

A nonwoven fabric was prepared in accordance with the following procedure: A mixture of 50 percent by weight of nylon staple fibers (polyhexamethylene adipamide), which had an average length of approximately 1½ inches and a denier measurement of 3 denier per filament and about 30 crimps per inch and 50 percent by weight of acetate staple fibers (cellulose acetate) which had an average length of approximately 1$\frac{9}{16}$ inches, a denier measurement of about 3 denier per filament and approximately 30 crimps per inch, were thoroughly pre-opened and blended together on a blender-opener. The blended materials were then conveyed to a Rando-Webber and formed into a mat of random-laid fibers having a thickness of about 10 mm. and weighing approximately 60 grams per square yard. The web-forming operation as well as the blending and fiber-opening steps were carried out at room temperature (about 20° C.) and a relative humidity of approximately 65 percent. The uniform web so formed was then bonded by passing the fibrous mat between a metallic screen and a perforated, stainless steel drum, both of which guide the unbonded web into a solution of bonding agent which contained, by weight, about 220 parts of thermoplastic, polymeric acrylic emulsion of which 99 parts by weight are polymer solids and 274 parts by weight are water. The bonding solution also contained 2 parts by weight of a liquid triazine-formaldehyde resin in 50 percent solution as a cross-linking agent and 2 parts by weight of ammonium chloride catalyst. The binding solution further contained 2 parts by weight of alkyl aryl polyether alcohol as a wetting agent. After thoroughly immersing the web in the solution of bonding agent, it was conveyed over a vacuum box where excessive binder was removed from the fibrous web. The fibrous

web was heated to a temperature of approximately 125° C. to aid in removing excess binder therefrom and was then passed through a heating zone at a temperature of approximately 150° C. for about 2 to 3 minutes in order to cure the treated fabric. The nonwoven fabric so formed possesses the ability to be stretched in a multiple number of directions at the same time and to return to its original shape and contains approximately 70 percent by weight of fibrous material and 30 percent by weight of solid binder.

EXAMPLE II

The procedure of Example I was repeated except that the nonwoven fabric which was made contained 50 percent by weight of nylon staple fibers (polyhexamethylene adipamide) which had an average length of approximately 1½ inches, a denier measurement of 3 denier per filament and about 30 crimps per square inch, 35 percent by weight of acetate staple fibers (cellulose acetate) which had an average length of approximately 1 9/16 inches, a denier measurement of 3 denier per filament and approximately 30 crimps per inch and 15 percent by weight of uncrimped nylon staple fibers, such as those mentioned above, but having a denier measurement of about 2.8 denier per filament. As with the nonwoven fabric prepared in Example I, this fabric exhibited good qualities of multi-directional stretchability and return to original shape and contained approximately 70 percent by weight of fibrous material and 30 percent by weight of the solid binder.

EXAMPLE III

The procedure of the foregoing examples was repeated and a fabric was prepared which contained 50 percent by weight of nylon staple fibers (polyhexamethylene adipamide) which had an average length of approximately 1½ inches, a denier measurement of 3 denier per filament and about 30 crimps per inch, 35 percent by weight of acetate staple fibers (cellulose acetate) which had an average length of approximately 1 9/16 inches, a denier measurement of 3 denier per filament and approximately 30 crimps per inch and 15 percent by weight of nylon staple fibers such as those mentioned above which had an average length of approximately 1½ inches, a denier measurement of 3 denier per filament and approximately 10 crimps per inch. In lieu of the solution of binding agent in the foregoing examples, the thermoplastic acrylic emulsion polymer was replaced by a carboxy modified polymeric butadiene-acrylonitrile bonding agent which was employed in a solution of 198 parts which contained about 99 parts by weight of the polymeric solids. As with the fabrics prepared in Examples I and II, the nonwoven fabric of this example exhibited excellent properties of multi-directional stretchability as well as ease of processing and contained about 70 percent by weight of fibrous material and about 30 percent by weight of solid binder.

EXAMPLE IV

The procedure of the foregoing examples was once more repeated except that there was employed to make the nonwoven fabric 50 percent by weight of nylon staple fibers (polyhexamethylene adipamide) of an average length of approximately 1½ inches, a denier measurement of 3 denier per filament and about 30 crimps per inch, 30 percent by weight of acetate staple fibers (cellulose acetate) of an average length of approximately 1 9/16 inches, a denier measurement of 3 denier per filament and approximately 30 crimps per inch, 10 percent by weight of uncrimped nylon staple fibers which had a denier measurement of about 2.8 denier per filament and approximately 1½ inches in length and, finally, 10 percent by weight of nylon staple fibers having the same length and denier measurements but which contained only about 10 crimps per inch. The fibrous web formed from the blend was bonded together in the same manner as in the foregoing examples and the carboxy modified polymeric butadiene-acrylonitrile bonding agent employed in Example III was once more utilized. The resulting nonwoven fabric exhibited excellent properties of multi-directional stretchability and contained approximately 70 percent by weight of fibrous material and 35 percent by weight of solid binder.

The nonwoven fabrics made in accordance with the preceding examples exhibited excellent properties of stretchability and recovery to normal shape in comparison to like fabrics which contained the same materials but which had a normal amount of crimp.

The fabrics prepared in accordance with the present invention exhibit many desirable characteristics. They are especially adapted for use in all areas where a nonwoven stretch fabric is generally employed and have the ability to stretch in a multiple number of directions and substantially return to their normal shape. Moreover, this property of stretchability is relatively permanent, i.e., it generally endures for the life of the fabric.

It is to be understood by those skilled in the art that many apparently widely different embodiments of this invention can be made without departing from the spirit and scope thereof. Accordingly, it is to be understood that this invention is not to be limited to the specific embodiments thereof, except as defined in the appended claims.

What is claimed is:

1. A nonwoven fabric which exhibits multi-directional stretchability and substantially complete recovery of original shape, said fabric comprising from 10 to 35 percent by weight of said fabric of a carboxylated polymeric butadiene-styrene bonding agent, from 85 to 50 percent by weight of said fabric of a blend of nylon and acetate staples having from 20 to 40 crimps per inch and from 5 to 15 percent by weight of said fabric of nylon staples having less than 20 crimps per inch.

2. A nonwoven fabric which exhibits multi-directional stretchability and substantially complete recovery of original shape, said fabric consisting essentially of a carboxylated polymeric butadiene-styrene bonding agent and a stable fibrous material, comprising a blend having a major portion of nylon and acetate staples having from 20 to 40 crimps per inch and a minor portion of nylon staples having less than 20 crimps per inch.

References Cited

UNITED STATES PATENTS

3,117,055 1/1964 Guandique et al. ____ 161—170

OTHER REFERENCES

"Synthetic Rubber" by Whitby, John Wiley and Sons 1954, pp. 696.

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