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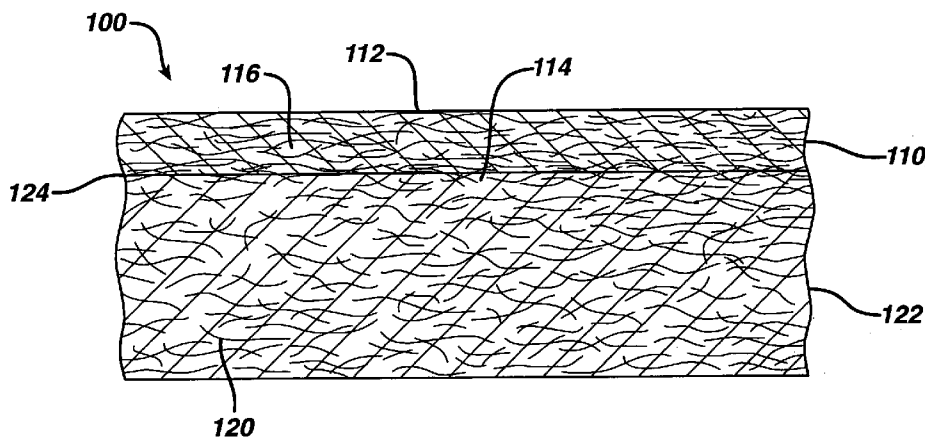
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(57) Abstract: Provided are layered non-woven structures comprising a fibrous, water-permeable anchoring layer and a fibrous layer having fibers entangled about the anchoring layer, including patterned and non-patterned structures. Also provided are personal care products comprising the present structures and methods of making the structures.



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NON-WOVEN STRUCTURES AND METHODS OF MAKING THE SAME

FIELD OF THE INVENTION

The present invention relates generally to layered, composite materials. More specifically, the present invention relates to layered, composite materials exhibiting advantageous lamination strength, and one or more additional beneficial properties such as drapeability, loftiness, abrasion resistance, liquid absorbency, softness, and/or visual appeal.

BACKGROUND

Non-woven materials are used widely in a variety of commercially-available personal care products including, for example, wipes and feminine hygiene products, such as napkins, liners, and tampons, and the like. In many of these applications, it is desirable for the non-woven materials to be abrasion resistant, so that the material maintains its integrity in use. Applicants have further recognized that it is also desirable for such abrasion resistant materials to have other beneficial properties.

For example, Applicant's have recognized that it would be desirable to have an abrasion resistant material that also possesses a visible pattern defined therein. Such patterns are capable of conveying information such as brand identification and aesthetic indicia, but are also capable of providing functional benefits (e.g., directing fluid to be absorbed to appropriate locations). It is further desirable for the above-mentioned patterns to have good definition and durability in use.

Applicants have also recognized that it would be desirable to have abrasion resistant materials, particularly ones that are patterned, that have additional beneficial properties, for example, "drapeability" so as to provide comfort to the user. As used herein, the term "drapeable" refers to the tendency of a material to hang in a substantially vertical fashion due to gravity when held in a cantilevered manner from one end of the material. Materials exhibiting high drapeability tend to conform to the shape of an abutting surface, such as against a user's skin, thereby tending to enhance comfort to the user of a product comprising the high-drape material. Applicants have further recognized that it is also

desirable in certain applications for abrasion resistant nonwovens to be bulky (i.e., low density).

Applicants have further recognized, however, that conventional materials having relatively high drapeability characteristics also tend to be relatively dense, thin, smooth, therefore lacking in a cushiony feel, which may further be desired in a variety of products. For example, many relatively drapeable materials have been made via conventional spunlacing (i.e., hydroentanglement), but nevertheless are either deficient with respect to one or more of abrasion resistance, lamination strength, bulkiness, or other properties. Furthermore, such conventional drapeable materials are typically lacking in visible patterns, which could otherwise be used to communicate information to the user.

Accordingly, applicants have recognized the need for non-woven materials that exhibit the highly desirable, and unique combination of high-abrasion resistance and visible patterning for use in any of a variety of articles. In addition, applicants have recognized the need for unique methods of producing such materials, including, but not necessarily limited to, methods of producing such materials via the hydroentanglement of non-wovens.

SUMMARY OF INVENTION

Applicants have met the need identified above by producing a fibrous, composite structure having the unique and desirable combination of relatively high lamination strength in combination with high drapeability and/or low density properties.

According to one aspect, the present invention provides layered, composite materials comprising a fibrous, fluid-permeable anchoring layer having tensile strength of at least about 5 N/5cm and a fibrous layer comprising fibers entangled about the anchoring layer, the composite material comprising a cross-section of entangled region and a cross-section of unentangled region, wherein the entangled region and unentangled region are visibly distinct from one another.

Also provided are methods of making certain composite materials comprising urging a stream of fluid into contact with a layered structure comprising a layer of unbonded fibers and a fluid-permeable, anchoring layer having a tensile strength of at least about 5 N/5cm, wherein the anchoring layer is positioned to at least partially shield the layer of unbonded fibers from the stream of fluid, to produce a composite material comprising a cross-section of entangled region and a cross-section of unentangled region, wherein the entangled region and unentangled region are visibly distinct from one another.

According to yet another aspect, provided are methods of producing a layered, composite material comprising urging a stream of fluid into contact with a layered structure comprising a layer of unbonded fibers and a fluid-permeable, anchoring layer having a tensile strength of at least about 5 N/5cm, wherein the layered structure is supported on a topographic forming surface and wherein the layered structure is contacted for a time sufficient to conform such layered structure to said topographic forming surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Examples of embodiments of the present invention will now be described with reference to the drawings, in which:

Figure 1 is a cross-sectional view of an embodiment of a layered, composite material of the invention described herein;

Figure 2 is a cross-sectional view of another embodiment of a layered, composite material of the invention described herein;

Figure 3 is a top, plan view of another embodiment of a layered, composite material of the invention described herein, showing additional features thereof;

Figure 4 is a cross-sectional view of the layered, composite material of Figure 3, taken through line 3-3';

Figure 5 is a cross-sectional view depicting the formation of a layered, composite material according to a process consistent with embodiments of the invention described herein;

Figure 6 is a cross-sectional view depicting the formation of a layered, composite material according to another process consistent with embodiments of the invention described herein;

Figure 7 is a perspective view of a mask that may be used to form a layered composite material consistent with embodiments of the invention described herein;

Figure 8 is a plan view of a length of patterned, layered composite material 810 consistent with embodiments of the invention described herein; and

Figure 9 is a cross-sectional view depicting the patterning of a layered, composite material according to embodiments of the invention described herein.

DESCRIPTION OF PREFERRED EMBODIMENTS

According to certain embodiments, the present invention is directed to layered, composite materials comprising a fibrous, fluid permeable anchoring layer and a fibrous layer having fibers entangled about the anchoring layer, which composite materials exhibit a unique combination of relatively high lamination strength in conjunction in one or more relatively high drapeability, and/or low density (high bulkiness or "bulk") as compared to conventional non-woven structures. Such unique materials are, in certain embodiments, also beneficially abrasion resistant, durable, soft, comfortable, and/or absorbent. In certain embodiments, such materials are further useful for providing various other benefits, including fluid absorption or fluid isolation, cleansing, and exfoliation capability in a variety of products.

In particular, applicants have measured the lamination strength of composite materials according to certain embodiments of the present invention in accord with the "Lamination Strength Test" described in detail below. As will be understood by those of skill in the art, a resulting higher Lamination Strength Value indicates a relatively greater ability for the anchoring layer and fibrous layer having fibers entangled about the anchoring layer of the composite material to resist de-bonding from one another as a result of applied force and a lower Lamination Strength Value indicates a relatively lesser ability for the two layers to resist de-bonding upon applied force. In addition, applicants have recognized that a relatively high lamination strength tends to correlate to the consumer-desirable "durability" of the layered, composite material. According to certain embodiments, the present composite material exhibit a Lamination Strength Value that is about 20 grams or more, more preferably about 50 grams or more, and even more preferably from about 100 grams or more.

Applicants have also measured the drapeability of the present structures via the "Drapeability Test", described in detail below and understood by those of skill in the art. Applicants have recognized that in certain embodiments the present structures exhibit not only desirably high lamination strength, as described above, but also exhibit relatively high drapeability in combination therewith. In particular, according to certain embodiments, the present structures exhibit a drapeability (basis weight/MCB) that is greater than about 4

grams per square meter per gram (gsm/g) or greater, preferably greater than about 6 gsm/g, and even more preferably from about 8 gsm/g to about 16 gsm/g.

Applicants have also measured the density of the composite materials of certain preferred embodiments of the present invention via the "Density Test," described in detail below and understood by those of skill in the art. Applicants have recognized that in certain embodiments the present structures exhibit not only desirably high lamination strength, as described above, but also exhibit relatively low density in combination therewith. According to certain embodiments, the present structures exhibit a density that is about 0.15 g/cc or less, more preferably about 0.12 g/cc or less, and even more preferably from about 0.12 g/cc to about 0.03 g/cc.

According to certain embodiments, applicants have recognized that in addition to relatively high lamination strength in combination with relatively high drapeability and/or relatively low density, the composite materials of the present invention further comprise one or more properties selected from relatively high absorbent capacity, relatively high tensile strength, desirable thickness, and combinations of two or more thereof. For example, in certain embodiments of the invention, the layered, composite material has an absorbent capacity that is greater than about 3 g/g, preferably greater than about 4 g/g, and more preferably about 5 g/g. In certain embodiments, the composite material has a tensile strength in the machine direction (measured via the "Tensile Strength Test," described in detail below and understood by those of skill in the art) of about 10 N/5cm or more, preferably about 15 N/5cm or more, more preferably about 20 N/5cm or more. The thickness of the composite materials of the present invention may be optimized for use in any of a wide range of articles and any suitable/desired thickness for a particular article may be used. In certain preferred embodiments, the composite materials of the present invention have a thickness of less than about 10mm, preferably less than about 5mm, more preferably less than about 2mm, and even more preferably from about 0.3mm to about 2mm.

Figure 1 is a cross-sectional view depicting an embodiment of a layered, composite material 100 consistent with embodiments of the invention described herein. The layered, composite material 100 comprises a fibrous, fluid-permeable anchoring layer 110 and a

fibrous layer 122 having fibers 120, at least a portion of which are entangled about anchoring layer 110.

The fluid-permeable, anchoring layer 110 may comprise any suitable fibrous material that is permeable to fluids. By permeable to fluids, it is meant that gases or liquids, such as water (and the like) may be urged through a cross-section of the fluid-permeable, anchoring layer 110, i.e. from an outer surface 112 of the fluid-permeable, anchoring layer 110, through the fluid-permeable, anchoring layer 110 to emerge from an inner surface 114 of the fluid-permeable, anchoring layer 110. In certain preferred embodiments, to facilitate the movement of fluid through the fluid-permeable, anchoring layer 110, the fluid-permeable, anchoring layer 110 comprises a network of interconnected pores 116. In certain preferred embodiments, the anchoring layer has a percent open area of about 25% or more. Preferably, the fluid-permeable, anchoring layer 110 is also generally resistant to dissolution and mechanical degradation that would be caused by urging high pressure fluids such as water or air therethrough.

In certain embodiments, the fluid-permeable, anchoring layer 110 is relatively thin, for example, having thickness of less than about 2000 microns, more preferably from about 3 to about 2000 microns. The fluid-permeable, anchoring layer 110 may be of any suitable basis weight. In certain preferred embodiments, the anchoring layer has a basis weight of from about 5 gsm to about 20gsm, and more preferably, about 5 gsm to about 15 gsm. Furthermore, the fluid-permeable, anchoring layer 110 is preferably mechanically integrated such that it has a tensile strength of at least about 5 N/5cm. Additionally, it is desirable that the fluid-permeable anchoring layer is preferably selected to be relatively flexible (i.e. tends not to be stiff) which applicants have recognized tends to benefit in the drapeability associated with a material incorporating the anchoring layer.

In preferred embodiments, the fluid-permeable, anchoring layer 110 comprises or consists essentially of a polymeric material, such as a bonded, fibrous material, including a spun-bond or thermobonded, such as a through-air bonded, material, and the like. By "through air bond," it is meant fibers that have been oriented by various means such as carding and have been bonded together by passing a heated stream of air therethrough. By "spun bond" it is meant fibers that are melt spun by extruding molten thermoplastic polymer as fibers from a plurality of fine, usually circular, capillaries of a spinneret with

the diameter of the extruded fibers then being rapidly reduced by drawing and then quenching the fibers. Spun-bond fibers are usually continuous fibers. Suitable spun-bonded materials are formed from fibers having a diameter from about 3 microns to about 20 microns and having a fiber length greater than about 200mm. The fibers of the anchoring layer may include such materials as polyolefins such as polypropylene, polyethylene, bicomponent fibers formed from polypropylene, polyethylene, or combinations thereof. The spun bond fibers may be subsequently compressed to provide increased strength or reduced thickness. In a preferred embodiment, the fluid-permeable, anchoring layer 110 comprises or consists essentially of a spun bond material.

The outer surface 112 of the fluid-permeable, anchoring layer 110 is generally an abrasion resistant surface. By "abrasion resistant" it is meant that the outer surface 112 generally resists degradation from resilient objects, e.g., a hand or other body surfaces being passed across the outer surface 112.

The layered, composite material 100 comprises fibers 120 at least a portion of which are entangled about the fluid-permeable, anchoring layer 110. The fibers are preferably associated with a fibrous layer 122. The fibers entangled about the fluid-permeable, anchoring layer 110 preferably includes a plurality of fibers or filaments that are associated with one another and with the fluid-permeable, anchoring layer 110 such as by entanglement. As such, the fluid-permeable, anchoring layer 110 in effect serves as a "skeleton" for the layered, composite material 100.

The entanglement of the fibers about the fluid-permeable, anchoring layer 110 generally results in a bonding between the fibrous layer 122 and the fluid-permeable, anchoring layer 110 about an interface 124. While the interface 124 is depicted essentially a line in Figure 1, the interface 124 generally has a thickness associated therewith. The nature of the interface 124 is that of fibers twisted, knotted, tied or otherwise entangled about the fluid-permeable, anchoring layer 110.

In certain preferred embodiments, the anchoring layer 110 and the fibers of the fibrous layer 122 entangled about the anchoring layer 110 are substantially free of bonding formed from melting the fibers and/or anchoring layer 110 and/or bonding formed using chemical adhesives. As used herein the term "substantially free of bonding formed from melting the fibers and/or anchoring layer 110 and/or bonding formed using chemical

adhesives” means a material wherein less than 10% by weight of the fibers of fibrous layer 122 bonded to anchoring layer 110 are so bonded via melting or chemical adhesives. Preferably, a material substantially free of bonding formed from melting the fibers and/or anchoring layer 110 and/or bonding formed using chemical adhesives comprises less than 5%, and more preferably no fibers of fibrous layer 112, that are bonded to the anchoring layer 110 via melting or chemical adhesives. While applicants do not wish to be bound by or to any theory of operation, it is believed that by restricting the bonding of the fibers of the fibrous layer 122 and the fluid-permeable, anchoring layer 110 to physical entanglement rather than melt bonding or chemical adhesives, the resulting layered, composite material 100 tends to be more drapeable.

Any of a wide variety of various fibers may be selected for use in the fibrous layer 122. Examples of suitable fibers include those derived from cellulose, polyester, rayon, polyolefin, polyvinyl alcohol, polyamide or other synthetic fibers, combinations of two or more thereof, and the like. Certain preferred fibers include cellulose, polyester, rayon, or polyolefin, alone or in combinations of two or more thereof. Examples of commercially available suitable fibers include “Galaxy” rayon fibers commercially available from Kelheim Fibers, Kelheim, Germany or Tencel lyocell fibers commercially available from Lenzing AG of Lenzing, Austria.

In certain embodiments of the invention, the fibers include cellulose such as, for example, wood pulp. In one embodiment of the invention, the fibrous layer 122 includes from about 0% to about 100% pulp, more preferably from about 5% to about 50%.

In certain preferred embodiments of the invention the wood pulp has a reduced capacity for hydrogen bonding. Wood pulp having reduced capacity for hydrogen bonding may be formed by a process that includes the step of treating a liquid suspension of pulp at a temperature of from 15° C. to about 60° C with an aqueous alkali metal salt solution having an alkali metal salt concentration of from about 2 weight percent to about 25 weight percent of said solution for a period of time ranging from about 5 minutes to about 60 minutes. Reagents suitable for caustic treatment include, but are not limited to, alkali metal hydroxides, such as sodium hydroxide, potassium hydroxide, calcium hydroxide, and rubidium hydroxide, lithium hydroxides, and benzyltrimethylammonium hydroxides. Sodium hydroxide is a particularly preferred reagent for use in the caustic treatment to

produce cellulosic fibers suitable for forming the superabsorbent cellulosic fibers in accordance with the present invention. The pulp preferably is treated with an aqueous solution containing from about 4 to about 30% by weight sodium hydroxide, (or any other suitable caustic material), more preferably from about 6 to about 20%, and most preferably from about 12 to about 16% by weight, based on the weight of the solution. Caustic treatment may be performed during or after bleaching, purification, and drying. Preferably, the caustic treatment is carried out during the bleaching and/or drying process. Pulp so produced is sometimes referred to as "caustic extractive pulp" or "mercerized pulp." Commercially available caustic extractive pulp suitable for use in the present invention include, for example, Porosanier-J-HP, available from Rayonier Performance Fibers Division (Jesup, Ga.), Buckeye's HPZ, available from Buckeye Technologies (Perry, Fla.), and TRUCCELL available from Weyerhaeuser company (Federal Way, Wash.).

In another preferred embodiment of the invention, the pulp having reduced capacity for hydrogen bonding is crosslinked. By "crosslinked", refers to cellulosic fibers that have primarily intrafiber chemical crosslink bonds. That is, the crosslink bonds are primarily between cellulose molecules of a single fiber, rather than between cellulose molecules of separate fibers.

The crosslinked fibers may be formed by various processes, such as, (1) the process described in U.S. Pat. No. 3,241,553, issued to F. H. Steiger on Mar. 22, 1966, in which individualized, crosslinked fibers are produced by crosslinking the fibers in an aqueous solution containing a crosslinking agent and a catalyst; or (2) the process described in U.S. Pat. No. 3,224,926 issued to L. J. Bernardin on Dec. 21, 1965, in which individualized, crosslinked fibers are produced by impregnating swollen fibers in an aqueous solution with crosslinking agent, dewatering and defiberizing the fibers by mechanical action, and drying the fibers at elevated temperature to effect crosslinking while the fibers are in a substantially individual state; among other known methods. Commercially available crosslinked pulp suitable for use in the present invention include, for example, Columbus Modified Fiber, grade #CHB416, available from Weyerhaeuser Corporation, (Federal Way, Wash.).

In certain embodiments, the layered, composite material 100 is preferably substantially free of fibers that are woven, knitted, tufted or stitch-bonding, i.e., the

layered, composite material preferably includes fibrous materials that are made directly from fiber rather than yarn.

In addition to fibers, the fibrous layer 122 may comprise various additional materials well known in the art of the manufacture of non-wovens for use in absorbent articles. For example, the fibrous layer 122 may comprise polymers or other chemical fiber-finishes or particulate materials such as superabsorbents which may be distributed among the fibers used to enhance fluid absorption properties or pigments or other light-reflecting agents to promote a particular appearance. The fibrous layer 122 is preferably substantially free of chemical binders that may otherwise increase stiffness or reduce the drapeability of the composite.

The fibrous layer 122 may be homogeneous or heterogeneous in terms of fiber composition, throughout its thickness. In certain preferred embodiments, the fibrous layer 122 comprises a heterogeneous mixture, for example, comprising cellulose and synthetic fibers. In certain other preferred embodiments, fibrous layer 122 is a homogeneous layer, for example, consisting essentially of cellulose fibers or essentially of synthetic fibers.

In certain preferred embodiments of the invention, 50% by weight or more of the fibers of the fibrous layer 122 are made of fibers having a length to diameter ratio greater than about 300. While such fibers may be staple fibers or continuous filaments, it is preferred that the fibers are staple fibers. The fibers may be, for example, cellulose fibers such as wood pulp or cotton; synthetic fibers such as polyester, rayon, polyolefin, polyvinyl alcohol, multi-component (core-sheath) fibers and combinations of two or more thereof. The fibers may be placed in association with one another using and suitable methods including those described in detail below.

The fibrous layer of the present invention may be of any suitable basis weight. In certain preferred embodiments, the fibrous layer 122 may have a basis weight from about 20 gsm to about 200 gsm, preferably from about 20 gsm to about 150 gsm.

In an alternative embodiment, as depicted in Figure 2, the fibrous layer 122 may itself comprise of a plurality of layers or strata. Figure 2 depicts an uppermost fibrous layer 210 and a lower fibrous layer 220. In one embodiment, the uppermost fibrous layer 210 comprises or consists essentially of one or more synthetic fibers such as olefinic or polyester or bicomponent fibers; and the lower fibrous layer 220 comprises or consists

essentially of cellulose fibers. Furthermore, while Figure 2 depicts fibrous layer 122 consisting of only 2 layers, additional layers having various compositions are contemplated.

In addition, while Figures 1 and 2 depict a single fluid-permeable, anchoring layer 110 one terminal end of the layered, composite material 100, it is within the scope of the invention to include a second fluid-permeable, anchoring layer 110 at an opposite terminal end of the layered, composite material 100, thereby creating a "sandwich" structure, by which one or more fibrous layers are, en masse, sandwiched between the two fluid permeable anchoring layers. In such a configuration, two separate abrasion resistant surfaces are present.

One may tailor the properties of the layered, composite materials based upon the desired properties. For example, generally to provide lower density and higher drapeability one may choose, for example primarily polyester, rayon, and blends thereof. If one were interested in providing high absorbent capacity and lower cost, one may select primarily wood pulp. In order to balance all of these properties, the fibrous layer 122 may itself comprise separate layers of these materials.

In certain embodiments of the invention, the layered, composite material is provided with a visible pattern. Figure 3 is a top plan view of a layered, composite material consistent with embodiments of the invention described herein. The layered, composite material 100 includes discrete raised regions 300 surrounded by a matrix 310 of low regions. Figure 4 is a cross section of Figure 3 taken through section 3-3', revealing various features thereof. The raised regions 300 and the lower regions 310 are visibly distinct from one another, e.g., a viewer of average and unaided eyesight should be able readily to discern the difference or contrast between the raised regions and the lower regions 310 when viewing the layered, composite material 100 from a distance of 12 inches. In one embodiment of the invention, the raised regions 300 preferably have a height 320 that is from about 0.1mm to about 5mm, more preferably from about 0.5mm to about 2mm, and a length or width of at least about 0.5mm, more preferably at least about 1mm, and most preferably at least about 3mm.

In one embodiment of the invention, the raised regions 300 are unentangled and unbonded, i.e., no significant bonding is evident at an interface 330 between the fluid-

permeable, anchoring layer 110 and the fibrous layer 122 in the raised region 300. In this embodiment of the invention, substantial bonding between the fluid-permeable, anchoring layer 110 and the fibrous layer 122 exists only within the lower regions 310, such as along interface 340. As such, cross sections of entangled regions 360 and cross sections of unentangled regions 350 (the boundaries of which are shown in phantom in Figure 4) are present within the layered, composite material 100.

Figure 4 depicts the layered, composite material 100 having a continuous cross-section (matrix) of entangled region 360 and a plurality of discrete cross-sections of unentangled regions 350 positioned substantially within the continuous cross-section of the entangled region. This configuration is often desirable to provide sufficient tensile strength to the layered, composite material 100. However, other configurations of raised regions and lower regions are also contemplated. For example, the raised regions may be arranged along an entire width or length of the layered, composite material 100 rather than be arranged as discrete regions 350 surrounded by or substantially within the lower regions 360. Furthermore, the sense of the entangled regions and unentangled regions may be "inverted" as compared to the material shown in Figure 3, e.g., the entangled regions may be positioned substantially within the unentangled regions.

In certain preferred embodiments, the layered, composite materials of the present invention are spun-lace structures. That is, they are materials derived from a hydroentanglement or "spun-lace" process, preferably such processes as are described herein. Applicants have found that the structures of the present invention exhibit excellent abrasion resistance and surprisingly good lamination strength and/or drapeability, and/or density as compared to conventional fibrous, non-woven structures, especially conventional spun-lace materials. Such novel and surprising combination of properties provides significant advantage to the instant structures in a variety of uses including, but not limited to, personal care articles such as feminine hygiene products and wipes.

In one embodiment of the invention, the layered, composite material is used as a component of a sanitary pad such as a sanitary napkin or pantiliner. For example, the layered, composite material may be a topsheet or an integrated topsheet/absorbent core layer of a pantiliner or sanitary napkin.

In certain preferred embodiments, the layered, composite material is such that the fluid-permeable, anchoring layer 110 is capable of being oriented towards the body of a user, and thus the fluid-permeable, anchoring layer 110 is part of a body-faceable surface of the sanitary pad. In certain preferred embodiments, the layered, composite material serves as an integrated topsheet/absorbent core layer of a sanitary napkin or pantiliner. Such an integrated topsheet/absorbent core layer comprising a layered, composite material of the present invention would be advantageous in that the integrated cover provides enhanced abrasion resistance, softness, absorbency, and drapeability, all of which contribute to enhancing comfort of the wearer.

In one embodiment of the invention, the fibrous, non-woven material is used as a component of a wipe, e.g., a "baby wipe," a personal care/cosmetic wipe or wipe (wet or dry) useful for personal cleansing, or a wipe for the cleansing of inanimate surfaces. Layered, composite materials of the present invention may be used a single layer wipe or as one or more layers in a multi-layered wipe. Preferably, the abrasion resistant surface(s) of the layered, composite materials are positioned on the external surface(s) of the wipe so as to contact the users skin. A wipe material comprising a layered, composite materials of the present invention would be advantageous in that the wipe has both good abrasion resistance (and therefore durability) as well as softness, compressibility and absorbency.

METHODS OF THE PRESENT INVENTION

Layered, composite materials of the present invention may be produced via any of a variety of novel methods discovered by applicants. For example, according to certain embodiments, the structures may be produced via a method including urging a stream of fluid into contact with a layered structure, wherein the layered structure includes fibers and a fluid-permeable, anchoring layer, wherein the fluid-permeable, anchoring layer is positioned to at least partially shield the layer of fibers from the stream of fluid.

Figure 5 illustrates one embodiment of a method of conducting a hydroentangling step according to the present invention. The hydroentangling step comprises providing a layer of fibers 520, which is laid onto a screen 590 (e.g. a metal or plastic screen), which in turn rests upon a movable conveyer (not shown). The term "layer" it is meant an assembly of fibers that has a thickness that is substantially less in dimension as compared with both a

length and a width 205 of said assembly. For example, the layer 520 may have a thickness that is less than about 10% of the width such as less than about 2% of the width. In a preferred embodiment, the thin layer 200 of fibers is substantially planar and less than about 20 mm in thickness, preferably less than about 5mm. The thin layer of fibers has a composition and properties as described above with reference to fibrous layer 122 described above and depicted in Figures 1 and 2.

The layer of fibers 520 may be unbonded to one another. By “unbonded,” it is meant that the fibers in the thin layer 520 are loosely associated with one another, and the layer has a very low tensile strength, such as less than about 5 N/5cm. In an alternative embodiment, the layer of fibers 520 are bonded to one another, e.g. loosely bonded, prior to spun-lacing.

Fluid-permeable, anchoring layer 110 is positioned atop the layer of fibers 520. The layer of fibers 520 and the fluid-permeable, anchoring layer 110 thereby form a target web 550 to be entangled. In operation, the target web 550 is moved in a machine direction within the range of jets 530 from which a stream of fluid 508, preferably a liquid, more preferably water, is urged. It is contemplated that the layer of fibers 520 may impact the target 550 in any suitable direction and with any pressure suitable to form a stabilized web. Preferably, the stream of fluid 508 are oriented to impact the layer in a substantially perpendicular manner and at a pressure of for example from about 500 psi to about 5000 psi. As used herein, the term “substantially perpendicular” (such as from about 20 degrees to about 0 degrees, preferably from about 10 to about 0 degrees, and more preferably from about 5 to about 0 degrees, and most preferably about 0 degrees).

The target web 550 may be moved in the machine direction before, during, and/or after contact with the stream of fluid 508 at any speed suitable for entangling the target. In certain embodiments, the stabilized web 210 is moved in the machine direction at a speed of at least about 10 feet per minute (fpm), such as from about 50 fpm to about 250 fpm.

Upon completion of the entangling step, the fluid-permeable anchoring layer is entangled about the layer of fibers, forming a layered composite material of the present invention, in a manner as described above and as depicted in the examples shown in Figures 1 and 2.

Figure 6 depicts hydroentanglement of a target web similar to that depicted in Figure 5, except that the stream of fluid 508 is urged through a mask 600 that moves relative to the jet 530. The mask 508 may revolve about a series of guides or rollers 660 in order to, at various points in time, align different portions of the mask 600 with the stream fluid 508.

The mask 600 has a spatially-varying permeability to the stream of fluid 508. In particular, as shown in Figure 6 and Figure 7 (a perspective view of the mask 600), the spatially varying permeability is created by including a pattern of high permeability portions 620 and low permeability portions 630. The high permeability portions 620 may be, for example, open space (which permits essentially all of the fluid to pass through the high permeability portion 620). Alternatively, high permeability portions 620 may comprise a supporting screen, such as screen 650 shown in Figure 7 that is sufficient to provide mechanical support to the mask 600, but does not impede a significant portion of the flow of the stream of fluid 508. In one embodiment, the high permeability portions 620 have an open area of at least about 50 percent, and more preferably at least about 65%.

By contrast, the low permeability portions 630 of the mask 600 typically block most or preferably all of the stream of fluid 508 urged into contact therewith from contacting the target web 550.

At a first instant in time, when the jet 530 is above a high permeability portion 620 of the mask, a portion of the target web 550 underneath the jet 530 is contacted with the stream of fluid 508 and is thereby entangled. In contrast, at a second instant in time, when the jet 530 is above a low permeability portion 630 of the mask, a portion of the target web 550 underneath the jet 530 is not contacted (or, alternatively, minimally contacted) with the stream of fluid 508 and is thereby left relatively unentangled.

Over a time interval (i.e., a full pattern cycle) over which the mask is allowed to revolve completely around, the pattern of high permeability portions 620 and low permeability portions 630 on the mask 600 are thereby transferred to a length of the target web 550, forming a patterned, layered composite material. An example of a length 800 of patterned, layered composite material 810 is shown in Figure 8. The process then repeats, generating a series of identical lengths of layered, composite material, which may later be separated from one another (e.g., by cutting).

Note that in Figure 8, a pattern of unentangled raised flowers is shown against a uniform flat background. Note that if the low permeability portions 630 of the mask 800 are not completely open (e.g., comprise a screen – as shown in Figure 7), then some of the blocked portions of the screen may be in effect “transferred” onto the layered composite material as a minority area of raised background features 850, e.g., fine lines or cells; distributed in a majority portion 860 of entangled regions that provide tensile to the layered, composite material.

The length 800 of the layered, composite material over which the pattern may be repeated (i.e., the length of the mask if laid on a flat surface) is variable and may be, for example from about 50 cm to about 10m. Note that the boundaries of length 80 are shown in phantom in Figure 8.

The mask 800 may be made by various methods known in the art. For example, mask 800 may be made by selectively etching a metal plate. The plate may be formed of a flexible sheet of aluminum, stainless steel, or copper, or from a polymeric material including plastic or rubber (which may be reinforced), and may have a thickness of, for example about 0.05mm to about 0.5mm.

While Figures 6-8 depict one process for creating a visibly patterned, layered, composite material, other processes are contemplated. For example, rather than utilizing a mask that moves relative to the jets, the jets may be selectively blocked in certain locations, thus giving rise to lines or stripes of unentangled raised regions adjoining or interspersed with entangled low regions.

In yet another embodiment of the invention, a visible pattern is provided using a topographic forming surface. In this embodiment of the invention a stream of fluid is urged into contact with a target web that is supported on a topographic forming surface. The topographic support member generally includes an arrangement of peaks and valleys as well as an arrangement of apertures and may be similar to, for example, the topographic support members disclosed in U.S. patents 5,827,597 and 5,674,587 (both to James et al.) which are hereby incorporated by reference in their entirety. The arrangement of peaks and valleys may be formed by any suitable techniques such as mechanical drilling, laser drilling, laser ablation, raster scanning, laser modulation, among other techniques.

In embodiments of the present inventive method, a layered structure comprising a layer of fibers and a fluid permeable anchoring layer are positioned on the topographic support member. Streams of fluid are directed onto the layered structure thereby molding the layered structure to the topographic support member and entangling the layer of fibers about the fluid permeable anchoring layer.

In one preferred embodiment as depicted in Figure 9, fluid, permeable anchoring layer 900 is positioned in direct contact with the topographic support member 910 and layer of fibers 920 is positioned on the fluid, permeable anchoring layer. As such, the layer of fibers 920 at least partially shields the fluid permeable anchoring layer from the fluid. The layer of fibers 920 may include various materials such as those described above for the fibrous layer 122.

In a further preferred embodiment, the layer of fibers includes cellulose such as wood pulp, preferably mercerized or crosslinked pulp as discussed above. In yet another preferred embodiment, the layer of fibers 920 includes at least two distinct layers, such as a layer of synthetic fibers 930 positioned directly on the fluid, permeable anchoring layer 900 and a layer of cellulose fibers 940 (e.g. pulp) positioned directly on the layer of long fibers 930. In this embodiment, the stream of fluid 508 sequentially impacts the layer of cellulose fibers 940, the layer of long fibers 930, the fluid, permeable anchoring layer 900, then the topographic support member 910. In this embodiment of the invention, the layer of synthetic fibers 930 and the fluid, permeable anchoring layer 900 act as barriers, preventing the relatively short cellulose fibers from being transported towards drainage apertures 960 formed in the topographic support member 910. As a result there is little chance of the short cellulose fibers clogging the drainage apertures 960, which would result in process difficulties.

EXAMPLES

The following Examples are illustrative of the present invention and are not intended to be limiting in any manner.

EXAMPLE 1

In each of the following examples, a target web was placed on a 80-mesh metal screen forming surface, on a rotating cylindrical drum. The target web consisted of a layer of fibrous material and a fluid-permeable anchoring layer. The fluid permeable anchoring layer used was a 12gsm layer of spun-bonded polypropylene, commercially available from BBA Fiberweb. The fibrous material was a blend of 70% rayon fibers and 30% polyester fibers of varying basis weight. The drum was rotated to move the layer of fibers at a linear speed of 100 fpm. The jets were oriented to expel a stream of pressurized water to strike the target web perpendicularly to the target web. The jets were arranged in a row of jets spaced to a jet density of 30 jets/inch. All fibrous layers were subject to an initial stabilization treatment in which water was urged through each of a number of 0.005-inch diameter jets at 600 psi to loosely bond the fibers prior to entangling with the spun-bonded polypropylene. The drum was allowed to rotate completely 6 times, thus allowing a given point on the layer of fibers to pass through the row of jets 6 times. The pressure of the water emanating from the jets was variable.

The lamination strength for each sample was measured using the Lamination Strength Test performed as follows (to yield a Lamination Strength Value (LSV)):

A 1in. x 1in. sample of the material (comprising an anchoring layer and a fibrous layer having fibers entangle about the anchoring layer) to be measured was cut. The sample was mounted flat, with double face adhesive tape (Scotch double-coated tape Model #666), on the surfaces of two stainless steel cubes (having surface dimensions of approximately 1in. x 1in.) and the sample is thus sandwiched between the two cube faces. The mounted sample is compressed between the cubes for at least 6 seconds at 5 psi or more. Next the cubes are crosshead pulled apart at a crosshead speed of 2 inches/minute and the force over time is measured using an Instron force-measurement gauge. The Lamination Strength Value is equal to the peak load (related to the first peak on the Instron output graphics display) recorded for the sample.

The following drapeability test was performed on various fibrous, non-woven structures to determine the drapeability (basis weight/MCB) according to the present invention. Modified Circular Bend Stiffness (MCB) is determined by a test that is modeled after the ASTM D 4032-82 CIRCULAR BEND PROCEDURE, the procedure being considerably modified and performed as follows. The CIRCULAR BEND PROCEDURE is a simultaneous multi-directional deformation of a material in which one face of a specimen becomes concave and the other face becomes convex. The CIRCULAR BEND PROCEDURE gives a force value related to flexural resistance, simultaneously averaging stiffness in all directions.

The apparatus necessary for the CIRCULAR BEND PROCEDURE is a modified Circular Bend Stiffness Tester, having the following parts:

1. A smooth-polished steel plate platform, which is 102.0 mm by 102.0 mm by 6.35 mm having an 18.75 mm diameter orifice. The lap edge of the orifice should be at a 45 degree angle to a depth of 4.75 mm;
2. A plunger having an overall length of 72.2 mm, a diameter of 6.25 mm, a ball nose having a radius of 2.97 mm and a needle-point extending 0.88 mm therefrom having a 0.33 mm base diameter and a point having a radius of less than 0.5 mm, the plunger being mounted concentric with the orifice and having equal clearance on all sides. Note that the needle-point is merely to prevent lateral movement of the test specimen during testing. Therefore, if the needle-point significantly adversely affects the test specimen (for example, punctures an inflatable structure), than the needle-point should not be used. The bottom of the plunger should be set well above the top of the orifice plate. From this position, the downward stroke of the ball nose is to the exact bottom of the plate orifice;
3. A force-measurement gauge and more specifically an Instron inverted compression load cell. The load cell has a load range of from about 0.0 to about 2000.0 g;
4. An actuator and more specifically the Instron Model No. 1122 having an inverted compression load cell. The Instron 1122 is made by the Instron Engineering Corporation, Canton, Mass.

In order to perform the procedure for this test, as explained below, three representative samples for each article are necessary. The location of the non-woven structure to be tested is selected by the operator. A 37.5 mm by

37.5 mm test specimen is cut from each of the three samples at corresponding locations. Prior to cutting the samples any release paper or packaging material is removed and any exposed adhesive, such as garment positioning adhesive, is covered with a non-tacky powder such as talc or the like. The talc should not affect the BW and MCB measurements.

The test specimens should not be folded or bent by the test person, and the handling of specimens must be kept to a minimum and to the edges to avoid affecting flexural-resistance properties.

The procedure for the CIRCULAR BEND PROCEDURE is as follows. The specimens are conditioned by leaving them in a room that is 21°C, +/-1°C. and 50%, +/-2.0%, relative humidity for a period of two hours.

The weight of each cut test specimen is measured in grams and divided by a factor of 0.0014. This is the basis weight in units of grams per square meter (gsm). The values obtained for the basis weight for each of the samples is averaged to provide an average basis weight (BW). This average basis weight (BW) may then be utilized in the formulas set forth above.

A test specimen is centered on the orifice platform below the plunger such that the body facing layer of the test specimen is facing the plunger and the barrier layer of the specimen is facing the platform. The plunger speed is set at 50.0 cm per minute per full stroke length. The indicator zero is checked and adjusted, if necessary. The plunger is actuated. Touching the test specimen during the testing should be avoided. The maximum force reading to the nearest gram is recorded. The above steps are repeated until all of three test specimens have been tested. An average is then taken from the three test values recorded to provide an average MCB stiffness. This average MCB value may then be used in the formulas set forth above. Drapeability is calculated as basis weight divided by the average MCB value determined above.

The following density test was performed on various thin layers of fibers and fibrous, non-woven structures to determine the thickness, according to the present invention.

Strips of material of 5 cm width are cut. To measure tensile strength in machine direction, strips are oriented such that machine direction is oriented longitudinally. To

measure tensile strength in cross-machine direction, strips are oriented such that cross-machine direction is oriented longitudinally. The procedure was accomplished using an Emveco gauge using an applied pressure of 0.07psi over a foot size of 2500 mm². The digital readout is accurate to 0.0025cm. An average of 5 readings was recorded as the thickness. The foot of the gauge is raised and the product sample is placed on the anvil such that the foot of the gauge is approximately centered on the location of interest on the product sample. When lowering the foot, care must be taken to prevent the foot from dropping onto the product sample or from undue force being applied. The foot was lowered at a rate of 0.1 inches/second. A load of 0.07 p.s.i.g. is applied to the sample and the read out is allowed to stabilize for approximately 10 seconds. The thickness reading is then taken. This procedure is repeated for at least three product samples and the average thickness is then calculated. Density was then calculated by dividing mass of the sample by the volume (length times width times average thickness, as determined above)

EXAMPLE 1A

The spunbond material layer as placed "under" the fibrous layer (i.e., the fibrous layer was positioned between the jets and the fluid-permeable anchoring layer). The jet pressure was 1500 psi. The web was moved across the jets 4 times. The resulting layered, composite material had a lamination strength (LSV) of 25grams (g.), a thickness of 0.77mm, a basis weight of 85 gsm, a density of 0.11 g/cc, and a drapeability of 7.9 gsm/g.

EXAMPLE 1B

The spunbond material layer as placed under the fibrous layer. The jet pressure was 1500 psi. The web was moved across the jets 8 times. The resulting layered, composite material had a lamination strength of 65grams (g.), a thickness of 0.73mm, a basis weight of 88 gsm, a density of 0.12 g/cc, and a drapeability of 8.6 gsm/g.

EXAMPLE 1C

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The spunbond material layer as placed on top of the fibrous layer. The jet pressure was 1500 psi. The web was moved across the jets 4 times. The resulting layered, composite material had a lamination strength of 32grams (g.), a thickness of 0.90mm, a basis weight of 90 gsm, a density of 0.10 g/cc, and a drapeability of 9.1 gsm/g.

EXAMPLE 1D

The spunbond material layer as placed on top of the fibrous layer. The jet pressure was 1500 psi. The web was moved across the jets 8 times. The resulting layered, composite material had a lamination strength of 106grams (g.), a thickness of 0.85mm, a basis weight of 83 gsm, a density of 0.10 g/cc, and a drapeability of 11.8 gsm/g.

EXAMPLE 1E

The spunbond material layer as placed on bottom of the fibrous layer. The jet pressure was 2000 psi. The web was moved across the jets 4 times. The resulting layered, composite material had a lamination strength of 47 grams (g.), a thickness of 0.79mm, a basis weight of 86 gsm, a density of 0.11 g/cc, and a drapeability of 8.5 gsm/g.

EXAMPLE 1F

The spunbond material layer as placed on bottom of the fibrous layer. The jet pressure was 2000 psi. The web was moved across the jets 8 times. The resulting layered, composite material had a lamination strength of 281 grams (g.), a thickness of 0.78mm, a basis weight of 89 gsm, a density of 0.12 g/cc, and a drapeability of 10.3 gsm/g.

EXAMPLE 1G

The spunbond material layer as placed on top of the fibrous layer. The jet pressure was 2000 psi. The web was moved across the jets 4 times. The resulting layered,

composite material had a lamination strength of 205 grams (g.), a thickness of 0.86mm, a basis weight of 83 gsm, a density of 0.10 g/cc, and a drapeability of 12.5 gsm/g.

EXAMPLE 1H

The spunbond material layer as placed on top of the fibrous layer. The jet pressure was 2000 psi. The web was moved across the jets 8 times. The resulting layered, composite material had a lamination strength of 341 grams (g.), a thickness of 0.92mm, a basis weight of 83 gsm, a density of 0.10 g/cc, and a drapeability of 11.8 gsm/g.

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EXAMPLE 2

In each of the following examples, a target web was placed on a 80-mesh metal screen forming surface, on a rotating cylindrical drum. The target web consisted of a layer of fibrous material between two separate fluid-permeable anchoring layers. The fluid permeable anchoring layer used was a 12gsm layer of spun-bonded polypropylene, commercially available from BBA Fiberweb. The fibrous material was either a blend of 70% rayon fibers and 30% polyester fibers of varying basis weight or pulp. The drum was rotated to move the layer of fibers at a linear speed of 100 fpm. The jets were oriented to expel a stream of pressurized water to strike the target web perpendicularly to the target web. The jets were arranged in a row of spaced to a jet density of 30 jets/inch. Aside from the pulp layers, all fibrous layers of synthetic fiber were subject to an initial stabilization treatment in which water was urged though each of a number of 0.005-inch diameter jets at 600 psi to loosely bond the fibers prior to entangling with the spun-bonded polypropylene (and are referred to in Table 2 as "pre-bond"). The drum was allowed to rotate completely a varying number of times. The pressure of the water emanating from the jets was variable.

COMPARATIVE EXAMPLE 2A

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The fibrous layer consisted of pulp. The jet pressure was 600 psi. The web was moved across the jets 4 times. The resulting layered, composite material had a lamination strength of 1g. at the top interface (closest to the jets) and a lamination strength of 1g. at the bottom interface (furthest from the jets), a thickness of 1.65mm, a basis weight of 204 gsm, a density of 0.124 g/cc, and a drapeability of 1.47 gsm/g.

COMPARATIVE EXAMPLE 2B

The fibrous layer consisted of mercerized pulp. The jet pressure was 600 psi. The web was moved across the jets 7 times. The resulting layered, composite material had a lamination strength of 2g. at the top interface (closest to the jets) and a lamination strength of 1g. at the bottom interface (furthest from the jets), a thickness of 1.69mm, a basis weight of 197 gsm, a density of 0.117 g/cc, and a drapeability of 1.35 gsm/g.

EXAMPLE 2C

The fibrous layer consisted of mercerized pulp. The jet pressure was 1200 psi. The web was moved across the jets 4 times. The resulting layered, composite material had a lamination strength of 41g. at the top interface (closest to the jets) and a lamination strength of 6g. at the bottom interface (furthest from the jets), a thickness of 1.42mm, a basis weight of 195 gsm, a density of 0.137 g/cc, and a drapeability of 1.40 gsm/g.

EXAMPLE 2D

The fibrous layer consisted of mercerized pulp. The jet pressure was 1200 psi. The web was moved across the jets 8 times. The resulting layered, composite material had a lamination strength of 100g. at the top interface (closest to the jets) and a lamination strength of 31g. at the bottom interface (furthest from the jets), a thickness of 1.58mm, a basis weight of 207 gsm, a density of 0.131 g/cc, and a drapeability of 1.25 gsm/g.

EXAMPLE 2E

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The fibrous layer consisted of mercerized pulp. The jet pressure was 1200 psi. The web was moved across the jets 16 times. The resulting layered, composite material had a lamination strength of 255g. at the top interface (closest to the jets) and a lamination strength of 109g. at the bottom interface (furthest from the jets), a thickness of 1.32mm, a basis weight of 192 gsm, a density of 0.145 g/cc, and a drapeability of 1.39 gsm/g.

EXAMPLE 2F

The fibrous layer consisted of the blend of synthetic fiber. The jet pressure was 1500 psi. The web was moved across the jets 4 times. The resulting layered, composite material had a lamination strength of 23g. at the top interface (closest to the jets) and a lamination strength of 11g. at the bottom interface (furthest from the jets), a thickness of 0.95mm, a basis weight of 98 gsm, a density of 0.103 g/cc, and a drapeability of 4.90 gsm/g.

EXAMPLE 2G

The fibrous layer consisted of the blend of synthetic fiber. The jet pressure was 1500 psi. The web was moved across the jets 8 times. The resulting layered, composite material had a lamination strength of 35g. at the top interface (closest to the jets) and a lamination strength of 24g. at the bottom interface (furthest from the jets), a thickness of 0.89mm, a basis weight of 97 gsm, a density of 0.109 g/cc, and a drapeability of 5.39 gsm/g.

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EXAMPLE 3

In each of the following examples, samples were placed on a topographical forming surface (an acetal sleeve) having an arrangement of peaks and valleys in a "tricot" pattern, similar to those described in U.S. patent 5,827,597, and also including a pattern of raised flowers. The fluid permeable anchoring layer used was a 10 gsm layer of spun-bonded

fabric commercially available from BBA Fiberweb. The drum was rotated to move the layer of fibers at a linear speed of 100 fpm. The jets were oriented perpendicularly to the layer of fibers and arranged in a row spaced to a jet density of 30 jets/inch. The drum was allowed to rotate completely 6 times, thus allowing a given point on the layer of fibers to pass through the row of jets 6 times.

Example 3A

The layer of fibers 920 was a pre-bonded layer of a blend of 30% polyester fibers and 70% rayon fibers having a total basis weight of 60 gsm. The resulting layered, composite material had excellent lamination strength and abrasion resistance and well-defined images.

Example 3B

The experiment in Example 2A was repeated except that a 90 gsm layer of mercerized pulp (Porosanier, commercially available from Rayonier Corporation) was placed on top of the layer of pre-bonded synthetic fibers. Lamination and image definition was excellent.

Table 1 shows materials made or tested in the above examples and the density, lamination strength, and drapeability associated therewith. Such values clearly illustrate the advantageous and surprisingly unique combination of high lamination strength and either or both of high drapeability or low density associated with the materials of the present invention. It is also notable from Table 1 that by placing the fluid-permeable anchoring layer above the fibrous layer that lamination strength is improved and drapeability remains high.

It is also notable that for otherwise similar process conditions, lamination strength is surprisingly greater between the fluid-permeable anchoring layer and the fibrous layer when the fluid-permeable anchoring layer is oriented on top of the fibrous layer. These high lamination strengths are possible without compromising drapeability or density.

Furthermore, Table 2 illustrates that it is surprisingly possible to form abrasion resistant "sandwich structure" materials that simultaneously have high drapeability, low

density and are resistant to delamination. It is also surprisingly noted that it is possible for such high lamination strength materials to be made at relatively low jet pressure, particularly for higher basis weights.

Table 1

Ex	Position of anchoring layer	psi	# passes	Lamination strength (g.)	Thickness (mm)	Basis Wt (gsm)	Density (g/cc)	MCB (g.)	Drapeability
1A	bottom	1500	4	25	0.77	85	0.11	11	7.9
1B	bottom	1500	8	65	0.73	88	0.12	10	8.6
1C	top	1500	4	32	0.90	90	0.10	10	9.1
1D	top	1500	8	106	0.85	83	0.10	7	11.8
1E	bottom	2000	4	47	0.79	86	0.11	10	8.5
1F	bottom	2000	8	281	0.78	89	0.12	9	10.3
1G	top	2000	4	205	0.86	83	0.10	7	12.5
1H	top	2000	8	341	0.92	90	0.10	8	11.8

Table 2

Ex	Core	psi	# passes	Lamination Strng., g		Thickness, mm	Basis Wt, gsm	Density, g/cm3	MCB	
				Top Face	Bottom				MCB, g	Drapeabilit
Comp1	poro pulp	600	4	1	1	1.65	204	0.124	139	1.47
Comp2	poro pulp	600	7	2	1	1.69	197	0.117	146	1.35
3	poro pulp	1200	4	41	6	1.42	195	0.137	139	1.40
4	poro pulp	1200	8	100	31	1.58	207	0.131	165	1.25
5	poro pulp	1200	16	255	109	1.32	192	0.145	138	1.39
7	poro pulp	1500	4	131	22	1.48	208	0.141	130	1.60
8	pre-bond	1500	4	23	11	0.95	98	0.103	20	4.90
9	pre-bond	1500	8	35	24	0.89	97	0.109	18	5.39

CLAIMS

We claim:

1. A method of producing a layered, composite material comprising urging a stream of fluid into contact with a layered structure comprising a layer of unbonded fibers and a fluid-permeable, anchoring layer having a tensile strength of at least about 5 N/5cm, wherein said layered structure is supported on a topographic forming surface and wherein said layered structure is contacted for a time sufficient to conform such layered structure to said topographic forming surface.
2. The method of claim 1 wherein said anchoring layer is positioned in direct contact with said topographic forming member.
3. The method of claim 2 wherein said anchoring layer comprises a spunbond material.
4. The method of claim 2 wherein said layer of unbonded fibers comprises cellulose fibers.
5. The method of claim 4 wherein said cellulose fibers comprise wood pulp.
6. The method of claim 5 wherein said wood pulp comprises mercerized or crosslinked pulp.
7. The method of claim 2 wherein said layer of unbonded fibers comprises a layer of long fibers positioned between said anchoring layer and said stream.
8. The method of claim 7 further comprising a layer of cellulose fibers positioned between said layer of long fibers and said stream.
9. The method of claim 8 wherein said cellulose fibers comprise wood pulp.

10. The method of claim 1 wherein said method produces a composite material having an LSV of at least about 20 grams.

FIG. 1

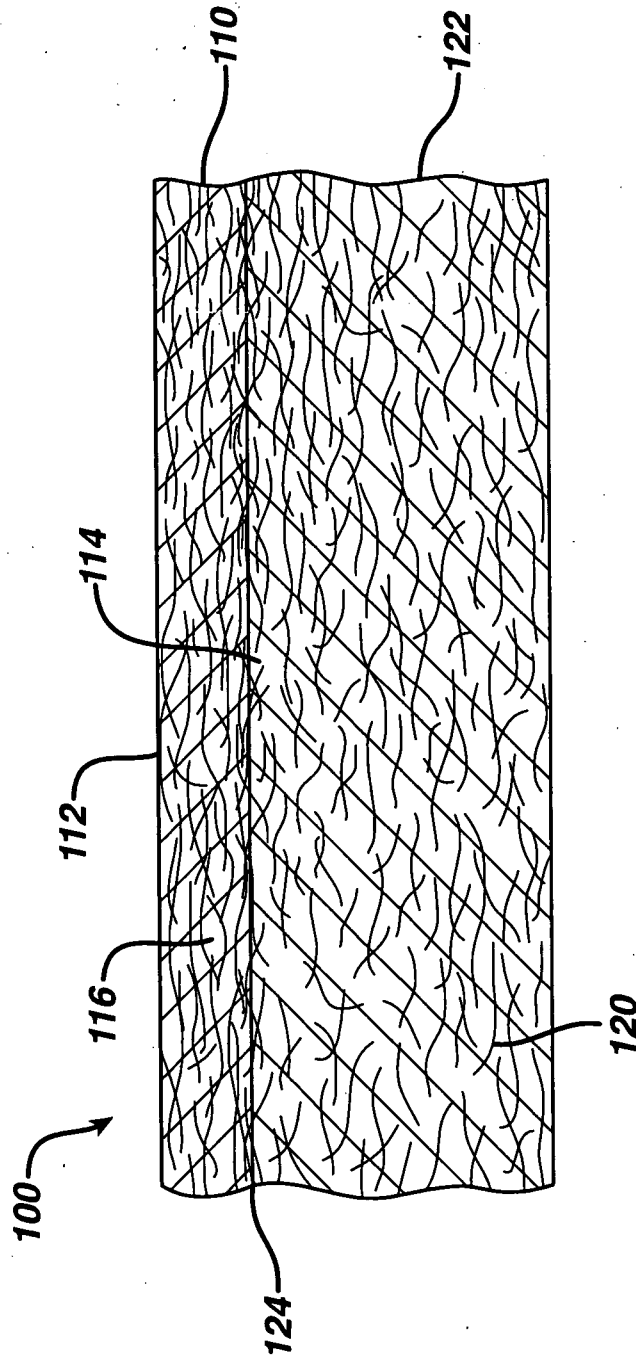


FIG. 2

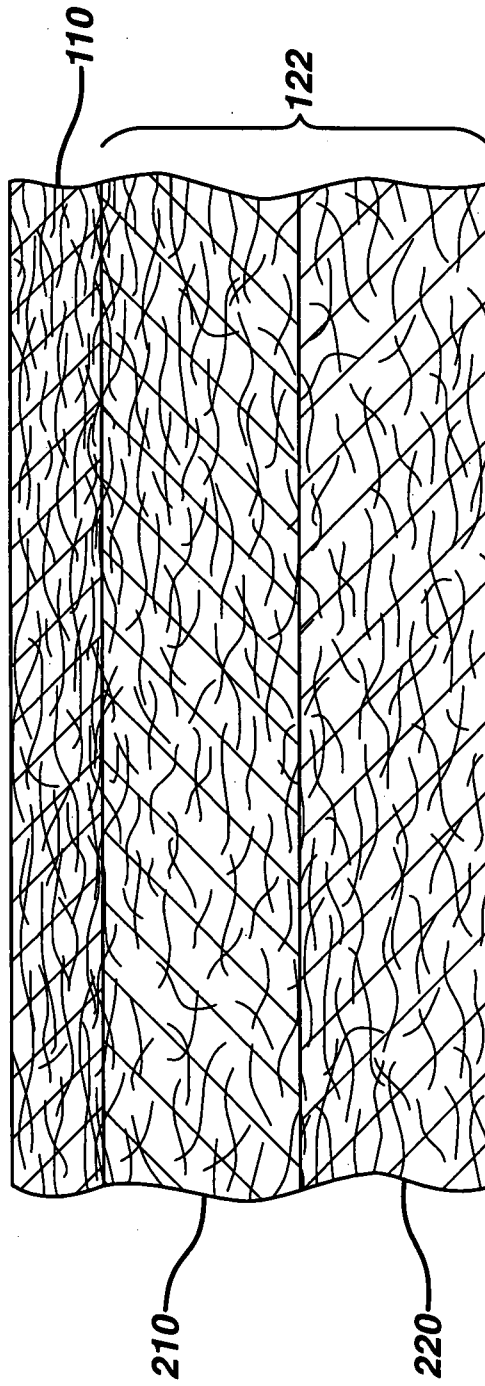


FIG. 3

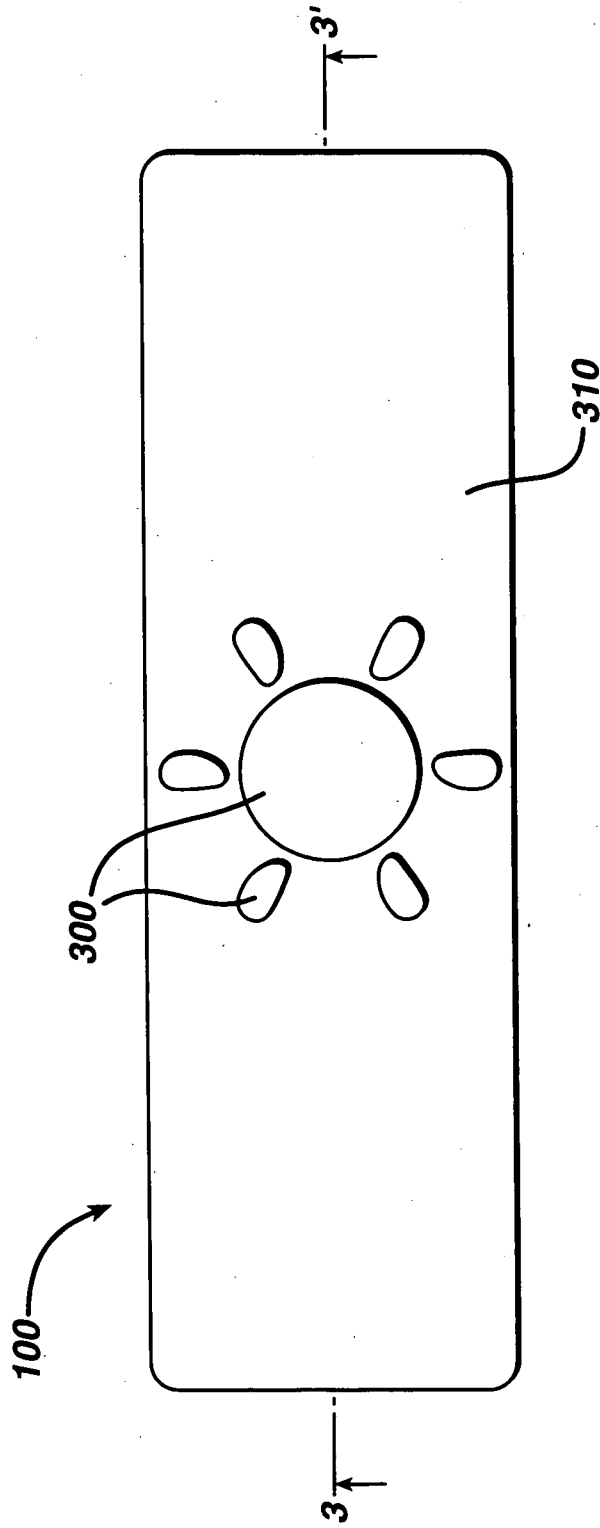
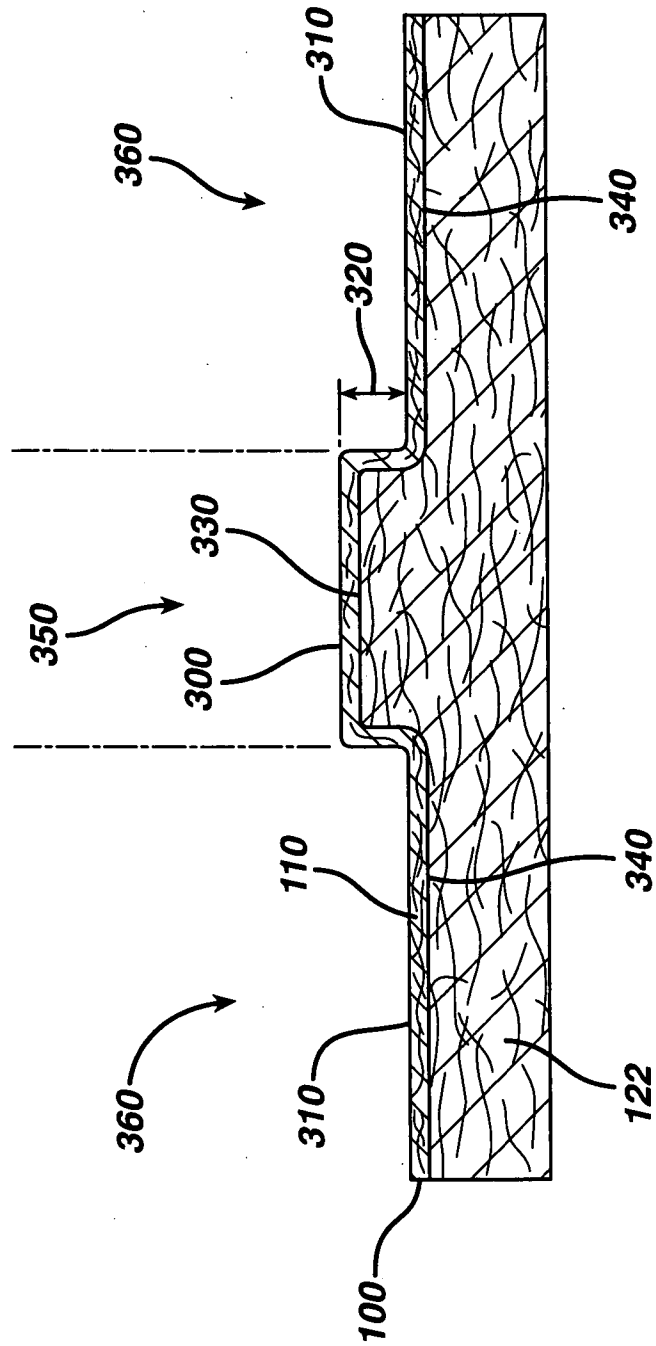


FIG. 4



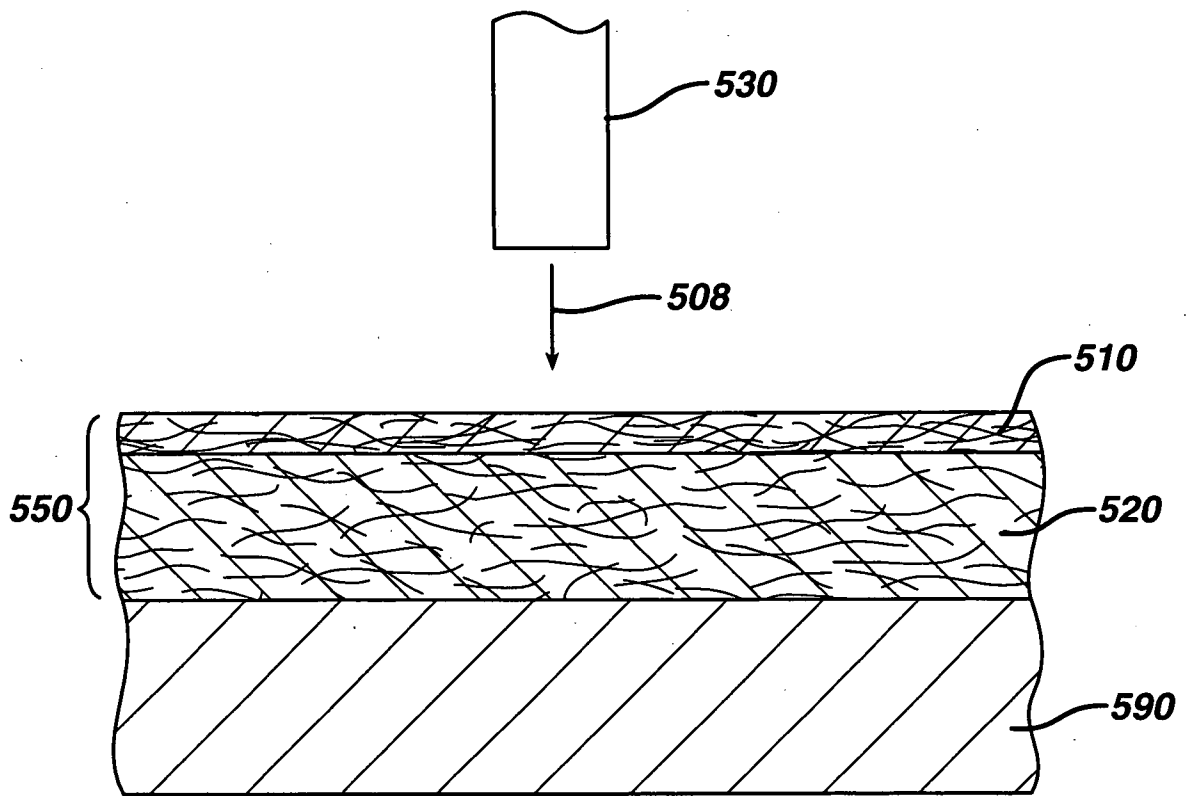


FIG. 5

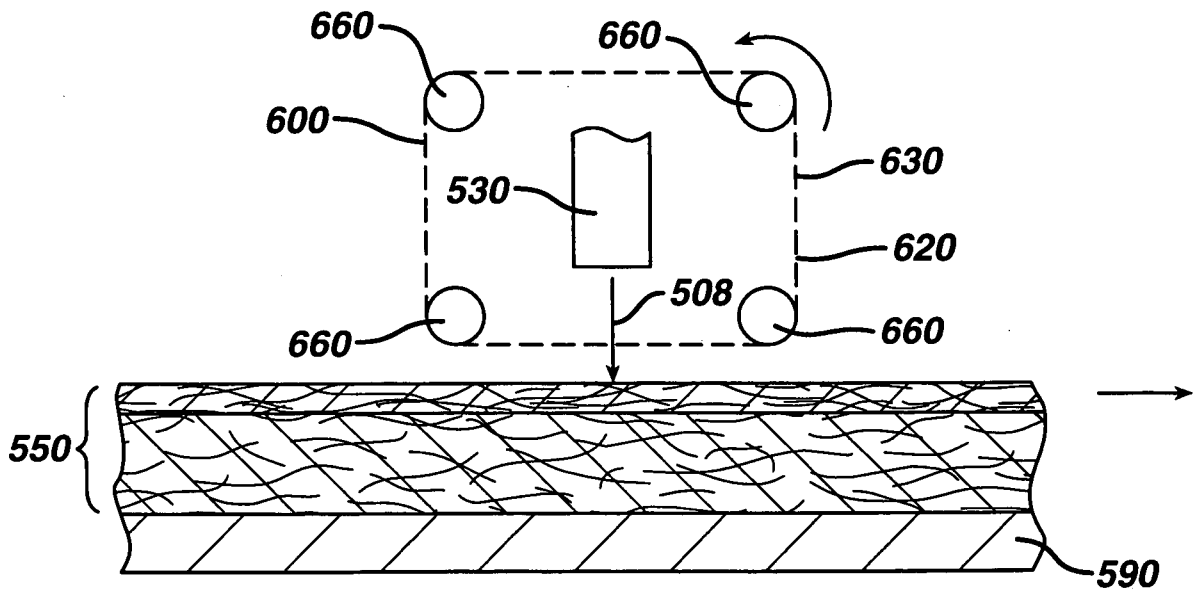


FIG. 6

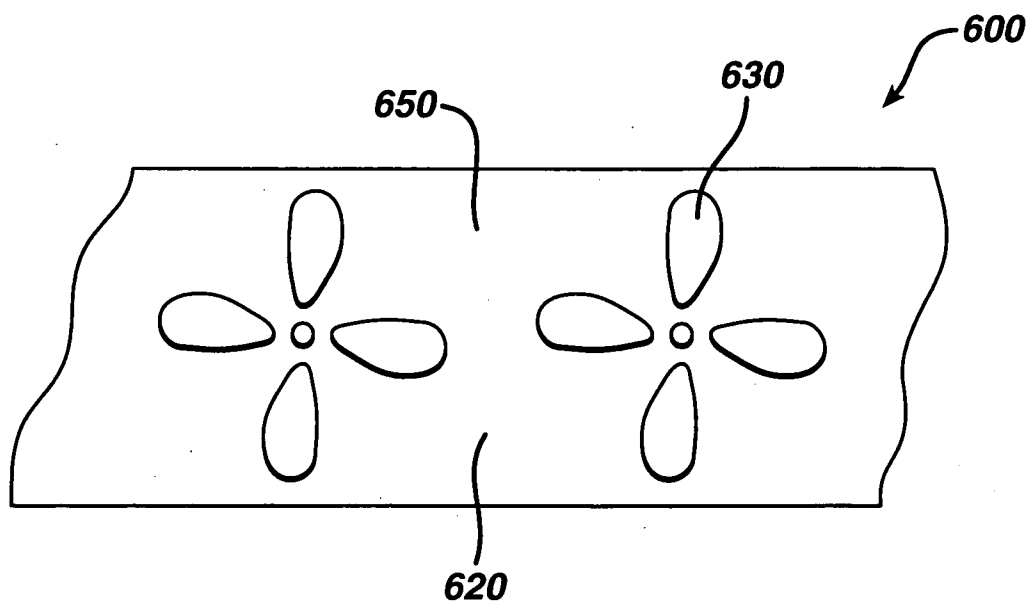


FIG. 7

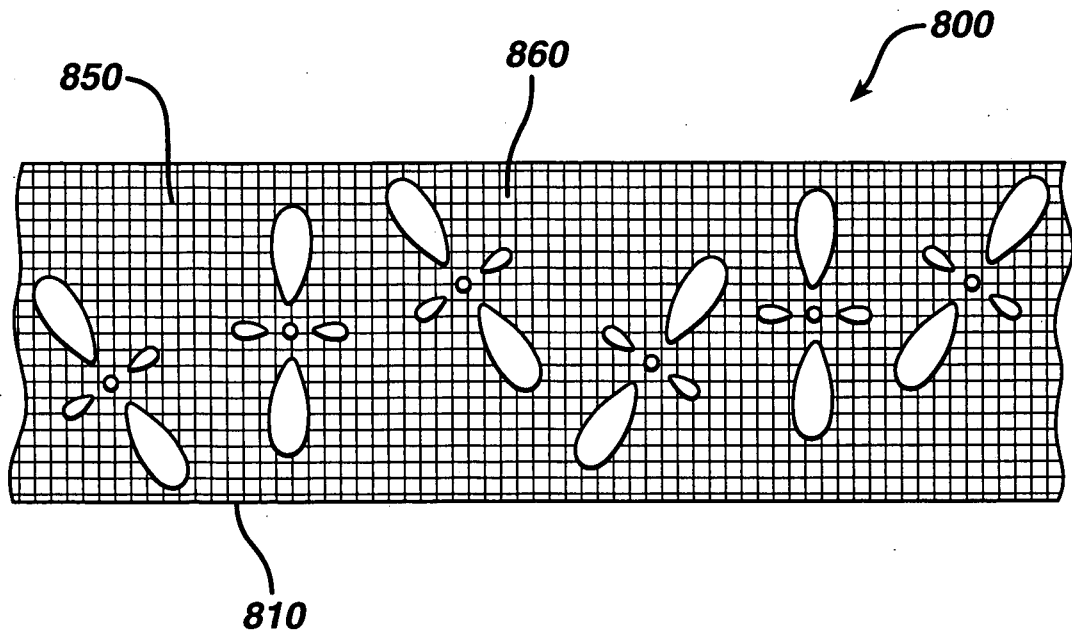


FIG. 8

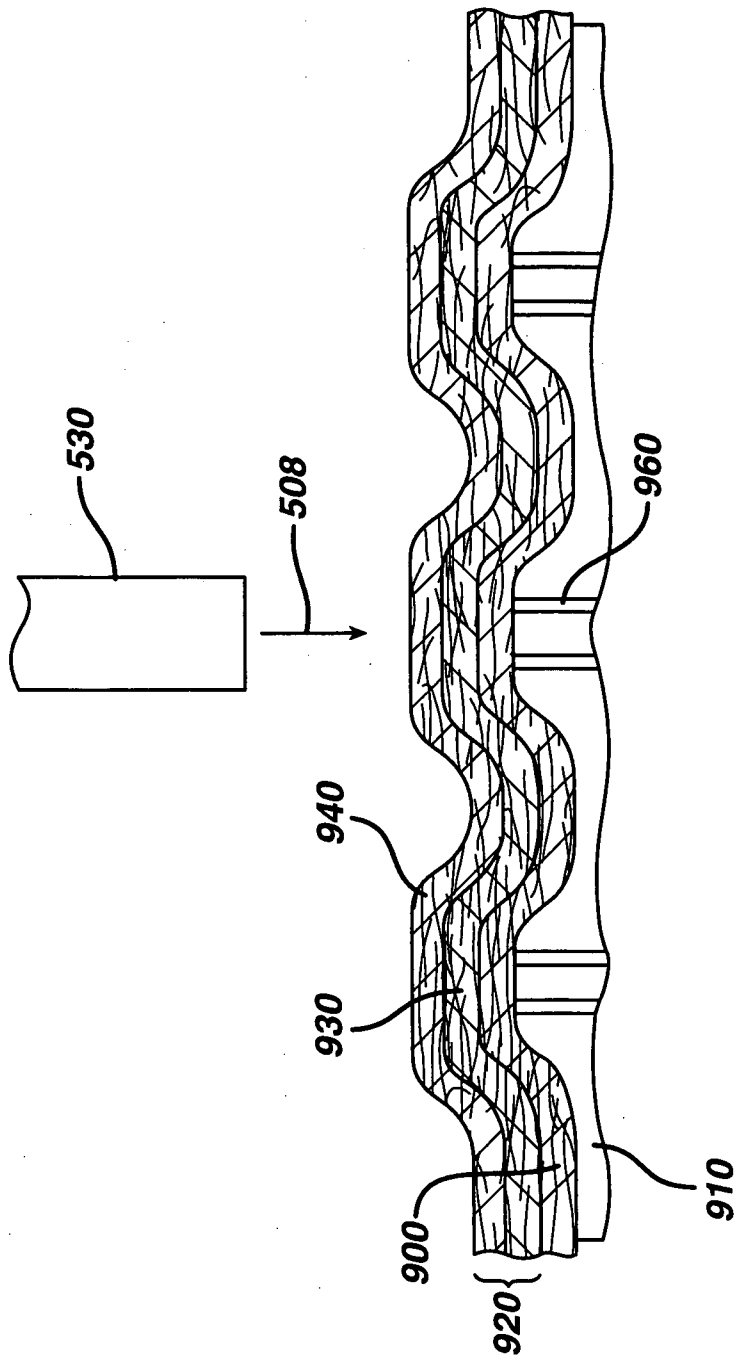


FIG. 9