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NONWOVEN CARPET AND METHOD OF MAKING THE SAME

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ABSTRACT OF THE DISCLOSURE

A nonwoven carpet is produced by needling a fibrous batt, flaming the pile face of the needle-punched batt to fuse the fiber ends so as to form balls on the ends thereof, placing a second batt over the flamed surface of the pile face and needling the composite. The thus needled composite may be employed alone as a carpet or as a carpet topping in combination with a backing which comprises a needled foam-fiber batt laminate.

This invention relates to needle loom nonwoven fabrics and, more particularly, to the production of nonwoven carpet and carpet toppings using needle punching techniques. The invention provides an improved method for producing a composite, multilayer, nonwoven, fibrous structure which may be used as unsupported carpet for trunk linings or as a carpet topping, as well as a method for producing a unique, needle loom, resilient, nonwoven carpet from a carpet topping and a carpet underlay. Highly serviceable and attractive yet relatively inexpensive carpets for either indoor or outdoor use may be readily produced by the methods of the invention using needle punching looms or needle felting equipment which are commercially available.

Using a batt of polyolefin fiber which had been needle-punched and which, as a necessary consequence of any needle felting operations, contains a smooth face and a pile face (from which polyolefin fiber ends slightly protrude.) I have found that by flaming the pile face until the slightly protruding polyolefin fiber ends undergo a characteristic "balling" or "beading" (which occurs at or above the fusion temperature of the particular polyolefin fiber), it is possible to partially fuse a zone of polyolefin fiber immediately adjacent to the pile face and physically anchor most of the polyolefin fiber in the batt to this partially fused zone. Moreover, when a second fiber batt composed of polyolefin fiber or any other thermoplastic fiber is placed over the flamed pile face of the first needle-punched polyolefin batt and both layers are passed through a needle punching loom so that the second batt is the uppermost layer, fibers of the second batt are needled through the partially fused zone of the first batt with the result that both batts are now physically anchored to the partially fused zone. Structurally, the resultant composite product is a multilayer, nonwoven, fibrous structure in which the exposed surface derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt is termed the *pile face,* since needling results in a pile-like protrusion of fiber ends from such surface. The exposed surface of the composite structure which is derived from the second batt is termed the *smooth face.* These composite structures are particularly suitable for use as unsupported carpet for automotive trunk linings, or they may be used as carpet toppings in the fabrication of nonwoven carpets. Increased strength and dimensional stability may be imparted to these composite structures, if desired, by thermally laminating a woven scrim or mesh (fabric, or metal, the terms "scrim" and "mesh" being used interchangeably) to one surface of the composite structure, preferably to its smooth face to avoid marring the attractiveness or appearance of the pile face.

Based on these discoveries, the invention provides an improved method of producing a composite, multilayer, nonwoven, fibrous structure suitable for use as unsupported carpet or as carpet topping, which method comprises (a) passing a first batt of polyolefin fiber through a needle punching loom to partially compress and strengthen the batt and to create (i) a smooth face, and (ii) a pile face from which polyolefin fiber ends slightly protrude; (b) flaming the pile face of the needle-punched polyolefin batt until the polyolefin fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polyolefin fiber immediately adjacent to the pile face and physically anchoring most of the polyolefin fiber in the batt to such partially fused zone; and (c) placing a second fiber batt over the flamed pile face of the first needle-punched polyolefin batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of the polyolefin fiber. The invention also contemplates the products produced by this method, as well as a method for producing nonwoven carpet in which these composite structures are employed as carpet topping.

To produce these needle loomed, composite, multilayer, nonwoven, fibrous structures in accordance with the method of the invention the first batt must be composed primarily of polyolefin fiber, since only these fibers are capable of undergoing partial fusion rapidly in that zone which is immediately adjacent to the pile face. The use of higher melting thermoplastic fibers other than polyolefin fiber in the first batt may require excess temperatures or extended flaming of the pile face, both of which tend to mar the appearance of the batt, although such fibers may be used in the first batt. Among those polyolefin fibers which have been found suitable for use in the first batt are polyethylene, polypropylene, and various interpolymers and block copolymers of ethylene and propylene. The second batt, however, may be composed of any thermoplastic fiber, including the aforementioned polyolefin fibers, as well as one or more thermoplastic fibers other than polyolefin fiber. If polyolefin fiber is not employed in the second batt, but other thermoplastic fibers are used, then it is somewhat preferably to use in the second batt fibers of thermoplastic polymers having a melting point at least 50° C. higher than the polyolefin fiber of the first batt, or to partially include such cellulosic fibers as rayon or cellulose triacetate. For best results, however, both the first and second batts should be composed of polypropylene fiber, preferably using 15 denier by 6-inch polypropylene fiber which has been chemically stabilized against ultra-violet degradation and which has a high degree of resiliency.

In accordance with the method of the invention, the first batt of polyolefin fiber is passed through a needle punch loom to partially compress and strengthen the batt and to create a smooth face (which is derived from the upper face of the batt as it enters the needle punching loom). Any commercially available needle felting equipment may be used in the needling operations, such as the needle felting machines (the terms "needle felting," "needle punching," and "needle loom" being interchangeably used herein) such as those which are manufactured by James Hunter Machine Company, North Adams, Mass. The first batt of polyolefin fibers should be passed through the needle punching loom so that the batt re-

ceives from about 500 to about 1,000 needle penetrations per square inch.

The needle-punched polyolefin batt is than flamed on a flame laminator so that the flame is directed to the pile face of the batt, the rate at which the batt is passed through the flame laminator being such that the pile face is exposed to the flame for a period of time which is just sufficient to cause the polyolefin fiber ends which slightly protrude from the pile face to undergo a characteristic balling (which occurs at or above the fusion temperature of the polyolefin) thereby partially fusing a zone of polyolefin fiber immediately adjacent to the fiber face and physically anchoring most of the polyolefin fiber in the first batt to such partially fused zone.

A second fiber batt, preferably composed of polypropylene fiber, is then placed over the flamed pile face of the first batt, and the two layers are passed through a needle punching loom so that the second batt is the uppermost layer on entering the needle punching loom. Needling of the second batt to the first (previously needle-punched and flamed) batt drives fibers of the second batt through the partially fused zone of the first batt, thereby forming a composite, multilayer, non-woven fibrous structure in which both batts are physically anchored to the partially fused zone of polyolefin fiber. As carpet topping, the exposed surface of this composite structure which is derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt represents the pile face of the carpet topping, while the exposed face of the composite structure derived solely from the second batt represents the smooth face of the carpet topping.

In most cases, greater strengths are obtained when the density of needle penetrations per square inch employed in needling the second batt to the first batt is greater than that used in needling the first batt prior to flaming. As a general rule, the second needling operation in which the second batt is needled onto and through the first batt should be carried out by using from about 1,000 to about 2,000 needle penetrations per inch. Composite, multilayer, nonwoven, fibrous structures produced by the method of the invention are particularly satisfactory for use as carpet topping which, in turn, may be employed in the fabrication of nonwoven carpet.

An improved technique has been developed for producing resilient, nonwoven carpets from these carpet toppings. Basically, this technique utilizes the carpet topping, a woven scrim (either fabric or metal) and a carpet underlay, which is a composite, needle-punched foam/batt structure, the production of which is more fully described in my copending application, Ser. No. 605,184, filed Dec. 28, 1966, entitled "Carpet Underlay and Method of Making the Same," now Patent No. 3,441,464. The carpet underlay is produced by passing a third batt, preferably composed of polyolefin fiber, and a layer of flexible polyurethane foam (which may be either polyester or polyether-derived) through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam, which results in partially compressing the foam, the degree of compression being dependent upon the density and depth of needle penetration per square inch employed during this needling operation. The third batt should be the upper layer as the two layers pass through the needle punching loom. As the composite needle-punched foam/batt structure exits from the needle punching loom, the uppermost face is termed the *batt side,* since the needling occurred through the batt and then into the foam layer; the lower face is termed the *pile side,* since needling results in pile-like protrusion of those fiber ends of the third batt which had been needle-punched through the polyurethane foam layer. For most purposes, this carpet underlay may be used without further processing prior to fabricating the resilient, non-woven carpet of the invention. For certain types of carpet, such as throw rugs, area rugs and mats, however, it may be desirable to impart an anti-skid surface to the carpet underlay, in which case the carpet underlay should be further processed by flaming the batt side of the composite, needle-punching foam/batt structure to melt the fiber ends lying on the batt side until such fibre ends undergo the characteristic beading and to simultaneously form a transient adhesive at the flamed surface of the foam. When the flamed batt side undergoes cooling, the beaded fibre ends are bonded and interlocked with the compressed foam at the points of fibre penetration, allowing the foam to pillow up at other points. The flamed batt side now possesses an anti-skid surface; the pile side remains unaffected by this flaming and possesses a pile face.

To produce a highly serviceable, yet relatively inexpensive, resilient, non-woven carpet from these three components (i.e., carpet topping, woven scrim, and carpet underlay) the woven scrim should be interposed between the pile face of the carpet underlay and the smooth face of the carpet topping, and the two faces thermally fused to each other through the interposed scrim. Thermal fusion of the carpet topping to the carpet underlay through the interposed scrim may be accomplished either by heating the smooth face of the carpet topping, or by heating the pile face of the carpet underlay, or by heating both, so that the fibres on the surface of such heated face become soft and tacky, after which the smooth face of the carpet topping and the pile face of the carpet underlay are pressed together through the interposed scrim, thereby resulting in a fibre-to-fibre bond between the carpet topping and the carpet underlay.

Because this method of producing nonwoven carpets yields a product which is highly serviceable and attractive in appearance, yet relatively inexpensive to manufacture, the invention also contemplates the method of producing resilient, non-woven carpets which comprises

(A) forming a carpet topping having a smooth face and a pile face by (1) passing a first batt of polyolefin fibre through a needle punching loom to partially compress and strengthen the batt and to create (a) a smooth face, and (b) a pile face from which polyolefin fibre ends slightly protrude; (2) flaming the pile face of the needle-punched polyolefin batt until the polyolefin fibre ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polyolefin fibre immediately adjacent to the pile face and physically anchoring most of the polyolefin fibre in the batt to such partially fused zone; and (3) placing a second batt of thermoplastic fibre over the flamed pile face of the first needle-punched batt and then passing both batts through a needle punching loom so that fibres of the second batt are needled through the partially fused zone of the first batt, thereby forming a carpet topping consisting essentially of a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of polyolefin fiber, the exposed surface of such composite structure which is derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt constituting the pile face of the carpet topping, and the exposed surface of such composite structure which is derived solely from the second batt constituting the smooth face of the carpet topping;

(B) forming a carpet underlay having a batt side and a pile face by (1) passing a third batt of polyolefin fiber and a layer of polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite needle-punched foam/batt structure which contains (a) a batt side, through which side the needling occurred, and (b) a pile side from which protrude those fiber ends of the third batt which had been needle-punched through the polyurethane foam layer; and

(C) interposing a woven scrim between the smooth

face of the carpet topping and the pile face of the carpet underlay, and then thermally fusing the pile face of the carpet underlay and the smooth face of the carpet topping to each other through the interposed scrim, thereby forming a resilient, non-woven carpet.

Alternatively, prior to assembling the carpet components the carpet underlay may be flamed on its batt side to melt the polyolefin fiber ends lying on the batt side until such fiber ends undergo a characteristic beading and to simultaneously form a transient adhesive at the flamed surface of the foam, after which the flamed batt side is allowed to undergo cooling. This treatment interlocks the beaded fiber ends with the compressed foam at the points of fiber penetration and allows the foam to pillow up at other points, the resultant composite, multilayer, nonwoven fiber/polyurethane foam structure having (a) an antiskid surface on the flamed batt side, and (b) a pile face on the pile side. This further processing of the carpet underlay ordinarily is not required for most nonwoven carpets, but may be used advantageously for certain types, such as throw rugs, area rugs and mats.

As described in detail below, the method of the invention has been adapted for the manufacture of resilient, nonwoven polypropylene carpet for indoor use. For convenience, the method used for producing the carpet topping, the method used for producing the carpet underlay, as well as the method used for combining these elements into a nonwoven carpet, are separately described below:

PRODUCTION OF CARPET TOPPING

Polypropylene batting weighing 8 ounces per square yard and composed of 15 denier x 6-inch polypropylene fiber having acceptable lightfastness may be used for both the first and second batts in the carpet topping. The first batt is passed through a needle punching loom and needled with from 800 to 1,000 penetrations per square inch, using a penetration depth of from 7/16 to 9/16-inch and the most efficient running speed. After needling, the first batt is flamed on a flame laminator at a speed of 30 yards per minute, using compression. Under these conditions and with the flame directed to the pile face of the first batt, a zone of polypropylene fiber immediately adjacent to the pile face undergoes partial fusion, which is characterized by balling of the fiber ends protruding from the pile face.

The second batt may be the same or a contrasting color as the first batt. The second batt enters the needle loom such that it is placed on top of the previous needled first batt which, in turn, has its flame-fused face up and its smooth face down. The two batts are needled together using 1,600 penetrations per square inch and a penetration of 7/16-inch at the most efficient speed. The carpet topping is now completed and may be placed in rolls prior to further use.

PRODUCTION OF CARPET UNDERLAY

A polypropylene fiber batt weighing from 4 to 5 ounces per square yard is used in the production of the carpet underlay, although the staple length and denier can be mixed and the fiber may be of second quality or reworked stock. The polyurethane foam used is a flexible polyether-type polyurethane foam having a thickness of ½-inch. This third batt should be the same width as or slightly wider than the polyurethane foam onto which it is to be needled. In the needling process, the polyurethane foam enters the needle loom lying on the feed apron and the third batt feeds on top of the foam; the two elements are needled together using from about 350 to 400 penetrations per square inch with a penetration of ½ to ¾-inch. Under these conditions, the thickness of the foam is compressed by 50 to 60 percent. The carpet underlay is now completed and may be placed in rolls prior to further use.

If the carpet underlay is to be used in fabricating throw rugs, area rugs or mats, then it should be further processed (prior to being combined with the other two carpet elements) to impart an anti-skid surface. To impart this anti-skid surface, after needling the foam/batt should be passed through a flame laminator at a rate of 30 yards per minute with the flame directed to the batt side of the structure. Fiber lying parallel to the surface of the foam will melt into beads which will retain the compression of the foam at the points of fiber penetration and allow the foam to pillow up at other points. The resultant wafflelike effect creates an anti-skid surface when placed in contact with flooring. This type of carpet underlay is now completed and may be placed in rolls prior to further use.

COMBINING THE CARPET ELEMENTS

Nonwoven polypropylene carpet is produced by combining the three carpet elements namely (1) the carpet topping, (2) the carpet underlay, and (3) a woven scrim of spun fiberglass having a mesh no finer than 10 x 10 per inch. The three separately rolled elements, i.e., carpet topping, scrim and carpet underlay, are mounted on a flame laminator such that the carpet topping will pass over the flame roll with the flame directed at its smooth face. Alternatively, a flame laminator with dual burners may be used, in which case one flame is directed at the smooth face of the carpet topping and the other flame is directed at the pile face of the carpet underlay. The carpet underlay should be mounted such that the fiber ends protruding from the foam (pile side) will be squeezed into the melted face of the carpet topping with the scrim interposed between the carpet topping and carpet underlay. After mounting the three separately rolled elements, the laminator is run at 30 yards per minute (normal squeeze) with the flame directed at the smooth face of the carpet topping, under which conditions the flamed face of the carpet topping will melt. This procedure will result in the fiber ends of the carpet underlay being fused to the melted face of the carpet topping through the openings of the scrim. Moreover, the melted polypropylene also bonds to the foam surface squeezed through the mesh opening and also bonds to the yarn of the scrim, probably by encapsulation. A collateral affect of melting the fibers on the smooth face of the topping is the fusing of the fibers throughout this face so that fibers from the second batt which protrude on the pile face (which is the exposed wearing surface of the carpet) will be locked into the structure.

I claim:

1. A method of producing a composite, multilayer, nonwoven, fibrous structure suitable for use as unsupported carpet or as carpet topping which comprises

(a) passing a first batt of polyolefin fiber through a needle punching loom to partially compress and strengthen the batt and to create (i) a smooth face, and (ii) a pile face from which polyolefin fiber ends slightly protrude;

(b) flaming the pile face of the needle-punched polyolefin batt until the polyolefin fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polyolefin fiber immediately adjacent to the pile face and physically anchoring most of the polyolefin fiber in the batt to such partially fused zone; and

(c) placing a second fiber batt over the flamed pile face of the first needle-punched polyolefin batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of the polyolefin fiber.

2. The method of producing a composite, multilayer, nonwoven, fibrous structure according to claim 1, in which the first batt is composed of polypropylene fiber.

3. The method of producing a composite, multilayer, nonwoven, fibrous structure according to claim 1, in which the second batt is composed of a fiber of a thermoplastic

polymer having a melting point at least 50° C. higher than the polyolefin fiber of the first batt.

4. The method of producing a composite, multilayer, nonwoven, fibrous structure according to claim 1, in which the second batt is at least partially composed of cellulosic fiber.

5. A method of producing a composite, multilayer, nonwoven, fibrous structure suitable for use as carpet topping which comprises

(a) passing a first batt of polypropylene fiber through a needle punching loom to partially compress and strengthen the batt and to create (i) a smooth face, and (ii) a pile face from which polypropylene fiber ends slightly protrude;

(b) flaming the pile face of the needle-punched polypropylene batt until the polypropylene fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polypropylene fiber immediately adjacent to the pile face and physically anchoring most of the polypropylene fiber in the batt to such partially fused zone; and

(c) placing a second batt of polypropylene fiber over the flamed pile face of the first needle-punched polypropylene batt and then passing both batts through a needle punching loom so that the fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of polypropylene fiber.

6. The method of producing a composite, multilayer, nonwoven, fibrous structure according to claim 5, in which the first batt is passed through the needle punching loom so that it is needled with from about 500 to about 1,000 penetrations per square inch, and both batts are passed through the needle punching loom so that they are needled with from about 1,000 to about 2,000 penetrations per square inch.

7. The method of producing a composite, multilayer, nonwoven, fibrous structure according to claim 5, in which a woven scrim fabric is thermally laminated to the smooth face of the composite, multilayer, nonwoven, fibrous structure to impart increased strength and dimensional stability to the structure.

8. The method of producing a nonwoven carpet which comprises

(A) forming a carpet topping having a smooth face and a pile face by

(1) passing a first batt of polyolefin fiber through a needle punching loom to partially compress and strengthen the batt and to create (a) a smooth face, and (b) a pile face from which polyolefin fiber ends slightly protrude;

(2) flaming the pile face of the needle-punched polyolefin batt until the polyolefin fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polyolefin fiber immediately adjacent to the pile face and physically anchoring most of the polyolefin fiber in the batt to such partially fused zone; and

(3) placing a second batt of thermoplastic fiber over the flamed pile face of the first needle-punched batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a carpet topping consisting essentially of a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of polyolefin fiber, the exposed surface of such composite structure which is derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt constituting the pile face of the carpet topping and the exposed surface of such composite structure which is derived solely from the second batt constituting the smooth face of the carpet topping;

(B) forming a carpet underlay having a batt side and a pile face by

(1) passing a third batt of polyolefin fiber and a layer of polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite needle-punched foam/batt structure in which the foam is compressed to a predetermined density and which contains (a) a batt side, through which side the needling occurred, and (b) a pile side from which protrude those fiber ends of the third batt which had been needle-punched through the polyurethane foam layer; and

(C) interposing a woven scrim between the pile face of the carpet underlay and the smooth face of the carpet topping, and then thermally fusing the pile face of the carpet underlay and the smooth face of the carpet topping to each other through the interposed scrim, thereby forming a resilient, nonwoven carpet.

9. The method of producing nonwoven carpet which comprises

(A) forming a carpet topping having a smooth face and a pile face by

(1) passing a first batt of polypropylene fiber through a needle punching loom to partially compress and strengthen the batt and to create (a) a smooth face, and (b) a pile face from which polypropylene fiber ends slightly protrude;

(2) flaming the pile face of the needle-punched polypropylene batt until the polypropylene fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polypropylene fiber immediately adjacent to the pile face and physically anchoring most of the polypropylene fiber in the first batt to such partially fused zone; and

(3) placing a second batt of polypropylene fiber over the flamed pile face of the first needle-punched batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a carpet topping consisting essentially of a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of polypropylene fiber, the exposed surface of such composite structure which is derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt constituting the pile face of the carpet topping and the exposed surface of such composite structure which is derived solely from the second batt constituting the smooth face of the carpet topping;

(B) forming a carpet underlay having a batt side and a pile face by

(1) passing a third batt of polypropylene fiber and a layer of flexible polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite needle-punched foam/batt structure in which the foam is compressed to a predetermined density and which possesses (a) a batt side, through which side the needling occurred, and (b) a pile

side from which protrude those fiber ends of the third batt which had been needle punched through the polyurethane foam layer; and

(C) interposing a woven scrim between the pile face of the carpet underlay and the smooth face of the carpet topping, and then thermally fusing the pile face of the carpet underlay and the smooth face of the carpet topping to each other through the interposed scrim, thereby forming a nonwoven carpet.

10. The method of producing nonwoven carpet according to claim **8**, in which the carpet underlay is formed by

(1) passing a third batt of polyolefin fiber and a layer of polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite, needle-punched foam/batt structure in which the foam is compressed to a predetermined density and which contains (a) a batt side, through which side the needling occurred, and (b) a pile side from which protrude those fiber ends of the third batt which had been needle-punched through the polyurethane foam layer; and

(2) flaming the batt side of the composite, needle-punched foam/batt structure to melt the polyolefin fiber ends lying on the batt side until such fiber ends undergo a characteristic beading and to simultaneously form a transient adhesive at the flamed surface of the foam, and then allowing the flamed batt side to undergo cooling, thereby interlocking such beaded fiber ends with the compressed foam at the points of fiber penetration and allowing the foam to pillow up at other points.

11. Carpet topping consisting essentially of the composite, multilayer, nonwoven, fibrous structure formed by

(a) passing a first batt of polyolefin fiber through a needle punching loom to partially compress and strengthen the batt and create (i) a smooth face, and (ii) a pile face from which polyolefin fiber ends slightly protrude;

(b) flaming the pile face of the needle-punched polyolefin batt until the polyolefin fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polyolefin fiber immediately adjacent to the pile face and physically anchoring most of the polyolefin fiber in the batt to such partially fused zone; and

(c) placing a second fiber batt over the flamed pile face of the first needle-punched polyolefin batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a composite, multilayer, nonwoven fibrous structure in which both batts are physically anchored to the partially fused zone of the polyolefin fiber.

12. Carpet topping in accordance with claim **11**, in which the first and second batts are composed of polypropylene fiber.

13. Nonwoven carpet consisting essentially of the composite structure formed by

(A) forming a carpet topping having a smooth face and a pile face by

(1) passing a first batt of polyolefin fiber through a needle punching loom to partially compress and strengthen the batt and to create (a) a smooth face, and (b) a pile face from which polyolefin fiber ends slightly protrude;

(2) flaming the pile face of the needle punched polyolefin batt until the polyolefin fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polyolefin fiber immediately adjacent to the pile face and physically anchoring most of the polyolefin fiber in the batt to such partially fused zone; and

(3) placing a second batt of thermoplastic fiber over the flamed pile face of the first needle-punched batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a carpet topping consisting essentially of a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of polyolefin fiber, the exposed surface of such composite structure which is derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt constituting the pile face of the carpet topping and the exposed surface of such composite structure which is derived solely from the second batt constituting the smooth face of the carpet

(B) forming a carpet underlay having a batt side and a pile face by

(1) passing a third batt of polyolefin fiber and a layer of polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite needle-punched foam/batt structure in which the foam is compressed to a predetermined density and which contains (a) a batt side, through which side the needling occurred, and (b) a pile side from which protrude those fiber ends of the third batt which had been needle-punched through the polyurethane foam layer; and

(C) interposing a woven scrim between the pile face of the carpet underlay and the smooth face of the carpet topping, and then thermally fusing the pile face of the carpet underlay and the smooth face of the carpet topping to each other through the interposed scrim, thereby forming a resilient, non-woven carpet.

14. Nonwoven carpet consisting essentially of the composite structure formed by.

(A) forming a carpet topping having a smooth face and a pile face by

(1) passing a first batt of polypropylene fiber through a needle punching loom to partially compress and strengthen the batt and to create (a) a smooth face, and (b) a pile face from which polypropylene fiber ends slightly protrude;

(2) flaming the pile face of the needle-punched polypropylene batt until the polypropylene fiber ends which protrude from the pile face undergo a characteristic balling, thereby partially fusing a zone of polypropylene fiber immediately adjacent to the pile face and physically anchoring most of the polypropylene fiber in the first batt to such partially fused zone; and

(3) placing a second batt of polypropylene fiber over the flamed pile face of the first needle-punched batt and then passing both batts through a needle punching loom so that fibers of the second batt are needled through the partially fused zone of the first batt, thereby forming a carpet topping consisting essentially of a composite, multilayer, nonwoven, fibrous structure in which both batts are physically anchored to the partially fused zone of polypropylene fiber, the exposed surface of such composite structure which is derived from the first batt as well as those protruding fibers of the second batt which had been needled through the first batt constituting the pile face of the carpet topping and the

exposed surface of such composite structure which is derived solely from the second batt constituting the smooth face of the carpet topping;

(B) forming a carpet underlay having a batt side and a pile face by

(1) passing a third batt of polypropylene fiber and a layer of flexible polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite needle-punched foam/batt structure in which the foam is compressed to a predetermined density and which contains (a) a batt side, through which side the needling occurred, and (b) a pile side from which protrude those fiber ends of the third batt which had been needle punched through the polyurethane foam layer; and

(C) interposing a woven scrim between the pile face of the carpet underlay and the smooth face of the carpet topping, and then thermally fusing the pile face of the carpet underlay and the smooth face of the carpet topping to each other through the interposed scrim, thereby forming a non-woven carpet.

15. Nonwoven carpet according to claim **13**, in which the carpet underlay is formed by

(1) passing a third batt of polyolefin fiber and a layer of polyurethane foam through a needle punching loom so that the third batt is needled onto and through the layer of polyurethane foam to create a composite, needle-punched foam/batt structure in which the foam is compressed to a predetermined density and which contains (a) a batt side, through which side the needling occurred, and (b) a pile side from which protrude those fiber ends of the third batt which had been needle-punched through the polyurethane foam layer; and

(2) flaming the batt side of the composite, needle-punched foam/batt structure to melt the polyolefin fiber ends lying on the batt side until such fiber ends undergo a characteristic beading and to simultaneously form a transient adhesive at the flamed surface of the foam, and then allowing the flamed batt side to undergo cooling, thereby interlocking such beaded fiber ends with the compressed foam at the points of fiber penetration and allowing the foam to pillow up at other points.

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