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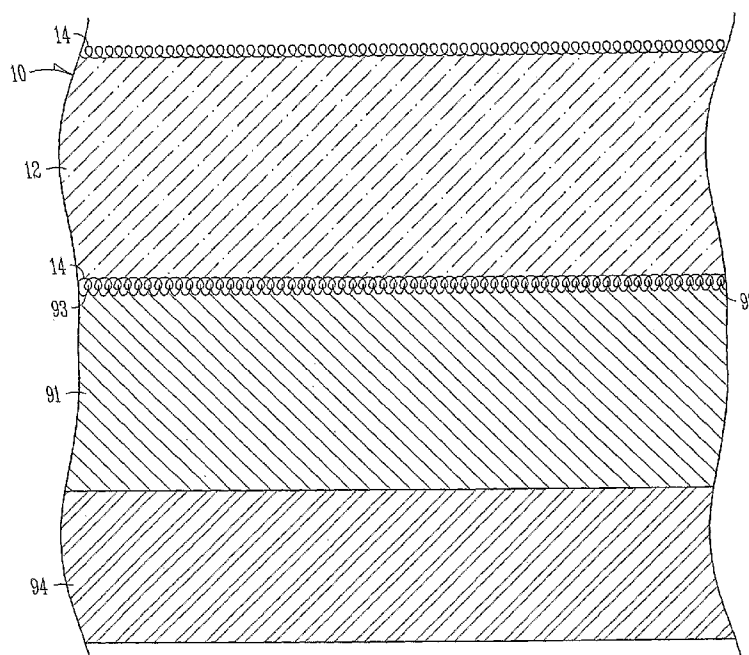
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(54) Title: FOAM FASTENING SYSTEM THAT INCLUDES A SURFACE MODIFIER



(57) Abstract: A fastening system having a nonwoven fabric that includes a web which is formed of a plurality of extruded strands and a foam layer that includes a surface having a plurality of free-standing struts which are adapted to engage at least a portion of the plurality of strands, at least some of the free-standing struts including a surface modifier.

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FOAM FASTENING SYSTEM THAT INCLUDES A SURFACE MODIFIER

This application is a continuation-in-part of application serial number 11/260,356
5 entitled "Nonwoven Fabric and Fastening System That Include An Auto-Adhesive
Material" and filed in the U.S. Patent and Trademark Office on October 27, 2006.
The entirety of application serial number 11/260,356 is hereby incorporated by
reference.

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Background of the Invention

Traditional hook and loop mechanical fasteners are widely used in numerous
products and articles such as diapers, shoes, disposable gowns, etc. In spite of
their prevalence, they suffer from several drawbacks. The hook material typically
15 is stiff and impermeable, and when used in articles worn on or near the human
body, may irritate the skin or be uncomfortable. The hook material typically
cannot be stretched or deformed significantly. Further, for some applications, the
entanglement of hooks into loop material can frequently be difficult to remove, or
may adhere to unintended surfaces. The highly abrasive nature of the hook
20 material can also damage some surfaces. The act of peeling the hooks and
loops apart can also result in a loud and unpleasant noise, making it difficult to
release a fastener discreetly. Further still, in some applications low peel strength
but high in-plane resistance to shear is desired, whereas conventional hook and
loop fasteners may offer excessively high peel strength to achieve a given level
25 of in-plane shear resistance.

Variations of hook and loop fasteners have been proposed in which a foam layer
is used to engage with hooks, but replacing low-cost, nonwoven fabrics with
thicker, generally more expensive foams does not appear to have provided
30 significant advantages, and does not address the known limitations of hook
layers.

What is needed is an improved mechanical fastener that engages nonwoven fabrics and that solves one or more of the aforementioned problems.

Summary of the Invention

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In response to the foregoing need, the present inventor undertook intensive research and development efforts that resulted in the discovery of an improved fastening system. One version of the present invention includes a fastening system having a nonwoven fabric that includes a web which is formed of a plurality of extruded strands and a foam layer that includes a surface having a plurality of free-standing struts which are adapted to engage at least a portion of the plurality of strands, at least some of the free-standing struts including a surface modifier.

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Another version of the present invention provides an absorbent article having a fastening system for securing the absorbent article about the waist of a wearer. The fastening system has a nonwoven fabric that includes a web which is formed of a plurality of extruded strands and a foam layer that includes a surface having a plurality of free-standing struts which are adapted to engage at least a portion of the plurality of strands. Further at least some of the free-standing struts including a surface modifier.

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Still another version of the present invention includes an absorbent article including a fastening system for securing the absorbent article about the waist of a wearer. The fastening system having a nonwoven fabric that includes a web which is formed of a plurality of extruded strands and a foam layer that includes a surface having a plurality of free-stranding struts which are adapted to engage at least a portion of the plurality of strands. Further at least some of the free-stranding struts including a surface modifier. The surface modifier is a cohesive or a polymer wax and a strength of a bond between the nonwoven fabric and a portion of the foam layer including the surface modifier is greater than 1.5 times a strength of a bond between the nonwoven fabric and a portion of the foam layer not including the surface modifier.

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Brief Description of the Drawings

FIG. 1 is a perspective view illustrating an example nonwoven fabric.

FIGS. 2A-2C are cross-section views illustrating example bicomponent
5 strands that may be used in the nonwoven fabric shown in FIG. 1.

FIG. 3 is a perspective view illustrating another example nonwoven fabric.

FIG. 4 is a side view of an example processing line that may be used to
form a nonwoven fabric.

FIG. 5 is an enlarged view illustrating a portion of an example web that
10 may be formed using the example processing line shown in FIG. 4.

FIG. 6 is a perspective view illustrating an example fastening system.

FIG. 7 is an enlarged side view of the example fastening system shown in
FIG. 6.

FIG. 8 illustrates an example absorbent article that includes the fastening
15 system shown in FIG. 6.

FIG. 9 is an SEM photomicrograph at 50X magnification of a razor-cut
cross-sectional surface of a foam layer engaged with a nonwoven fabric.

FIG. 10 is an SEM photomicrograph at 50X magnification of the surface of
a foam layer.

20 FIG. 11 is an SEM photomicrograph at 50X magnification of the surface of
a foam layer including a surface modifier.

FIG. 12 is an SEM photomicrograph at 75X magnification of a razor-cut
cross-sectional surface of a foam layer including a surface modifier.

FIG. 13 depicts apparatus used for the Curved Shear Attachment Strength
25 test.

FIG. 14 shows the geometry of a side view of a curved section of the
apparatus of FIG. 13.

FIG. 15 shows another view of the apparatus used for the Curved Shear
Attachment Strength test.

30 FIG. 16 depicts a configuration of test strips used in measuring peel
strength.

Definitions:

As used herein, a foam material is "**open-celled**" if at least 60% of the cells in the foam structure that are at least 1 micrometer (μm) in size are in fluid communication with at least one adjacent cell. In one embodiment of the present invention, at least 80% of the cells in the foam structure that are at least 1 μm in size are in fluid communication with at least one adjacent cell.

As used herein, the term "**strand**" refers to an elongated extrudate formed by passing a polymer through a forming orifice (e.g., a die). A strand may include a fiber, which is a discontinuous strand having a definite length, or a filament, which is a continuous strand of material.

As used herein, the term "**reticulated foam**", as it is commonly used among those skilled in the art, denotes solid foamed materials where substantially all intervening "window walls" or cell membranes have been removed from the cells of the foam, leaving a network consisting primarily of interconnected struts along the outlines of the cells formed during the foaming.

Reticulated foams are thus distinct from foams in which the window walls are merely broken, or foams in which only the outermost window walls or skin have been removed by physical means. Reticulated foams, by virtue of their general lack of cell membranes, are highly permeable to gas and liquid alike, offering little resistance to fluid flow, indeed much less than those foams in which the cell membranes have been retained.

Reticulation is typically achieved by known foam processing procedures applied to the foam after the cells have been formed. These procedures may involve the use of caustic treatments (e.g., see U.S. Patent No. 3,266,927, issued to Fritz et al. on August 16, 1966), attack by other reactive compounds such as ozone, or thermal treatments of the foam, removing all or substantially all of the "window walls" separating the cells throughout the foam. In some cases, other treatments such as controlled explosions are used to remove membranes around portions of cells (for example, a foam may be packed into an explosion chamber containing

an explosive gaseous medium which is then exploded). An example of explosive treatment of a foam is given in US Pat. No. 4,906,263, issued to von Blucher et al. on March 6, 1990.

- 5 Needling may also be used to open a closed cell foam material, as described in U.S. Patent No. 4,183,984, issued to Browers et al. on January 15, 1980. Other methods for creating an open cell foam material are disclosed in U.S. Patent No. 6,720,362, issued to Park et al. on April 13, 2004.
- 10 In one embodiment of the present invention, reticulation is only present in the outer portions of a foam layer at and near the engaging surface.

Alternatively, the cellular foam material may be inherently reticular as made. According to U.S. Patent No. 3,661,674, issued to Higgs et al. on May 9, 1972,
15 an inherently reticular polyester polyurethane foam may be made, for example, by allowing the foam-forming ingredients to react in the presence of a viscosity-retarding substance such as a further polyester having an acid component which is the same as that of the polyester used to make the foam material but which has a hydroxyl number of between 10 and 100 and a viscosity of less than 200
20 poises.

As used herein, the term “**stretchable**” refers to materials which, upon application of a stretching force, can be extended to a stretched dimension which
25 is at least 150% of an original dimension (i.e., at least 50% greater than an original, unstretched dimension) in one or more directions without rupturing. The term “elastic” refers to materials which are stretchable and which, upon release of the stretching force, will retract (recover) by at least 50% of the difference between the stretched dimension and the original dimension. For instance, a
30 material having an original dimension of 20 cm is stretchable if it can be extended to a dimension of at least 30 cm without rupture. The same material is elastic if, after being extended to 30 cm, it retracts to a dimension of 25 cm or less when the stretching force is removed.

As used herein, the term "**Denier**" refers to a weight-per-unit-length measurement of a linear material defined as the number of grams per 9000 meters. The term may refer to either an individual fiber or a bundle of fibers (yarn).

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As used herein, "**Decitex**" (abbreviated "dtex") is a term similar to denier except it is the weight in grams of 10,000 meters of a yarn or fiber.

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As used herein, the term "**hydroentangling**" refers to techniques of treating a fabric by application of high-velocity jets of water delivered from high-pressure orifices, whereby the fibers or filaments in the fabric are rearranged under the influence of water impingement. By way of example, U.S. Patent No. 3,485,706, issued to Evans on December 23, 1969, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith, discloses a

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hydroentanglement process for manufacture of nonwoven fabric webs. During hydroentanglement, the nonwoven fabric web is typically positioned on a foraminous forming surface as it is subjected to impingement by the water jets, whereby the fibers or filaments of the nonwoven fabric web become entangled, thus creating a nonwoven fabric web with coherency and integrity, while the

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specific features of the forming surface act to create the desired pattern in the nonwoven fabric web. Before leaving the nozzles, the water may have a pressure of up to about 60 Mpa (600 bar). The nozzles may have a diameter of 0.05 to 0.25 mm and may be spaced at 20 - 160 mesh. The jet hits the nonwoven fabric web surface, penetrates it and flows to the openings in the

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foraminous surface (the web support) and through suction slots. In this process, the fibers are entangled, which may cause compacting and bonding of the nonwoven fabric web. See also, U.S. Patent No. 5,389,202, issued to Everhart et al. on February 14, 1995, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith.

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The foraminous surface may be substantially planar or three-dimensional, and may be a perforated metal surface, a metal wire, a polymeric wire or fabric such as a through-drying fabric known in papermaking, or other surface. Related

examples of hydroentanglement technology are found, by way of examples, in U.S. Patent No. 4,805,275, issued to Suzuki et al. on February 21, 1989, where three-dimensional foraminous surfaces are disclosed. See also U.S. Patent Application 2002/0025753, published by Putnam et al. on February 28, 2002.

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As used herein, the phrase "**cluster of free-standing struts**" refers to one or more interconnected struts that extend away from a complete cell of the foam material, wherein the struts in the cluster are connected to the same complete cell. If first and second struts from first and second cells, respectively, join at a juncture and have a third strut (a free-standing strut) extending from the juncture, the first and second struts are considered to be part of a closed cell, and the cluster of free-standing struts would consist of the third strut. If the third strut branches into two other free-standing struts at an end away from the juncture, the third strut and the two other free-standing struts are all part of a cluster of free-standing struts.

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As used herein, the term "**free length**" of a free-standing strut or cluster of free-standing struts is the linear distance the free-standing strut or cluster of free-standing struts, respectively, extends away from the nearest portion of the first complete cell in the foam material attached to the free-standing strut or cluster of free-standing struts.

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The Foam Layer

In one embodiment of the present invention, the foam layer comprises an open-celled foam such as a melamine foam, a polyurethane foam, or other known open-celled foams. Such foam materials typically comprise rod-like struts forming a reticulated network that defines cells in the foam materials.

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Melamine-based foams may include the foams currently manufactured by BASF, located in Ludwigshafen, Germany, under the BASOTECT® brand name. For example, BASOTECT® 2011, with a density of about 0.01 g/cm³, may be used.

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Blocks of melamine-based foam are marketed by Procter & Gamble, located in Cincinnati, Ohio, under the MR. CLEAN® brand name. Similar materials are marketed under the CLEENPRO™ name by LEC, Inc., located in Tokyo, Japan, (several product executions are shown at

5 <http://www.users.bigpond.com/jmc.au/CLEENPRO/CLEENPRO-E.htm> and
<http://www.users.bigpond.com/jmc.au/CLEENPRO/CLEENPRO%20Family-E.htm>, both printed on November 13, 2003). Melamine-based foam is also marketed for acoustic and thermal insulation by many companies such as American Micro Industries, located in Chambersburg, Pennsylvania.

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Examples of potentially useful reticulated foams include the polyurethane reticulated foams of Foamex, Inc., located in Linwood, Pennsylvania, such as foam SIF-60z; and, the reticulated foams of the following firms: Crest Foam Industries, Inc., located in Moonachie, New Jersey, including FilterCrest®
15 reticulated foams; Scottfoam Corporation, located in Eddystone, Pennsylvania; Swisstex, Inc., located in Greenville, South Carolina; Recticell, located in Chicago, Illinois; and, the foams produced at Caligen Europe BV, located in Breda, the Netherlands, a subsidiary of British Vita PLC, located in Manchester, England.

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Examples of reticulated foams are also disclosed in the patent literature, including U.S. Patent No. 3,171,820, issued to Volz et al. on March 2, 1965; U.S. Patent No. 4,631,077, issued to Spicer et al. on December 23, 1986; U.S. Patent No. 4,656,196, issued to Kelly et al. on April 7, 1987; and, U.S. Patent No. 4,540,
25 717 issued to Mahnke et al. on September 10, 1985. Also of potential use are the open-celled foams marketed by Sydney Heath & Son, located in Burslem, Stoke on Trent, United Kingdom, including reticulated foam described as having 75 pores per inch. Reticulated foams may include polyurethane, polyester, and polyether types, as well as other known reticulated foams. Other foams that may
30 be considered include those of U.S. Patent No. 4,062,915, issued to Stricharczuk et al. on December 13, 1977.

Pore size in commercial open-celled foams is commonly expressed as pores per inch (ppi), based on measurement of the pores along a straight path of known length, which may also be expressed in terms of pores per centimeter (ppc).

According to the present invention, the foam material in the foam layer may have
5 an characteristic pore size of any of the following: from about 1 ppc to about 200 ppc; from about 3 ppc to about 180 ppc; from about 10 pc to about 150 ppc; from about 15 ppc to about 130 ppc; from about 15 ppc to about 100 ppc; or, from about 20 ppc to about 65 ppc.

10 The free-standing struts of the foam material, by way of example only, may have an effective diameter of about 0.3 microns or greater, such as about 1 micron or greater, about 3 microns or greater, or about 10 microns or greater, such as any of the following: from about 0.3 micros to about 30 microns; from about 1 micron to about 30 microns; from about 3 microns to about 30 microns; from about 1
15 micron to about 20 microns; and, from about 1 micron to about 10 microns. The free length of a free-standing strut, the free length of a plurality, or cluster, of free-standing struts effective in engaging a landing layer, the free length of a characteristic free-standing strut, the average free length of free-standing struts on a surface of a foam material, or the median free length of free-standing struts
20 on a surface of a foam material, may be any of the following: greater than about 3 microns; greater than about 10 microns; greater than about 20 microns; greater than about 50 microns; greater than about 100 microns; greater than about 500 microns; greater than about 1000 microns; and, greater than about 2000 microns, such as from about 10 microns to about 2000 microns, or from
25 about 50 microns to about 1000 microns, or from about 100 microns to about 500 microns. The ratio of free length of a free-standing strut (or related measures thereof previously discussed) to effective diameter of a free-standing strut may be about 5 microns or greater, 10 microns or greater, 20 microns or greater, 50 microns or greater, and 100 microns or greater, such as from about 5 microns to
30 about 100 microns, or from about 10 microns to about 200 microns.

Other open-celled foam materials may also be considered, such as a layer of an aminoplast foam (e.g., foams made from urea-formaldehyde resins or melamine-

formaldehyde resins), a phenolic foam such as a foam made from phenol-formaldehyde resins. Any aminoplast foam or other open-celled foam disclosed in U.S. Patent No. 4,125,664, issued to Giesemann on November 14, 1978, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith, may be used to produce the articles of the present invention. Other foams that may be used within the scope of the present invention include those disclosed in U.S. Patent No. 4,666,948, issued to Woerner et al. on May. 19, 1987; U.S. Patent No. 5,234,969, issued to Clark et al. on August 10, 1993; U.S. Patent No. 6,133,332, issued to Shibamura on October 17, 2000; and, World Patent Application No. WO 91/14731, published by Mäder et al. on October 3, 1991, the disclosures of which are each incorporated by reference to the extent that they are non-contradictory herewith.

In one embodiment of the present invention, the foam layer comprises a thermoset foam, and the thermoset components of the foam layer may comprise over 50%, over 60%, over 80%, or over 90% of the mass of the foam layer. Alternatively, the solid polymeric components of the foam layer may consist essentially of one or more thermoset materials. In another embodiment of the present invention, the foam layer may be substantially free of thermoplastic materials. In another embodiment of the present invention, the foam layer may not comprise more than 50% of any one of a component selected from polyolefin materials, polyurethanes, silicones, and polyesters.

The foam layer may comprise more than one kind of foam. For example, heterogeneous foam layers may be considered with structures or compositions similar to any of those disclosed in U.S. Patent No. 5,817,704, issued to Shiveley et al. on October 6, 1998, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith. Two or more kinds of foam material may be blended or joined together during foam manufacture or existing foams may be laminated or otherwise joined together.

The foam layer may be cut or sliced to any desired thickness, and may be cut to be planar, sinusoidal, or to have other geometric features. Principles for cutting

- and slicing a foam layer are disclosed in European Patent No. EP 191,475, published by Gotoh et al. on August 20, 1986; U.S. Patent No. 5,670,101, issued to Nathoo et al. on September 23, 1997, which shows a slicer (object no. 32 in Figure 3) that slices foam material into multiple layers at once, presumably by the action of multiple cutting blades; and, U.S. Patent No. 6,245,697, issued to Conrad et al. on June 12, 2001, which discloses the use of a sharp reciprocating saw blade to slice a foam material into thin layers, such as from about 0.5 mm to about 5 mm in thickness.
- Another method for slicing foam material to thin small layers (e.g., about 1 mm in thickness or greater) is found in Japanese Patent Application No. JP 2001-179684A, published by Toshiro on July 3, 2001, which discloses joining a reinforcing layer to a foam material prior to slicing to allow the thin layer to be processed more easily. The foam material with a reinforcing layer is compressed in a nip and then encounters a blade that severs a thin layer away from the main body of the foam material. By extension to the present invention, a reinforcing layer, such as a nonwoven web or paper towel, may be adhesively joined to a thick block of foam material, and then pass through a nip and encounter a knife blade oriented to slice away a thin section of foam material attached to the reinforcing layer. The remaining thicker block of foam material could then again be attached to a second reinforcing layer on one side, and the foam material adjacent to the reinforcing layer could be sliced off, as before, and the process could be repeated until the foam material had been substantially cut into a plurality of thin layers attached to a reinforcing layer. Both sides of the initial foam material block may be attached to a reinforcing layer, if desired, optionally allowing the final split to divide a foam material into two thin layers both attached to reinforcing layers.

In addition to being sliced from larger foam material blocks, the foam material may be formed directly in thin layers using methods such as those disclosed in World Patent Application No. WO 98/28118, published by Peterson et al. on July 2, 1998.

The foam material may also be perforated, as may the reinforcing layer. One method for perforating foam materials is disclosed in World Patent Application No. WO 00/15697, published by Park et al. on March 23, 2000. The foam material may also have a plurality of short slits or elongated perforations applied normal to the plane of the foam material, such as the slit materials in U.S. Patent No. 5,397,316, issued to LaVon et al. on March 14, 1995.

Reinforcing Layer:

10 The foam layer may be reinforced with an underlying reinforcing layer such as a nonwoven web, a tissue web, a woven fabric, a scrim material, and the like. In one embodiment of the present invention, the reinforcing layer may generally comprise cellulosic fibers and may comprise a paper material such as a latex-reinforced creped towel, an uncreped through-air-dried towel reinforced with wet strength resins or other binding agents, other single-ply or multi-ply tissue structures (multi-ply tissues may generally require interply bonding means such as adhesive attachment for good mechanical integrity), a coform layer comprising wood pulp fibers intermingled with thermoplastic material that has been thermally bonded (e.g., by application of heated air, heated calendering, etc.), and airlaid material comprising bicomponent binder fibers, a hydroknit comprising hydraulically entangled paper fibers on a nonwoven substrate, and the like. The reinforcing layer, such as a web, may comprise a plurality of layers bonded together.

25 Foam layers joined to reinforcing layers are disclosed in commonly owned U.S. Patent Application Serial Number 10/744,238, filed by Chen et al. on December 22, 2003, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith. While the products of the Chen et al. application are primarily intended to serve as cleaning devices, the combinations of foam layers and reinforcing layers disclosed therein may be adapted for the present invention.

The reinforcing layer may be coextensive with the foam layer, or may extend across only a portion of the foam layer, or may extend beyond all or any of the lateral sides of the foam layer.

- 5 Attachment of the reinforcing web to the foam material may be accomplished by adhesive means suitable for maintaining good flexibility in the article. In addition, the adhesive means may also provide good strength under humid or wet conditions and the stresses typical during use of the article. In one embodiment of the present invention, the adhesive means comprises a water-insoluble hot
- 10 melt adhesive material having a Shore A hardness of about 95 or less, specifically about 75 or less, more specifically about 55 or less, more specifically still about 40 or less, and most specifically about 30 or less, such as from about 10 to about 95, or from about 20 to about 55. Useful adhesive materials may include, but are not limited to those disclosed in U.S. Patent No. 6,541,679,
- 15 issued to Betrabet et al. on April 1, 2003 and U.S. Patent No. 5,827,393, issued to Kinzelmann et al. on October 27, 1998, as well as the commercial HYSOL® hotmelts of Henkel Loctite Corporation, located in Rocky Hill, Connecticut, as well as polyolefin, urethane, and polyamide hotmelts. The adhesive material may have a glass transition temperature between about -10°C and about +30° C. or
- 20 between about 10°C. and about 25°C. The tensile strength of the adhesive material may be at least about 100 psi, at least about 300 psi, or at least about 500 psi.

In one embodiment of the present invention, the adhesive means may comprise

25 an adhesive material with a plurality of hydrophilic groups suitable for maintaining good adhesion with cellulose material even when the cellulose material is wet. Such adhesive materials may comprise EVA (ethylene vinyl acetate), and may include, by way of example, the EVA HYSOL® hotmelts commercially available from Henkel Loctite Corporation, located in Rocky Hill, Connecticut, including 232

30 EVA HYSOL®, 236 EVA HYSOL®, 1942 EVA HYSOL®, 0420 EVA HYSOL® SPRAYPAC®, 0437 EVA HYSOL® SPRAYPAC®, CoolMelt EVA HYSOL®, QuikPac EVA HYSOL®, SuperPac EVA HYSOL®, and WaxPac EVA HYSOL®. EVA-based adhesive materials may be modified through the addition of tackifiers

and other conditioners, such as Wingtack 86 tackifying resin manufactured by Goodyear Corporation, located in Akron, Ohio.

5 In another embodiment of the present invention, the adhesive means comprises an elastomeric adhesive material such as a rubber-based or silicone-based adhesive material, including silicone sealants and latex adhesive materials such as acrylic latex. In one embodiment of the present invention, however, the adhesive means is substantially free of natural latex or proteins associated with natural latex. In another embodiment of the present invention, the adhesive
10 means is substantially free of any kind of latex.

The adhesive means may also comprise fibers or particulates that are either tacky or may be heated to melt a portion thereof for fusing a fibrous web to the foam layers. For example, bicomponent binder fibers may be used, in which the
15 fibers include a sheath having a lower melting point than a core fiber (e.g., a polypropylene or polyethylene sheath around a polyester core). The binder fibers may be applied in a separated loose form, or may be provided as a prebonded fusible web. In one embodiment of the present invention, the adhesive means comprises a combination of adhesive particles or fibers such as bicomponent
20 binder fibers and a hotmelt or reactive adhesive material. For example, bicomponent binder fibers may be present in or on a reinforcing layer prior to application of a hotmelt or other flowable or liquid adhesive (e.g., by spray, extrusions, or printing) to either the reinforcing layer or the foam, followed by joining of the reinforcing layer to the foam layer and optional application of heat or
25 other curing means. The particulate adhesive component may already be active (e.g., partially molten) when the foam is joined to the reinforcing layer.

In general, the adhesive means may be applied by spray nozzles, glue guns, bead applicators, extruders, gravure printing, flexographic printing, ink-jet
30 printing, coating, and the like. The adhesive means may be, but need not be, uniformly applied on either the surface of the foam layer or the surface of the reinforcing layer or both, and may be applied selectively in regions where high strength is needed such as along the perimeter of the interfacial area between

the reinforcing layer and the foam layer. The adhesive means may also be applied in a pattern or in a substantially random distribution.

5 The foam layer may have a thickness about 1 mm to about 15 mm, from about 2 mm to about 12 mm, from about 3 mm to about 10 mm, and from about 4 mm to about 8 mm. The ratio of the thickness of the reinforcing layer to the thickness of the foam layer may be any of the following: from about 1 to about 200; from about 3 to about 10; from about 4 to about 10; from about 0.2 to about 2; from about 0.3 to about 2; from about 0.3 to about 1; less than about 1; greater than about 1; and, from about 0.5 to about 1.5.

The reinforcing layer joined to the foam layer may be a nonwoven web, a tissue web, a film, an apertured web, a laminate, and the like. Suitable nonwoven webs may include meltblown webs, spunbond webs, spunlace webs, and the like. The reinforcing layer may be elastomeric, such as the webs disclosed in U.S. Patent No. 4,707,398, issued to Boggs on November 17, 1987; U.S. Patent No. 4,741,949, issued to Morman et al. on May 3, 1988; and, U.S. Patent No. 5,520,980, issued to Morgan et al. on May 28, 1996. The reinforcing layer may be a neck-bonded laminate or other stretchable laminate.

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Alternatively, a foam layer may be produced such that a reinforcing layer is unitary with the foam material itself. For example, a single layer of foam material may be produced with a skin on one side that may reinforce the foam material. Similarly, a foam layer may have substantially closed cells on one side and substantially open cells on the other side. Such a foam layer may be an example of a "gradient foam material" having a gradient in the thickness direction pertaining to a material property such as pore size, openness of the pores, density, etc. Gradient foam materials comprising one side providing a reinforcing function may be produced from foams having a skin on one side or from closed-cell foam materials in which one surface is converted to an open-cell foam material through chemical or mechanical means to remove windows from the foam material and liberate free-standing struts on one surface.

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Further, the foam layer may also comprise adhesive material to further enhance bonding of the foam material to a landing layer. The adhesive material may be provided on a tab or extension of a reinforcing layer such that the adhesive treated zone is not on the foam material itself but on an attached portion of another material, or the adhesive material may be present on the surface or within the body of the foam material. In one embodiment of the present invention, viscous adhesive material is present within the foam material but not necessarily on the surface of the foam material, such that adhesive attachment does not occur when the foam material contacts another material unless the foam material is loaded sufficiently to bring the internal adhesive into contact with the other material (e.g., a landing layer). Pressure sensitive adhesive material may be sprayed on the surface of a foam material, or injected or impregnated into the foam material to form spaced-apart deposits within the foam material. An adhesive section attached to a foam layer may be shielded with release paper or other means to prevent premature attachment.

In another embodiment of the present invention, the addition of adhesive means to a foam layer fastening system may help increase the peel strength of the foam layer fastening system, when higher peel is desired.

The Landing Material

The landing material for use in the landing layer of the present invention may be a loop material known in past hook and loop systems, though for best results the size of the loops or holes in the landing layer should be adjusted for effective attachment with the foam layer to be used. The loop material may be a web comprising hook-engageable, free-standing loops extending from at least one surface of the loop material.

The landing material may be a nonwoven web such as a meltspun (meltblown or spunbond web), a needled fibrous web, or a hydroentangled web (e.g., a spunlace web, particularly one with microfibers hydroentangled onto a base

fabric). The landing layer may comprise fibrous loops that rise away from the plane of the fabric or lie in the plane of the fabric, making it possible for the loops to be engaged by a suitable opposing surface having free-standing struts of the foam layer.

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It has been found that good results may be obtained when the landing layer has numerous loop segments rising from the surface of the fabric with a characteristic loop height greater than about 30 microns, such as about 50 microns or greater, about 80 microns or greater, about 100 microns or greater, or about 150 microns or greater, which may span characteristic ranges such as from about 30 microns to 1000 microns, or from about 50 microns to 700 microns, or from about 80 microns to about 600 microns, or from about 100 microns to about 500 microns. The linear distance on the surface of the fabric between the two ends of an elevated loop segment (or the distance between the points where the loop segments return to the plane of the fabric) may be about 80 microns or greater, such as about 150 microns or greater, about 300 microns or greater, or about 500 microns or greater, with characteristic ranges such as from about 80 microns to about 1000 microns, or from about 100 microns to about 800 microns, or from about 100 microns to about 600 microns. However, other size ranges are also within the scope of the present invention and may be considered, provided that the free-standing struts of the engaging surface of a foam layer are capable of adequate engagement with the loop segments or holes on the engaging surface of the landing layer.

25 In one embodiment of the present invention, the landing layer comprises loop segments comprising microfibers having an effective fiber diameter of about 30 microns or less, about 20 microns or less, about 10 microns or less, about 5 microns or less, about 2 microns or less, or about 1 micron or less. The fiber diameters of the microfibers may range from about 0.1 micron to about 30 microns, or from about 1 micron to about 30 microns, or from about 1 micron to about 20 microns, or from about 2 microns to about 20 microns. Such microfibers may be produced by known meltblown processes, for example. Bicomponent meltblown fibers, as used herein includes other multi-component

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conjugate fibers, may be used to obtain extremely fine fibers by splitting the fibers or removing one of the components. Splitting may be done by mechanical or chemical means. For example, a bicomponent side-by-side or pie-segment type fiber may be split using hydroentanglement using high-velocity jets of water to
5 split the multi-component fibers. Chemical treatment to cause swelling of a component (e.g., by application with caustic or other swelling agents) or to dissolve a component may also result in splitting. Steam treatment, microwaves, mechanical straining, and other techniques may also be applied to suitable multi-component fibers to promote splitting. The bicomponent fibers may be round in
10 cross-section or non-round, such as multilobal fibers, and may be twisted, crimped, helical, or substantially straight. Bicomponent combinations, by way of example only, may include any of the following: polypropylene, polyethylene, polyesters, PBT (polybutyleneterephthalate), polylactic acids, polyamides, PHA, and the like. Additional details on microfiber production are found in U.S. Patent
15 Application Publication No. 2004/0161994 A1, published by Arora et al. on August 19, 2004; the microfibers of the Arora et al. document may also be used within the scope of the present invention.

A landing layers comprising microfibers may be woven textiles or nonwoven
20 fabrics, and may comprise a single type of microfibers or a plurality of microfibers types, and may comprise fibers, webs, or other structural elements others than microfibers. Exemplary materials comprising microfibers that may be considered for use in a landing layer according to the present invention include the following:

- Spunlace webs, particularly those comprising microfibers, as
25 manufactured by Polymer Group, Inc. (located at North Charleston, South Carolina). Patents and applications assigned to Polymer Group, Inc. (PGI) that involve hydroentangling include U.S. Patent Application Publication No. 2002/0025753, published by Putnam et al. on February 28, 2002; U.S. Patent No. 6,306,234, issued to Barker et al. on
30 October 23, 2001; U.S. Patent No. 6,314,627, issued to Ngai et al. on November 13, 2001; U.S. Patent Application Publication No. 2002/0146957, published by Fuller et al. on October 10, 2002; U.S. Pat. No. 6,675,429, issued to Carter et al. on January 13, 2004; U.S.

Patent No. 6,606,771, issued to Curtis et al. on August 19, 2003; U.S. Patent No. 6,564,436, issued to Black et al. on May 20, 2003; U.S. Patent No. 6,516,502, issued to Moody et al. on February 11, 2003; U.S. Pat. No. 6,725,512, issued to Carter et al. on April 27, 2004; U.S. Pat. No. 6,735,833, issued to Putnam et al. on May 18, 2004; and, U.S. Patent No. 6,343,410, issued to Greenway et al. on February 5, 2002, the disclosures of which are each incorporated by reference to the extent that they are non-contradictory herewith. Commercial PGI products that may be used in various embodiments of the present invention include PGI's MediSoft™ fabrics, Comfortlace™ fabrics for feminine hygiene products, said to be made with PGI's Laminar Air Controlled Embossing (LACE) process that adds a 3-D image or bulky surface layer to a reticulated film, and Miratec™ fabrics or other fabrics made with PGI's Apex® hydroentanglement technology in which a 3-D image may be added to a fabric.

- Looped material wherein the loops are formed in a landing layer according to U.S. Patent Application Publication No. 2004/0157036A1, published by Provost et al. on August 12, 2004. The loop material is formed by needling a batt of fibers through a carrier sheet such as a plastic film, to form loops on the opposing side of the carrier sheet. A binder, such as a powder resin or plastic film, is placed over the fiber side of the product and fused to the carrier sheet to bond the fibers in place. In some cases the product is needled in only discrete areas, leaving other areas free of loops.
- Apertured nonwoven webs made according to U.S. Patent No. 5,369,858, issued to Gilmore et al. on December 6, 1994. This patent document is a nonwoven fabric comprising at least one layer of textile fibers or net of polymeric filaments and at least one web of melt blown microfibers, bonded together by hydroentangling. The nonwoven fabric may be apertured by hydroentangling or may have areas of higher density and areas of lower density. The technology is assigned to Fiberweb North America located in Simpsonville, South Carolina.

- Microfiber cloths marketed as cleaning cloths, such as Modern Magic® MicroFiber Cleaning Cloths by Modern Plastics, Inc. located in Bridgeport, Connecticut; the MicroFiber Cleaning Cloths of TAP Plastics, Inc. located in Stockton, California; or, the Scotch-Brite® MicroFiber Cleaning Cloths of 3M, Inc. located in St. Paul, Minnesota.
- OFO-3 Micro Fiber made by Oimo Industrial Co., Ltd., located in Taipei, Taiwan, a cloth made of mechanically split microfiber made from a PET/nylon bicomponent fiber that is hydraulically needled, splitting the fiber into 166 parts, according to supplier information at <http://www.allproducts.com/household/oimo/22-ofo-3.html> (viewed on May 17, 2004).

Microfibers may be made from numerous polymers such as cellulose (e.g., lyocell solvent-spun fibers), polyolefins, polyamides, polyesters, PHA, polylactic acid, acrylic, and the like. Microfibers may also include electrospun fibers, which are also referred to as nanofibers.

Known loop materials that may be adapted for use in a landing layer of the present invention include the loop materials disclosed in U.S. Patent No. 5,622,578, issued to Thomas on April 22, 1997. The loops, as disclosed in the patent document, are manufactured by the process of extruding liquid material through the apertures of a depositing member onto a moving substrate to form the base of the loop, stretching the liquid material in a direction parallel to the plane of the substrate, severing the stretched material to form a distal end which fuses with an adjacent amount of stretched material to form a loop.

Loop materials that may be adapted for use in a landing layer of the present invention may include laminates of nonwoven materials, such as nonwoven webs joined to films or multiple layers of fibrous nonwoven webs. Such laminated may include those disclosed in U.S. Patent Application Publication No. 2003/0077430, published by Grimm et al. on April 24, 2003, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith. The laminates disclosed in Grimm et al. document comprise at least one layer of a

polyolefin endless filament nonwoven fabric, such as a polypropylene endless filament nonwoven fabric, having a maximum tensile strength in the machine running direction that is at least as great as crosswise to that direction (e.g., in a ratio of about 1:1 to about 2.5:1), and made up essentially of fibers having a titer of less than about 4.5 dtex, such as in the range of about 0.8 dtex to about 4.4 dtex, more specifically from about 1.5 dtex to about 2.8 dtex, as well as a second layer of a nonwoven fabric that is bonded to the first layer, which includes a sheet of crimped, such as two-dimensionally and/or spirally crimped, staple fibers made of polyolefins, and whose crimped fibers are coarser than the fibers of the nonwoven fabric of the first layer, and can have titer of about 3.3 dtex to about 20 dtex, more specifically about 5.0 dtex to about 12.0 dtex, whereby the at least two nonwoven fabric layers may be bonded to one another at the common interface by bonding in the form of a predetermined pattern. The second layer can act as the loop layer in the material of the Grimm et al. document.

Alternatively, the landing layer of the present invention may comprise openings (holes) that may be engaged by free-standing struts in a foam layer. The openings may be pores in the surface of the landing layer defined by surrounding fibers. Such openings may have a characteristic diameter greater than about 0.5 microns (μm), such as from about 0.5 μm to about 3 millimeters (mm), or from about 1 μm to about 2 mm, or from about 2 μm to about 1.2 mm, or from about 4 μm to about 1 mm, or less than about 1 mm. The openings may maintain an effective diameter of about 0.5 microns or greater, about 1 micron or greater, about 2 microns or greater, or about 4 microns or greater, continuously from the surface plane of the landing layer surrounding the opening to a "hole depth" in the landing layer of about any of the following or greater: 2 microns, 5 microns, 10 microns, 50 microns, 100 microns, 300 microns, 600 microns, 1 mm, 2 mm, and 3 mm. If the opening provides a continuous vertical opening adapted to receive a vertically oriented cylindrical free-standing strut of diameter D extending a maximum distance L into the landing layer, the opening may have a Cylindrical Hole Depth of L with respect to a free-standing strut diameter of D. Thus, for an example, a free-standing strut having a maximum diameter of about 50 microns and a height of about 500 microns relative to its base (the region where it

connects to two or more other struts) should be able to penetrate about 300 microns into a substantially flat landing layer with openings having a Cylindrical Hole Depth of about 300 microns with respect to a free-standing strut diameter of about 50 microns.

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In one embodiment of the present invention, the landing layer comprises fine microfibers that may provide loop elements to engage the free-standing struts of the foam layer. In another embodiment of the present invention, the microfibers are provided in a spunlace web in which microfibers have been hydroentangled on a nonwoven or woven backing layer.

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In one alternative embodiment of the present invention, the landing layer may also comprise an open-celled foam material, such as a melamine-based foam layer. It has been found that one foam layer of melamine foam material may engage effective, under some circumstances, with another foam layer of melamine foam material, for the open cells and cell windows of a melamine foam material structure may serve as loops suitable for engaging free-standing struts from another foam layer. In such an embodiment, the foam layer or the landing layer comprising a foam layer may each further comprise a reinforcing layer.

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Manufacture of Melamine Foam

Principles for manufacturing melamine-based foam are well known. Melamine-based foams are currently manufactured by BASF, located in Ludwigshafen, Germany, under the BASOTECT® brand name. Principles for production of melamine-based foam are disclosed in EP-B 071,671, published by Mahnke et al. on December 17, 1979. According to Mahnke et al. document, they are produced by foaming an aqueous solution or dispersion of a melamine-formaldehyde condensation product which comprises an emulsifier (e.g., metal alkyl sulfonates and metal alkylaryl sulfonates such as sodium dodecylbenzene sulfonate), an acidic curing agent, and a blowing agent, such as a C5 -C7 hydrocarbon, and curing the melamine-formaldehyde condensate at an elevated temperature. The foams are reported to have the following range of properties:

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- a density according to DIN 53 420 between 4 and 80 grams per liter (g/l), corresponding to a range of 0.004 g/cc to 0.08 g/cc (though for purposes of the present invention the density may also range from about 0.006 g/cc to about 0.1 g/cc, or other useful ranges);
- 5 • a thermal conductivity according to DIN 52 612 smaller than 0.06 W/m °K;
- a compression hardness according to DIN 53 577 under 60% penetration, divided by the density, yielding a quotient less than 0.3 (N/cm²)/(g/l), and preferably less than 0.2 (N/cm²)/(g/l), whereby after measurement of compression hardness the thickness of the foam recovers to at least 70% and preferably at least 90% of its original thickness;
- 10 • an elasticity modulus according to DIN 53 423, divided by the density of the foam, under 0.25 (N/mm²)/(g/l) and preferably under 0.15 (N/mm²)/(g/l);
- 15 • a bending path at rupture according to DIN 53 423 greater than 6 mm and preferably greater than 12 mm;
- a tensile strength according to DIN 53 571 of at least 0.07 N/mm² or preferably at least 0.1 N/mm²; and,
- 20 • by German Standard Specification DIN 4102 they show at least standard flammability resistance and preferably show low flammability.

U.S. Patent No. 6,503,615, issued to Horii et al. on January 7, 2003, discloses a wiping cleaner made from an open-celled foam such as a melamine-based foam, the wiping cleaner having a density of 5 kg/m³ to 50 kg/m³ in accordance with JIS K 6401, a tensile strength of 0.6 kg/cm² to 1.6 kg/cm² in accordance with JIS K 6301, an elongation at break of 8% to 20% in accordance with JIS K 6301 and a cell number of 80 cells/25 mm to 300 cells/25 mm as measured in accordance with JIS K 6402. Melamine-based foam materials having such mechanical properties may be used within the scope of the present invention.

Related foam materials are disclosed in U.S. Patent No. 3,093,600, issued to Spencer et al. on June 11, 1963. Agents are present to improve the elasticity and tear strength of the foam material. Melamine-based foam materials are also disclosed in British Patent No. GB 1,443,024, issued to Russo et al. on July 21,
5 1976.

A foam material for use in the present invention may be heat compressed to modify its mechanical properties, as described in U.S. Patent No. 6,608,118, issued to Kosaka et al. on August 19, 2003, the disclosure of which is
10 incorporated by reference to the extent that it is non-contradictory herewith.

Brittle foam materials may be made, as described in German publication DE-AS 12 97 331, from phenolic components, urea-based components, or melamine-based components, in aqueous solution with a blowing agent and a hardening
15 catalyst.

The brittle foam material may comprise organic or inorganic filler particles, such as from about 5% to about 30% by weight of a particulate material. Exemplary particulate materials may include clays such as kaolin, talc, calcium oxide,
20 calcium carbonate, silica, alumina, zeolites, carbides, quartz, and the like. The fillers may also be fibrous materials, such as wood fibers, papermaking fibers, coconut fibers, milkweed fibers, flax, kenaf, sisal, bagasse, and the like. The filler particles or fibers added to the foam material may be heterogeneously distributed or may be distributed homogeneously.

25 The foam material or a portion thereof may also be impregnated with a material to reinforce or harden the foam material, if desired, such as impregnation with water glass or other silicate compounds, as disclosed in U.S. Patent No. 4,125,664, issued to Giesemann on November 14, 1978, the disclosure of which
30 is incorporated by reference to the extent that it is non-contradictory herewith. Adhesive materials, hot melts, cleaning agents, bleaching agents (e.g., peroxides), antimicrobials, and other additives may be impregnated in the foam material.

The foam layer may be rectangular in plan view, but may have any other shape, such as semicircles, circles, ovals, diamonds, sinusoidal shapes, dog bone shapes, and the like. The foam layer need not be planar, but may be molded or shaped into three-dimensional topographies for aesthetic or functional purposes. For example, melamine-based foam material may be thermally molded according to the process discussed in U.S. Patent No. 6,608,118, issued to Kosaka et al. on August 19, 2003, previously incorporated by reference. The Kosaka et al. document, discussed above, discloses molding the foam at 210 to 350 C (or, more particularly, from 230°C to 280°C or from 240°C to 270°C) for 3 minutes or longer to cause plastic deformation under load, wherein the foam is compressed to a thickness of about 1/1.2 to about 1/12 the original thickness, or from about 1/1.5 to about 1/7 of the original thickness. The molded melamine foams can be joined to a urethane sponge layer to form a composite material, according to the Kosaka et al. document.

As described by Kosaka et al. document, the melamine-based foam may be produced by blending major starting materials of melamine and formaldehyde, or a precursor thereof, with a blowing agent, a catalyst and an emulsifier, injecting the resultant mixture into a mold, and applying or generating heat (e.g., by irradiation or electromagnetic energy) to cause foaming and curing. The molar ratio of melamine to formaldehyde (i.e., melamine:formaldehyde) for producing the precursor is, according to the Kosaka et al. reference, preferably 1:1.5 to 1:4, or more particularly 1:2 to 1:3.5. The number average molecular weight of the precursor may be from about 200 to about 1,000, or from about 200 to about 400. Formalin, an aqueous solution of formaldehyde, may be used as a formaldehyde source.

Melamine is also known by the chemical name 2,4,6-triamino-1,3,5-triazine. As other monomers corresponding to melamine, there may be used C1-5 alkyl-substituted melamines such as methylolmelamine, methylmethylolmelamine and methylbutylolmelamine, urea, urethane, carbonic acid amides, dicyandiamide, guanidine, sulfurylamides, sulfonic acid amides, aliphatic amines, phenols and

the derivatives thereof. As aldehydes, there may be used acetaldehyde, trimethylol acetaldehyde, acrolein, benzaldehyde, furfural, glyoxal, phthalaldehyde, terephthalaldehyde, and the like.

5 As the blowing agent, there may be used pentane, trichlorofluoromethane, trichlorotrifluoroethane, and the like. As the catalyst, by way of example, formic acid may be used and, as the emulsifier, anionic surfactants such as sodium sulfonate may be used.

10 Other useful methods for producing melamine-based foam materials are disclosed in U.S. Patent No. 5,413,853, issued to Imashiro et al. on May 9, 1995, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith. According to Imashiro et al. document, a melamine resin foam of the present invention may be obtained by coating a hydrophobic
15 component on a known melamine-formaldehyde resin foam body obtained by foaming a resin composition composed mainly of a melamine-formaldehyde condensate and a blowing agent. The components used in the present melamine resin foam material may therefore be the same as those conventionally used in production of melamine-formaldehyde resins or their foams, except for the
20 hydrophobic component.

As an example, the Imashiro et al. document discloses a melamine-formaldehyde condensate obtained by mixing melamine, formalin and paraformaldehyde and reacting them in the presence of an alkali catalyst with heating. The mixing ratio
25 of melamine and formaldehyde can be, for example, 1:3 in terms of molar ratio.

The melamine-formaldehyde condensate may have a viscosity of about 1,000-100,000 cP, more specifically 5,000-15,000 cP and may have a pH of 8-9.

30 As the blowing agent, a straight- chain alkyl hydrocarbon such as pentane or hexane is disclosed.

In order to obtain a homogeneous foam material, the resin composition composed mainly of a melamine-formaldehyde condensate and a blowing agent may contain an emulsifier. Such an emulsifier may include, for example, metal alkylsulfonates and metal alkylarylsulfonates.

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The resin composition may further contain a curing agent in order to cure the foamed resin composition. Such a curing agent may include, for example, acidic curing agents such as formic acid, hydrochloric acid, sulfuric acid and oxalic acid.

- 10 The foam material disclosed by Imashiro et al. document may be obtained by adding as necessary an emulsifier, a curing agent and further a filler, etc. to the resin composition composed mainly of a melamine-formaldehyde condensate and a blowing agent, heat-treating the resulting mixture at a temperature equal to or higher than the boiling point of the blowing agent to give rise to foaming, and
- 15 curing the resulting foam material.

In another embodiment of the present invention, the foam material may comprise a melamine-based foam material having an isocyanate component (isocyanate-based polymers are generally understood to include polyurethanes, polyureas,

20 polyisocyanurates and mixtures thereof). Such foam materials may be made according to U.S. Patent No. 5,436,278, issued to Imashiro et al. on July 25, 1995, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith, which discloses a process for producing a melamine resin foam material comprising a melamine/formaldehyde condensate, a blowing

25 agent and an isocyanate. One embodiment of the present invention includes the production of a melamine resin foam material obtained by reacting melamine and formaldehyde in the presence of a silane coupling agent. The isocyanate component used in U.S. Patent No. 5,436,278 document may be exemplified by CR 200 (a trademark of polymeric-4, 4'-diphenylmethanediisocyanate, produced

30 by Mitsui Toatsu Chemicals, Inc.) and Sumidur E211, E212 and L (trademarks of MDI type prepolymers, produced by Sumitomo Bayer Urethane Co., Ltd). One example therein comprises 100 parts by weight of melamine/formaldehyde condensate (76% concentration), 6.3 parts sodium dodecylbenzenesulfonate

(30% concentration), 7.6 parts pentane, 9.5 parts ammonium chloride, 2.7 parts formic acid, and 7.6 parts CR 200. A mixture of these components was placed in a mold and foamed at 100°C, yielding a material with a density of 26.8 kg/m³ (0.0268 g/cm³), a compression stress of 0.23 kgf/cm², and a compression strain of 2.7%. In general, the melamine-based foam materials discussed in U.S. Patent No. 5,436,278 document typically had a density of 25 kg/m³ - 100 kg/m³, a compression strain by JIS K 7220 of 2.7% - 4.2% (this is said to be improved by about 40% - 130% over the 1.9% value of conventional fragile melamine foam materials), and a thermal conductivity measured between 10°C to 55°C of 0.005 kcal/m-h-°C. or less (this is far smaller than 0.01 kcal/m-h-°C. which is said to be the value of conventional fragile foam materials). Other foam materials comprising melamine and isocyanates are disclosed in the World Patent Application No. WO 99/23160, published by Sufi on May 14, 1999, the U.S. equivalent of which is U.S. Patent Application Serial No.98/23864, the disclosure of which is incorporated by reference to the extent that it is non-contradictory herewith.

In another embodiment of the present invention, a melamine-based foam material may be used that is produced according to the World Patent Application No. WO 0/226872, published by Baumgartl et al. on April 4, 2002. Such foam materials have been tempered at elevated temperature to improve their suitability for use as absorbent articles in proximity to the human body. During or after the tempering process, further treatment with at least one polymer is disclosed, the polymer containing primary and/or secondary amino groups and having a molar mass of at least 300, although this polymer treatment may be skipped, if desired, when the foam materials discussed in the WO 0/226872 document are applied to the present invention. Such foam materials may have a specific surface area determined by BET of at least 0.5 m²/g. Exemplary phenolic foam materials include the dry floral foam materials made by Oasis Floral Products, located in Kent, Ohio, as well as the water-absorbent open-celled brittle phenolic foam materials manufactured by Aspach Floral Foam Company Ltd., located in Kowloon, HongKong, partially described at http://www.aspachk.com/v9/aspac/why_aspac.html. Open-cell phenolic foam

- materials may be made from the phenolic resins of PA Resins, located in Malmö, Sweden, combined with suitable hardeners (e.g., an organic sulfonic acid) and emulsifiers with a blowing agent such as pentane. Phenolic resins may include resole resins or novolac resins, for example, such as the Bakelite® Resin 1743 PS from (Bakelite AG, located in Iserlohn-Letmathe, Germany, which is used for floral foam materials.

Self-attachment

- 10 In several useful embodiments of the present invention, a self-attachment material is provided that comprises both a foam layer and a landing zone disposed on opposing sides of the self-attachment material (e.g., a first surface and a second surface that are integrally joined prior to attachment of the two surfaces with the foam attachment system of the present invention). In one
15 embodiment of the present invention, the self-attachment material is a laminate of a foam layer and a landing layer such as a fibrous loop layer. The foam layer may be provided with free-standing struts rising from an exposed first outer surface of the foam layer. The landing layer serves to provide a second outer surface opposite the first outer surface. When the foam layer (the first outer
20 surface) of the self-attachment material is brought into contact with the landing layer (the second outer surface) of the self-attachment material, effective attachment is possible.

- The laminate of the foam layer and the landing layer may be produced by any
25 known means, such as by adhesive bonding, ultrasonic bonding, thermal bonding, hydroentanglement, needling, laser bonding, and fastening by the use of mechanical fasteners such as conventional hook and loop materials. While the foam layer may be joined to the landing layer by engagement of free-standing struts into loops or holes of the landing layer alone, in other embodiments of the
30 present invention, another attachment means may be used to provide greater z-direction bonding strength or peel resistance such that the laminate will not readily come apart under peel forces or other lifting forces (e.g., z-direction forces).

Description of the Invention

FIG. 1 illustrates a nonwoven fabric 10 that includes a first web 12. The first web
5 12 is formed of extruded strands 14 that may include an auto-adhesive material.

As used herein, nonwoven fabric refers to a web of material that has been formed
without use of weaving processes that typically produce a structure of individual
strands which are interwoven in a repeating manner. The nonwoven fabric may
10 be formed by a variety of processes (e.g. meltblowing, spunbonding, film
aperturing and staple fiber carding).

Although only a portion of the first web 12 is shown in FIG. 1, it should be noted
that the first web 12 may be any size or shape. In addition, the first web 12 may
15 be a variety of different thickness depending on the application where the
nonwoven fabric 10 is used. The extruded strands 14 may be formed through
any extrusion process that is known now or discovered in the future (e.g.,
meltblowing).

20 As used herein, the term "auto-adhesive" refers to self-adhesive properties of a
material. An auto-adhesive is substantially non-adhesive with respect to many
other materials. Some auto-adhesives may be repeatedly adhered together and
separated at service (e.g., room) temperature.

25 In some embodiments, the auto-adhesive material may be a polymeric material
that includes thermoplastic elastomers. As an example, the thermoplastic
elastomers may have molecules that include sequential arrangements of unique
combinations of monomer units. The thermoplastic elastomers should have
relatively stable auto-adhesive properties and be substantially non-adhesive with
30 respect to other materials.

In addition, the auto-adhesive material may include a thermoplastic elastomer
that has physical cross-links which restrict the elastomer mobility (i.e., flow).

Restricting the elastomeric mobility may promote the auto-adhesive properties of a thermoplastic elastomer.

5 Some example thermoplastic elastomers that may be used in the auto-adhesive material include multiblock copolymers of radial, triblock and diblock structures including non-rubbery segments of mono- and polycyclic aromatic hydrocarbons, and more particularly, mono- and polycyclic arenes. As examples, mono- and polycyclic arenes may include substituted and unsubstituted poly(vinyl)arenes of monocyclic and bicyclic structure.

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In some embodiments, the thermoplastic elastomers may include non-rubbery segments of substituted or unsubstituted monocyclic arenes of sufficient segment molecular weight to assure phase separation at room temperature. As examples, monocyclic arenes may include polystyrene and substituted polystyrenes that
15 have monomer units such as styrene and alkyl substituted styrene (e.g., alpha methylstyrene and 4-methylstyrene). Other examples include substituted or unsubstituted polycyclic arenes that have monomer units (e.g., 2-vinyl naphthalene and 6-ethyl-2-vinyl naphthalene).

20 It should be noted that the thermoplastic elastomers may also include rubbery segments that are polymer blocks which may be composed of homopolymers of a monomer, or a copolymer that includes two or more monomers selected from aliphatic conjugated diene compounds (e.g., 1,3-butadiene and isoprene). Some example rubbery materials include polyisoprene, polybutadiene and styrene
25 butadiene rubbers. Other example rubbery materials include saturated olefin rubber of either ethylene/butylene or ethylene/propylene copolymers, which may be derived from the corresponding unsaturated polyalkylene moieties (e.g., hydrogenated polybutadiene and polyisoprene).

30 In addition, the thermoplastic elastomer may be part of a styrenic block copolymer system that includes rubbery segments which may be saturated by hydrogenating unsaturated precursors (e.g., a styrene-butadiene-styrene (SBS) block copolymer that has center or mid-segments which include a mixture of 1,4

and 1,2 isomers). As an example, a -butadiene-styrene (SBS) block copolymer that includes center or mid-segments which have a mixture of 1,4 and 1,2 isomers may be hydrogenated to obtain (i) a styrene-ethylene-butylene-styrene (SEBS) block copolymer; or (ii) a styrene-ethylene-propylene-styrene (SEPS) block copolymer.

In some embodiments, the auto-adhesive material may include a mixture of a polyethylene and a block copolymer. As an example, the auto-adhesive material may include a mixture of one or more block copolymers selected from the group consisting of poly(styrene)-co-poly(ethylene-butylene)-co-poly(styrene) copolymer, poly(styrene)-co-poly(ethylene-butylene) copolymer, and a polyethylene polymer. In some embodiments, the one or more block copolymers may be between about 30 weight percent to about 95 weight percent of the auto-adhesive material, and the polyethylene polymer may be between about 5 weight percent to about 70 weight percent of the auto-adhesive material (wherein all weight percents are based on the total weight amount of the block copolymer and the polyethylene polymer that are present in the auto-adhesive layer).

As used herein, the Peak Load of Auto-adhesive Strength represents a force that is required to separate the nonwoven fabric 10 when it is attached to itself. When the nonwoven fabric 10 is used as an adhesive component, the Peak load of Auto-adhesive Strength should meet the adhesive strength requirement for a particular application. If a nonwoven fabric 10 is used in a fastening system, the Peak Load of Auto-adhesive Strength for the nonwoven fabric 10 needs to be high enough to prevent the fastening system from opening during use. A nonwoven fabric 10 that exhibits too low of a Peak Load of Auto-adhesive Strength may not be suitable for some fastening system applications.

The nonwoven fabric 10 readily bonds to other items that include a similar auto-adhesive material with a strength that is greater than the strength which is generated when the nonwoven fabric 10 is bonded to any other type of material (e.g., a bonding strength that is at least twice as great). As an example, the nonwoven fabric 10 may exhibit a Peak Load of Auto-Adhesive Strength value

that is greater than about 100 grams per inch width of the nonwoven fabric 10 (about 118 grams per centimeter width of the layer), and up to about 2000 grams per inch width of the nonwoven fabric 10 (about 787 grams per centimeter width of the layer). The method by which the Peak Load of Auto-Adhesive Strength value for a web is determined is set forth in U.S. Patent No. 6,261,278 which is incorporated by reference herein.

The type of auto-adhesive material that may be used to form the plurality of strands 14 will be selected based on (i) processing parameters; (ii) physical properties; (iii) packaging issues; and (iv) costs (among other factors). The first web 12 should have properties that are required for a particular product and/or process. The physical properties of the auto-adhesive material may be controlled to define properties for the nonwoven fabric 10 such as melting temperature, shear strength, crystallinity, elasticity, hardness, tensile strength, tackiness and heat stability (among other properties).

In some embodiments, the nonwoven fabric 10 may be made by melt spinning thermoplastic materials. This type of nonwoven fabric 10 may be referred to as a spunbond material.

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Example methods for making spunbond polymeric materials are described in U.S. Pat. No. 4,692,618 to Dorschner et al., and U.S. Pat. No. 4,340,563 to Appel et al. both of which disclose methods for making spunbond nonwoven webs from thermoplastic materials by extruding the thermoplastic material through a spinneret and drawing the extruded material into filaments with a stream of high velocity air to form a random web on a collecting surface. U.S. Pat. No. 3,692,618 to Dorschner et al. discloses a process wherein bundles of polymeric filaments are drawn with a plurality of eductive guns by very high speed air while U.S. Pat. No. 4,340,563 to Appel et al. discloses a process wherein thermoplastic filaments are drawn through a single wide nozzle by a stream of high velocity air. Some other example melt spinning processes are described in U.S. Pat. No. 3,338,992 to Kinney; U.S. Pat. No. 3,341,394 to Kinney; U.S. Pat. No. 3,502,538 to Levy; U.S. Pat. No. 3,502,763 to Hartmann; U.S. Pat. No. 3,909,009 to

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Hartmann; U.S. Pat. No. 3,542,615 to Dobo et al., and Canadian Patent Number 803,714 to Harmon.

5 In some embodiments, desirable physical properties may be incorporated into the nonwoven fabric 10 by forming the strands 14 out of a multicomponent or bicomponent material where at least of one the materials in the bicomponent material is an auto-adhesive material. The auto-adhesive material may be similar to any of the auto-adhesive materials described above.

10 As used herein, strand refers to an elongated extrudate formed by passing a polymer through a forming orifice (e.g., a die). A strand may include a fiber, which is a discontinuous strand having a definite length, or a filament, which is a continuous strand of material.

15 Some example methods for making a nonwoven fabric from multicomponent or bicomponent materials are disclosed. U.S. Pat. No. 4,068,036 to Stanistreet, U.S. Pat. No. 3,423,266 to Davies et al., and U.S. Pat. No. 3,595,731 to Davies et al. disclose methods for melt spinning bicomponent filaments to form a nonwoven fabric. The nonwoven fabric 10 may be formed by cutting the meltspun strands
20 into staple fibers, and then forming a bonded carded web, or by laying the continuous bicomponent filaments onto a forming surface and thereafter bonding the web.

FIGS. 2A-2C illustrate some example forms of bicomponent strands 14 that may
25 be used to form web 12. The strands 14 include a first component 15 and a second component 16 that are arranged in substantially distinct zones across the cross-section of the bicomponent strands 14 and extend along the length of the bicomponent strands 14. The first component 15 of the bicomponent strand includes an auto-adhesive material and constitutes at least a portion of the
30 peripheral surface 17 on the bicomponent strands 14. Since the first component 15 exhibits different properties than the second component 16, the strands 14 may exhibit properties of the first and second components 15, 16.

The first and second components 15, 16 may be arranged in a side-by-side arrangement as shown in FIG. 2A. FIG. 2B shows an eccentric sheath/core arrangement where the second component 16 is the core of the strand 14 and first component 15 is the sheath of the strand 14. It should be noted that the
5 resulting filaments or fibers may exhibit a high level of natural helical crimp in the sheath/core arrangement illustrated in FIG. 2B. In addition, the first and second components 15, 16 may be formed into a concentric sheath/core arrangement as shown in FIG. 2C.

10 Although the strands 14 are disclosed as bicomponent filaments or fibers, it should be understood that the nonwoven fabric 10 may include strands 14 which have one, two or more components. In addition, the nonwoven fabric 10 may be formed of single component strands that are combined with multicomponent strands. The type of materials that are selected for the first and second
15 components 15, 16 will be based on processing parameters and the physical properties of the material (among other factors).

It should be noted the auto-adhesive material may include additives. In addition, when the strands 14 are formed of a bicomponent (or multicomponent) strands
20 14, some (or all) of components that form the strands 14 may include additives. As an example, the strands 14 may include pigments, anti-oxidants, stabilizers, surfactants, waxes, flow promoters, plasticizers, nucleating agents and particulates (among other additives). In some embodiments, the additives may be included to promote processing of the strands 14 and/or web 12.

25 As shown in FIG. 3, the nonwoven fabric 10 may be formed of multiple webs 12, 22, 32. The first web 12 of extruded strands 14 may be similar to first web 12 described above. The first web 12 may be bonded to a second web 22 of extruded strands 14 such that the first and second webs 12, 22 are positioned in
30 laminar surface-to-surface relationship. In addition, the second web 22 may be bonded to a third web 32 such that the second and third webs 22, 32 are positioned in laminar surface-to-surface relationship.

In some embodiments, the second and/or third webs 22, 32 may be a spunbond material while in other embodiments the second and/or third webs 22, 32 may be made by meltblowing techniques. Some example meltblowing techniques are described in U.S. Pat. No. 4,041,203, the disclosure of which is incorporated
5 herein by reference. U.S. Pat. No. 4,041,203 references the following publications on meltblowing techniques which are also incorporated herein by reference: An article entitled "Superfine Thermoplastic Fibers" appearing in INDUSTRIAL & ENGINEERING CHEMISTRY, Vol. 48, No. 8, pp. 1342-1346 which describes work done at the Naval Research Laboratories in Washington,
10 D.C.; Naval Research Laboratory Report 111437, dated Apr. 15, 1954; U.S. Pat. Nos. 3,715,251; 3,704,198; 3,676,242; and 3,595,245; and British Specification No. 1,217,892.

Each of the second and third webs 22, 32 may have substantially the same
15 composition as the first web 12 or have a different composition than the first web 12. In addition, the second and third webs 22, 32 may be formed from single component, bicomponent or multicomponent strands 14.

In some embodiments, the first, second and/or third webs 12, 22, 32 may formed
20 separately and then bonded together (e.g., by thermal point bonding). It should be noted that when the first, second and possibly third web are bonded together, and a common elastomeric polymer is present in the strands 14 that form the first, second and third webs 12, 22, 32, the bonding between the first, second and third webs 12, 22, 32 may be more durable.

25 In other embodiments, the first, second and third webs 12, 22, 32 may be formed in a continuous process wherein each of the first, second and third webs 12, 22, 32 is formed one on top of the other. Both processes are described in U.S. Pat. No. 4,041,203, which has already been incorporated herein by reference.

30 The types of materials that are selected for the extruded strands 14 that make up the first, second and third webs 12, 22, 32 will be based on processing parameters and the desired physical properties of the nonwoven fabric 10

(among other factors). The first, second and third webs 12, 22, 32 may be attached together through any method that is known now or discovered in the future. Although the first, second and third webs 12, 22, 32 are partially shown as webs of the same size, it should be noted that the first, second and third webs 12, 22, 32 may be different sizes and/or shapes. In addition, the first, second and third webs 12, 22, 32 may be the same (or different) thicknesses.

A method of forming a nonwoven fabric 10 will now be described with reference to FIG. 4. The method includes extruding a plurality of strands 14 where at least some of the strands 14 may be formed of an auto-adhesive material. The method further includes routing the plurality of strands 14 toward a moving support 66 and depositing the plurality of strands 14 onto the moving support 66. The method further includes stabilizing the plurality of strands 14 to form a web 12.

FIG. 4 shows an example processing line 40 that is arranged to produce a web 12 that includes a plurality of bicomponent continuous strands 14 (e.g., filaments or fibers). It should be understood that the processing line 40 may be adapted to form a nonwoven fabric 10 that includes one, two or multiple components in each strand 14. In addition, the processing line 40 may be adapted to form a nonwoven fabric 10 that include single component strands 14 in combination with multicomponent strands 14.

In the example embodiment that is illustrated in FIG. 4, the first and second components 15, 16 may be separately co-extruded in two different extruders 41, 42. It should be noted that the first and second extruders 41, 42 may be any extruder that is known now or discovered in the future.

In some embodiments, the first and second components 15, 16 are in the form of solid resin pellets (or particles) that are heated above their melting temperature and advanced along a path (e.g., by a rotating auger). The first component 15 is routed through one conduit 46 while the second component 16 is simultaneously routed through another conduit 48.

Both flow streams are directed into a spin pack 50 that initially forms the strands 14. As an example, the spin pack 50 may include a plate that has a plurality of holes or openings through which the extruded material flows. The number of openings per square inch in the spin pack 50 may range from about 5 to about 500 openings per square inch. The size of each opening in the spin pack may vary from about 0.1 millimeter (mm) to about 2.0 mm in diameter. It should be noted that the openings in the spin pack 50 may have a circular cross-section, or have a bilobal, trilobal, square, triangular, rectangular or oval cross-section depending on the properties that are desired for the nonwoven fabric 10.

In the example embodiment that is illustrated in FIG. 4, the first and second components 15, 16 may be directed into the spin pack 50 and then routed through the spin pack 50 in such a manner that the second component 16 forms a core while the first component 15 forms a sheath which surrounds the core. As discussed above with regard to FIGS. 2A-2C, the bicomponent strands 14 may have a side by side configuration or a core/sheath design (among other possible configurations).

One bicomponent strand 14 will be formed for each opening formed in the plate within the spin pack 50. Each of the plurality of strands 14 simultaneously exits the spin pack 50 at a first speed. The initial diameter of each bicomponent strand 14 will be dictated by the size of the openings that are in the plate of the spin pack 50.

In some embodiments, the plurality of strands 14 are routed downwardly through a quench chamber 58 to form a plurality of cooled strands 14. It should be noted that directing the strands 14 downward allows gravity to assist in moving the strands 14. In addition, the downward movement may aid in keeping the strands 14 separated from one another.

The strands 14 are contacted by one or more streams of air as the strands move into the quench chamber 58. The velocity of the incoming air may be maintained or adjusted so that the strands 14 are efficiently cooled.

- 5 The plurality of strands are then routed to a draw unit 60 that may be located below the quenching chamber 50 so as to again take advantage of gravity. As used herein, drawing involves subjecting the cooled strands 14 to pressurized air that draws (i.e., pulls) the molten strands 14 which are exiting the spin pack 50 downward.

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The downward force that is generated by the pressurized air in the draw unit 60 causes the molten strands 14 to be lengthened and elongated. The amount that the diameter of the strands 14 is reduced depends upon several factors including (i) the number of molten strands 14 that are drawn; (ii) the distance over which the strands 14 are drawn; (iii) the pressure and temperature of the air that is used to draw the strands 14; and (iv) the spin line tension (among other factors).

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The cooled strands 14 are pulled within the draw unit 60 at a speed that is faster than the speed at which the continuous molten strands 14 exit the spin pack 50.

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The change in speed causes the molten strands to be lengthened and reduced in cross-sectional area. The cooled strands 14 may be completely solid upon exiting the draw unit 60.

- 25 The solid strands 14 are deposited onto a moving support 66 after exiting the draw unit 60. As an example, the moving support 66 may be a continuous forming wire or belt that is driven by a drive roll 68 and revolves about a guide roll 70.

- 30 The moving support 66 may be constructed as a fine, medium or coarse mesh that has no openings or a plurality of openings. As examples, the moving support 66 may have a configuration that is similar to a standard window screen, or the moving support 66 may be tightly woven to resemble a wire that is commonly used by the paper industry in the formation of paper. A vacuum chamber 72 may

be positioned below the moving support 66 to facilitate accumulation of the strands 14 onto the moving support 66.

5 In some embodiments, the strands 14 accumulate on the moving support 66 in a random orientation such that the accumulation of strands 14 at this point does not include any melt points or bonds that would stabilize the strands 14 into a web. The thickness and basis weight of the strands 14 is established in part by (i) the speed of the moving support 66; (ii) the number and diameter of the strands 14 that are deposited onto the moving support 66; and (iii) the speed at which the
10 strands 14 are being deposited onto the moving support 66.

Depending on the type of processing line 40, the moving support 66 may route the plurality of strands 14 under a hot air knife 76 that directs one or more streams of hot air onto the plurality of strands 14. The hot air needs to be of
15 sufficient temperature to melt some of the strands 14 at points where the strands 14 contact, intersect or overlap other strands 14.

As shown in FIG. 5, the strands 14 adhere to adjacent strands 14 at melt points 78 to form a stabilized web 12. The number of melt points 78 that form the web
20 12 is determined by a number of factors including: (i) the speed of the moving support 66; (ii) the temperature of the hot air; (iii) the types of material that are in the strands 14; and (iv) the degree to which the strands 14 are entangled (among other factors).

25 In some embodiments, the web 12 may be routed through a nip that is formed by a bond roll (not shown) and an anvil roll (not shown) which are heated to an elevated temperature. As an example, the bond roll may contain one or more protuberances that extend outward from the outer circumference of the bond roll. The protuberances may be sized and shaped to create a plurality of bonds in the
30 web 12 as the web 12 passes through the bond roll and the anvil roll. Once the web 12 has bonds formed therein, the web 12 becomes a bonded web 12.

The exact number and location of the bonds in the bonded web 12 is determined by the position and configuration of the protuberances that are on the outer circumference of the bond roll. As an example, at least one bond per square inch may be formed in the bonded web 12, although embodiments are contemplated where the percent bonded area varies. As an example, the percent bonded area may be from about 10% to about 30% of the total area of the web 12.

FIGS. 6 and 7 depict a fastening system 90. The fastening system 90 includes a nonwoven fabric 10 that has a web 12 which is formed of a plurality of extruded strands 14 where at least some of the strands 14 may include an auto-adhesive material. The fastening system 90 includes a foam layer 91 that has a surface 92 (see FIG. 7) which is formed of a plurality of free-stranding struts 93. At least a portion of the surface 92 of the foam layer 91 include a surface modifier (not shown). The free-standing struts 93 are adapted to engage at least a portion of the plurality of strands 14.

It should be noted that the nonwoven fabric 10 may be similar to any of the nonwoven fabrics 10 that are described above. In addition, the foam layer 91 may be similar to any of the foam layers that are described in U.S. patent application serial no. 10/956613 filed, September, 30, 2004 and European Patent 0235949A1, which are incorporated herein by reference. As an example, the foam layer 91 may be an open cell foam.

The surface modifier that is used on the surface 92 of the foam layer 91 may be similar to any of the auto-adhesive materials described above. Further the surface modifier that is used on the surface 92 of the foam layer 91 may be a low-tack adhesive or polymer wax. The types of surface modifier that is selected for the foam layer 91 that makes up the fastening system 90 will be based on processing parameters and the desired physical properties of the fastening system 90 (among other factors).

The surface modifier used on the surface 92 of the foam layer 91 may be applied utilizing numerous methods, for example spray nozzles, glue guns, bead

applicators, extruders, gravure printing, flexographic printing, ink-jet printing, coating, and the like. The surface modifier may be, but need not be, uniformly applied to surface 92 of the foam layer 91, and may be applied selectively in regions. The surface modifier may also be applied in a pattern or in a

5 substantially random distribution.

The surface modifier used on the surface 92 of the foam layer 91 at any add-on as may be required, however to provide beneficial cost, the add-on may be less than 100 gsm, alternatively less than 50 gsm, alternatively less than 30 gsm or

10 alternatively less than 25 gsm. To provide the desired benefit, the surface modifier may be used on the surface 92 of the foam layer 91 at an add-of of greater than 1 gsm, alternatively greater than 5 gsm, alternatively greater than 10 gsm or alternatively greater than 15 gsm.

15 The surface modifier may improve the bonding of the foam layer 91 to the strands 14 of the web 12 as compared to a foam layer 91 which does not have a surface modifier on the surface 92. A strength of a bond between the web 12 and a portion of the foam layer 91 including the surface modifier may be greater than 1.5 times, alternatively greater than 2.5 times or alternatively greater than 2.0

20 times a strength of a bond between the web 12 and a portion of the foam layer 91 not including the surface modifier. The strength of the bond may be measured by the peak shear load, peak peel, or other suitable test method.

The surface modifier may improve the bonding of the foam layer 91 by a number

25 of mechanisms. For example the surface modifier may improve the attachment by stiffening the surface 92 of the foam layer 91 thereby improving the mechanical interlocking between the surface 92 and the nonwoven fabric 10. When the primary mechanism for improvement is improved mechanical interlocking, there may be minimal decrease in peel and shear strength when the

30 surface modifier/ foam layer 91 surface 92 has been contaminated. For example when the foam layer 91 surface 92 is contaminated with water, for example in the "moist" test method as described below,

the "moist" attachment of the foam layer 91 including the surface modifier and the nonwoven fabric 10 may be greater than 90%, alternatively greater than 80% or alternatively greater than 60% of a "dry" attachment of the foam layer 91 including the surface modifier and the nonwoven fabric 10 as tested by the moist
5 shear or moist peel test as described below.

In some embodiments, the surface modifier that is used on the surface 92 of the foam layer 91 may be similar or identical to an auto-adhesive that may be included on some of the plurality of strands 14.

10

In some embodiments, at least some of the plurality of strands 14 may include an auto-adhesive material that may form auto-adhesive loops that engage the auto-adhesive free-standing struts 93 of the foam layer 91. In addition, at least a portion of some of the auto-adhesive free-standing struts 93 may form auto-
15 adhesive hooks such that the auto-adhesive hooks are adapted to engage the auto-adhesive loops on the web 12.

It should be noted that the extent to which the strands 14 form loops and the free-standing struts 93 form hooks will depend in part on how the respective
20 nonwoven fabric 10 and foam layer 91 are fabricated. As an example, the free-standing struts 93 may have diameters of about 500 microns or less.

In some embodiments, the foam layer 91 may be reinforced by attaching a support 94 to the foam layer 91. The support 94 may be attached to the foam
25 layer 91 by any means (e.g., adhesive lamination of the support 94 to the foam layer 91 or formation of the foam layer 91 on the support 94). As an example, the support 94 may be dipped into a liquid that is cured to form the foam layer 91. U.S. Patent No. 6,613,113, issued to Minick et al. on September 2, 2003 describes such a process.

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Adding the support 94 to the foam layer 91 may improve strength and/or flexibility of the foam layer 91. Improving the strength and flexibility of the foam layer 91

may increase the number of applications where the fastening system 90 may be used.

5 In some embodiments, the free-standing struts 93 of the foam layer 91 may be treated to have increased surface roughness which may facilitate attachment of the free-standing struts 93 to the nonwoven fabric 10. As an example, the free-standing struts 93 may be roughened by attaching particles to them (e.g., microspheres, mineral filler, etc.).

10 In other embodiments, the free-standing struts 93 may be etched or otherwise treated (e.g., by chemical attack, laser ablation, electron beam treatment, etc.) to remove portions of the surface material in individual free-standing struts 93. U.S. Patent No. 3,922,455, issued to Brumlik et al. on November 25, 1975 describes some examples of textured elements that may correspond to modified free-
15 standing struts 93.

FIG. 8 illustrates an example disposable absorbent article 95 (shown as a training pant) that may include any of fastening systems 90 described herein. The illustrated example absorbent article 95 is similar to the training pant disclosed in
20 U.S. Patent No. 6,562,167, issued to Coenen et al. on May 13, 2003 (which is incorporated herein by reference).

The example absorbent article 95 is illustrated in a partially fastened mode in FIG. 8. In the illustrated example embodiment, the foam layer 91 of the fastening
25 system 90 is joined to front side panels 96 on the training pant 95 and a portion of the nonwoven fabric 10 is attached to rear panels 97 on the training pant 95. The fastening system 90 secures the training pant 95 about the waist of a wearer by engaging the nonwoven fabric 10 with the foam layer 91.

30 The fastening system 90 of the present invention may be useful in a variety of other applications. As examples, the fastening system 90 may be incorporated into other products such as adult incontinent products, bed pads, other catamenial devices, sanitary napkins, tampons, wipes, bibs, wound dressings,

surgical capes or drapes, soiled garment bags, garbage bags, storage bags and product packaging. The fastening system 90 may be especially well suited to diaper-related applications because surface modifier or the auto-adhesive material in the nonwoven fabric 10 is not readily contaminated with many of the materials that are commonly present in diaper changing environments (e.g., baby lotions, oils and powders).

The fastening system 90 may be secured to diapers (or other products) using thermal bonding and/or adhesives (among other techniques). As an example, one section of the fastening system 90 may be secured to one portion of a diaper such that the section is designed to engage another section of the fastening system 90 on another portion of the diaper.

The fastening system 90 may also be decorative in color and/or shape depending on consumer appeal. There are also embodiments that are contemplated where the fastening system 90 has an unobtrusive product form such that the fastening system 90 does not interfere with the aesthetics of the products where the fastening system 90 is located.

Now specific attention will be given to physical samples which were created to demonstrate the present invention.

Representative Example 1

An SEM photomicrograph was obtained showing a representative reticulated foam engaged with a representative nonwoven fabric, FIG. 9. Specifically, Z65CLY, a fully reticulated foam produced by Foamex International located in Eddystone, PA, having a fully reticulated structure with all membranes between foam cells removed and a thickness of 3mm and density of 65 pores per inch was engaged in an elastic nonwoven fabric as described in U.S. Patent Publication 20040110442 filed August 30, 2002 and U.S. Patent Application 11/017984 filed December 20, 2004.

Examination at low magnification with reflected light and transmitted light microscopy of both the outer surfaces and of a cross-section of the foam material cut in half show that the foam material is a substantially uniform block of semi-rigid foam material with an open cell structure. For example, FIG. 9 was taken at 50X magnification in transmitted light showing a razor-cut cross-sectional surface of the Z65CLY foam which is engaged in an elastic nonwoven fabric. The foam material was cut in half through its center after engagement with the nonwoven fabric. All surfaces of the foam material, inside and outside, appear substantially as shown in FIG. 10, showing a network of interconnected filaments serving as struts in an open-celled foam network that appeared to be substantially uniform throughout. Further, as shown in FIG. 9 the free-standing struts on the surface of the foam can releasably attach to the non-woven by means of catching fibers under the struts, or struts of the foam latching underneath fibers or fiber clusters.

Foam material samples were prepared for SEM analysis by cutting out a cube $\frac{1}{2}$ " on a side with a razor blade. Thinner segments of the foam material were cut from the cube and mounted onto a 1" diameter flat disc holder with double-stick tape. The mounted foam material samples were metallized with gold using a vacuum sputter coater to approximately 250 angstroms thickness. SEM analysis was performed with a JSM-840 electron microscope available from Jeol USA Inc., located in Peabody, Maine, with an accelerating voltage of 5 kV, a beam current of 300 picoAmps, a working distance of 36 to 12 millimeters, and magnification of 30X to 15,000X.

Representative Examples 2A, 2B, 2C, 2D, 2E

The Z65CLY foam was coated with a surface modifier, specifically H9078-01 from Bostic, Inc. located in Wauwatosa. The H9078-01 has an application temperature range from $\sim 250^{\circ}\text{F}$ to $\sim 300^{\circ}\text{F}$. The H9087-01 is tacky at elevated temperatures, but becomes essentially non-tacky as it cools to room temperature. The Z65CLY foam was coated with the H9078-01 with a meltblown adhesive applicator utilizing the following conditions: melt tank temperature 300°F ; die temperature 290°F , air temperature 365°F ; nip pressure 25 pli, air pressure 17

psig; line speed 30 ft/min; forming height 1.75 inches; and open time 0.2 sec. Samples of coated foam were covered with release paper following the coating procedure to prevent roll blocking and protect the coat. Five different samples were produced that different in the add-on levels of the coat.

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Sample 2A – 0 gsm add-on

Sample 2B – 5 gsm add-on

Sample 2C – 10 gsm add-on

Sample 2D – 15 gsm add-on

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Sample 2E – 20 gsm add-on

SEM Photomicrography

FIG. 10 is an SEM photomicrograph at 50X magnification of the surface of sample 2A (0 gsm add-on). FIG. 11 is an SEM photomicrograph at 50X magnification of the surface of sample 2C (10 gsm add-on). FIG. 12 is an SEM photomicrograph at 75X magnification of a razor-cut cross-sectional surface of sample 2C (10 gsm add-on). The SEM images show that the H9078-01 coating appears either as strings or as irregular lumps on the foam cells. The H9078-01 coating is often seen to drape over the strut edges or wrap around the struts. The H9078-01 coating appears to be confined mostly to the surface or near the surface to a depth of about one or two cells. This is most evident in the cross-sectional view, FIG. 11.

It should be noted that the H9078-01 coating does not fill up the open cells or totally cover or block the surface. Therefore the number of free-standing struts capable of engagement remains almost unchanged. Further, there remains a significant amount of open space (foam cell holes) that provide for the breathability of the coated foam material. This distinguishes it favorably from conventional hook material that is generally non-breathable.

Curved Shear Attachment Strength

The curved shear strength of the bonding of Samples 2A, 2B, 2C, 2D and 2E with a model nonwoven fabric were measured to assess how the coating procedure
5 affected the ability of the foam layer to attach to fibrous landing layers. The model nonwoven fabric was an SBL material, specifically the waistband material of Huggies® Convertibles Diapers (SBL) and described in U.S. Patent U.S.
Patent 4,720,415 issued January 19, 1988 to Taylor et al., which is incorporated herein by reference. More specifically the SBL material was created with two 0.4
10 osy polypropylene spundbond facings and a 1.298 osy Kraton G2760 core. Further, the SBL had a 232% unreferenced stretch-to-stop. Results are shown in Table 1.

Curved Shear Attachment Strength Test Method

15 The shear attachment strength of attachment of foam layers to landing layers of the present invention was obtained using a universal testing machine, an MTS Alliance RT/1 testing machine (commercially available from the MTS Systems Corp., located at Eden Prairie, Minnesota) running with TestWorks® 4 software,
20 version 4.04c, with a 100 N load cell. For the test procedure, an upper clamp was used with rubber-lined jaws that are pneumatically loaded for good grasping of test samples. Into the lower mount of the test device was placed a special rig as shown in FIG. 13 which provided a curved surface against which an
overlapping region of a foam layer and landing layer could be subject to tensile
25 force. In FIG. 13, the test rig 600 comprises a cylindrical base 602 adapted for mounting into the lower mount of the universal testing machine (not shown), joined to a an attachment section 604 comprising a horizontal beam 606 and a vertical beam 608 which is bolted into a curved section 610.

30 Further details about the geometry of the curved section 610 are shown in the cross-sectional view of FIG. 14, which shows that the curved section 610 represents a circular arc subtending an angle ϕ of 110 degrees, has a thickness T of 0.5 inches, and a width W of 4.5 inches. The length of the curved section 610,

the distance it extends into the plane of the paper in FIG. 14 (the left-to-right distance spanned by the curved section 610 in FIG. 13) is 8 inches. The curved section 610 made of rigid nylitron and has a smooth surface finish (a shape turned finish) of 32 microinches in roughness (a "32 finish") as measured with a
5 Microfinish Comparator (Gar Electroforming, Danbury, Connecticut).

As shown in FIG. 13 and also in a side view in FIG. 15, the curved section 610 is used to hold a length of a two-inch wide foam layer strip 614 and a length of a three-inch wide landing layer strip 616 that overlap and are joined in an
10 attachment zone 618 while the remote ends of the foam layer strip 614 and the landing layer strip 616 are also held in an upper clamp 620 connected to the movable head (not shown) of the universal testing machine (not shown). The joining of the foam layer and landing layer strips 614 and 616, respectively, in the attachment zone 618 is carried out by superposing the laterally centered, aligned
15 foam layer and landing layer strips 614 and 616, respectively, to form an overlap region 612 that was 1 inch long and then applying a load to ensure good contact. Unless otherwise specified, the load was provided by a brass laboratory roller having a mass of 7.0 kilograms, which was slowly rolled over the attachment zone 618 twice (forward and then back). After attaching the foam layer and
20 landing layer strips 614 and 616, respectively, the attachment zone 618 is then centered on the lower portion of the curved section 610 and the ends of the foam layer and landing layer strips 614 and 616, respectively, remote from the attachment zone 618 are then placed in the jaw of the upper clamp 620. The lower surface of the upper clamp 620 is 3 inches above the upper surface of the
25 curved section 610 before the test procedure begins. There is negligible tension yet no significant slack in the foam layer and landing layer strips 614 and 616, respectively, before the test procedure begins.

A measure of the strength of the attachment in the overlap region 612 may be
30 obtained by running the universal test machine as if a tensile test were being carried out and measuring the peak load at failure. The test procedure is executed by moving the upper mount upwards at a crosshead speed of 10 inches per minute until there is failure, which may be failure of the attachment zone 618

or, in some cases, breaking of one of the foam layer and landing layer strips 614 and 616, respectively, elsewhere. The peak load before failure is the attachment strength.

5 Table 1 Curved Shear Attachment Strength

Sample	Peak Load, gf			n*	Energy to peak, g*cm		
	Avg.	S. Dev.	%COV		Avg.	S.Dev.	%COV
2A – SBL	470	87	18	5	839	281	33
2B – SBL	1654	179	11	5	11381	3224	28
2C – SBL	1554	412	27	10	11797	2664	23
2D – SBL	1939	200	10	5	10584	3043	29
2E – SBL	2036	213	10	5	19557	4875	25

n* - number of specimen tested per sample

The testing indicates that the coating resulted in a significant increase in the attachment strength as measured by the peak shear load: 3.5 to 4 times
 10 depending on the basis weight of the coating. Further, the attachment strength generally increased with an increase in the basis weight of the coating.

Further curved shear attachment strength testing was conducted on two additional nonwoven fabrics. Again the first nonwoven fabric was the SBL
 15 material which forms the back waist band on Huggies® Convertibles diapers (SBL). The second nonwoven fabric was the SBL material with fibers modified through a picking/combing process to have more loft (Modified-SBL). Specifically, the original SBL was subjected to a mechanical modification process that increased the availability for engagement of the fibers in the engaging
 20 surface with reticulated foams. The engaging surface of SBL was mechanically modified with a 15 lb. hand roller that had a sheet of Velcro® 85-1065 (commercially available from Velcro USA Inc. of Manchester, NH) hook material wrapped around the outer surface, such that the hooks of the hook material extended away from the roll. The engaging surface of each fibrous non-woven
 25 web was treated with this hook-wrapped roller by rolling the wrapped roller over

the engaging surface two times back and forth in one direction and two times back and forth in a direction 90 degrees to the first direction.

The third nonwoven fabric was an elastic nonwoven fabric as described in U.S.

- 5 Patent Publication 2005/0101206 filed August 13, 2004 and U.S. Patent Application 11/017984 filed December 20, 2004 (elastic nonwoven). Specifically the elastic nonwoven material has a facing that is 0.8 osy bicomponent sheath/core spunbond comprised of an 80wt% core of Dow EG8185 metallocene polyethylene and 20% sheath of Dow Aspun 6811A polyethylene. The elastic
- 10 nonwoven has a breathable elastic film that is described in Example 5 (page 15, paragraphs 149 and 150 of US 2005/0101206). The elastic nonwoven is adhesively laminated to a film with Bostic H9375 adhesive. (adhesive is disclosed in example 7, page 16, of US 2005/0101206).
- 15 Each of the three nonwoven fabrics (SBL, modified SBL and elastic nonwoven) were bonded with 2A (0 gsm add-on) and 2C (10 gsm add-on) and tested according to the test set forth above. The results are set for the in Table 2.

Table 2 Curved Shear Attachment Strength

Sample	Peak Load, gf			n*	Energy to peak, g*cm		
	Avg.	S. Dev.	%COV		Avg.	S.Dev.	%COV
2A – SBL	470	87	18	5	839	281	33
2C – SBL	1554	412	27	10	11797	2664	23
2A – Modified SBL	1223	185	15	3	5181	1589	31
2C – Modified SBL	2626	804	31	4	32212	13052	41
2A – Elastic nonwoven	939	95	10	4	2436	631	26
2C – Elastic nonwoven	2571	454	18	4	22312	7946	36

20 n* - number of specimen tested per sample

Refastenability

- Testing was further conducted to determine the refastenability of the coated
- 25 Z65CLY foam. Refastenability is required for many disposable garment

application in order to provide more comfort and better fit of the product to the wearer. Refastenability of the coated foam (Sample 2C -10 gsm add-on) and two different nonwoven fabrics (modified SBL and elastic nonwoven) was tested with the results presented in Tables 3 and 4. Two samples were tested per code (x_1 , x_2). After the first attachment was measured, the testing apparatus was reset. Then the test material rejoined as described above and the second attachment was measured. This was repeated for the third, fourth and fifth attachment.

Table 3 Refastenability of Attachment for 2C and Modified SBL
Curved Attachment Strength

Sample	Peak Load, gf					Energy to peak, g*cm				
	x_1	x_2	Avg.	S. Dev.	%COV	x_1	x_2	Avg.	S.Dev.	%COV
1 st attachment	2588	1992	2290	421.8	18.4	28569	17985	23277	7484.0	32.2
2 nd attachment	3414	2260	2837	816.5	28.8	35774	20797	28286	10590.7	37.4
3 rd attachment	3027	2112	2569	646.5	25.2	27390	16214	21802	7902.3	36.2
4 th attachment	2614	2011	2312	426.5	18.4	22135	14595	18365	5331.6	29.0
5 th attachment	2003	1776	1890	160.2	8.5	14631	12030	13330	1838.8	13.8

Table 4 Refastenability of Attachment for 2C and Elastic nonwoven
Curved Attachment Strength

Sample	Peak Load, gf					Energy to peak, g*cm				
	x_1	x_2	Avg.	S.Dev.	%COV	x_1	x_2	Avg.	S.Dev.	%COV
1 st attachment	2872	2956	2914	59.0	2.0	28203	29291	28747	769.3	2.7
2 nd attachment	3419	3417	3418	1.8	0.1	32390	30166	31278	1572.6	5.0
3 rd attachment	3201	3328	3265	89.6	2.7	24488	24874	24681	273.2	1.1
4 th attachment	2402	2837	2620	307.7	11.7	16124	23203	19663	5005.8	25.5
5 th attachment	On the 5 th attachment for both x_1 and x_2 , the elastic nonwoven broke before the bond broke.									

The results of the testing indicates good refastenability with both nonwoven fabrics (modified SBL, elastic nonwoven). Attachment strength for the 2nd

attachment was greater than the first attachment strength for both nonwoven fabrics. The 3rd, 4th and 5th attachments resulted in a slight decline in peak load values.

5 Evaluation of Dry versus Moist Modified Foam

As shown in the previous example, using a surface modified foam layer results in a doubling of the strength of the foam attachment to a number of nonwoven fabrics. While not to be bound by theory, it is believed that two potential
10 mechanisms for this improvement may exist. First, the surface modifier may stiffen the surface of the foam and free-standing struts, and potentially increase the coefficient of friction of the surface of the foam, and therefore increase the shear strength of the foam layer/nonwoven fabric bond. The second potential
15 mechanism may be that the surface modifier may act similar to a pressure-sensitive adhesive, providing a direct adhesive bond to the fibers of the nonwoven fabric.

Even though the surface of the coated foam was not tacky, an experiment was conducted to evaluate the mechanism of shear strength improvement. The
20 experiment consisted of slightly moistening the surface of the coated foam layer and then measuring the attachment strength of the moist coated foam layer. The attachment strength of the moist coated foam layer was compared to the attachment strength of dry coated foam layer. Moisture in this experiment is
25 thought to act as an inhibitor of adhesive interactions, so that if the adhesive mechanism was the cause of the attachment strength increase, the increase should have been reversed and reverted to the value seen in the uncoated foam.

Moist Shear / Peel Strength Test Method

30 In the moist versus dry experiment, samples of the Z65CLY foam coated with 10 gsm add-of of H9076 (Sample 2C) were submerged in water, the excess water was removed by blotting with paper towels until the samples were slightly moist. Curved Shear strength testing was conducted utilizing the test method as

described above with two nonwoven fabrics (SBL, Modified SBL). Results are shown in Table 5.

Table 5 Curved Shear Attachment Strength – Moist versus Dry

Sample	Peak Load, gf			n*	Energy to peak, g*cm		
	Avg.	S. Dev.	%COV		Avg.	S.Dev.	%COV
2A – SBL - Dry	310	40	13	5			
2C – SBL - Dry	1677	124	7	4	11797	2664	23
2C – SBL - Moist	1687	186	11	4	10584	3043	29
2A – Modified SBL - Dry	1233	185	14	4			
2C – Modified SBL - Dry	2531	559	22	4	32737	11790	36
2C – Modified SBL – Moist	2266	261	12	5	24335	3081	13

5 n* - number of specimen tested per sample

In addition peel testing was performed on the materials as well. The results are shown in Table 6 with the test method following.

10 Table 6 Peel Attachment Strength – Moist versus Dry

Sample	Peak Load, gf			n*	Average Load, gf		
	Avg.	S. Dev.	%COV		Avg.	S.Dev.	%COV
2A – SBL - Dry	0						
2C – SBL - Dry	53	12	22	3	43	18	42
2C – SBL - Moist	66	12	18	4	19	7	34
2A – Modified SBL - Dry	0						
2C – Modified SBL - Dry	92	11	12	4	45	3	7
2C – Modified SBL – Moist	71	19	27	2	38	16	43

n* - number of specimen tested per sample

The shear testing results show a slight directional decrease for the moist foam layer over the dry foam layer for Modified SBL. On the other hand, the moist foam layer showed a slight directional increase for the moist foam layer over the dry foam layer for SBL.

Peel Strength Test Method

Peel tests were conducted with the universal test machine (not shown) using the 180° peel configuration shown in FIG. 16, where the foam layer and nonwoven fabric 614 and 616, respectively, are joined in an attachment zone 618 configured to be peeled apart as the remote ends of the strips 614 and 616, respectively, are moved away from each other as they are held in the jaws of an upper clamp 620 and a lower clamp 621 as shown. Using the universal testing machine (not shown) as described in the curved shear attachment test method, the force required to peel apart the attached foam layer and nonwoven fabric 614 and 616, respectively, may be measured. The crosshead speed for the peel testing was 20 inches per minute. The attachment zone 618 had a length (overlap distance) of two inches, and a width of 3 inches (6 square inches total overlap area 612). The gauge length (distance between the upper and lower clamps 620 and 621, respectively) for the test set up was 1.5 inches. The Testworks software used could not generate statistical results for peel values less than 10 grams of force. In all cases peel values for uncoated foam was 0.

The peel testing results show that the average peel loads had a directional tendency to be lower in case of moist foam samples. The difference between moist and dry samples were not statistically significant. In case of peak peel loads, a mixed tendency was observed, peel decreased for moist foams on Modified SBL, while increasing on SBL.

The results of the shear testing and peel testing indicate no statistical difference in attachment due to moisture. Hence, it is believed the improvement in attachment of the surface modified foam layer to nonwoven fabrics is due primarily to mechanical interlocking and stiffening of the foam surface. Adhesive interactions may play a secondary, albeit less significant, role in the attachment mechanism.

While the invention has been described in detail with respect to specific embodiments, it will be appreciated that there are variations of, and equivalents

to these embodiments. Accordingly, the scope of the present invention should be determined by the appended claims and any equivalents thereto.

What is claimed is:

1. A fastening system comprising:
a nonwoven fabric that includes a web which is formed of a plurality of extruded strands; and
5 a foam layer that includes a surface having a plurality of free-standing struts which are adapted to engage at least a portion of the plurality of strands, at least some of the free-standing struts including a surface modifier.
2. The fastening system of claim 1, wherein the plurality of free-standing
10 struts have diameters of about 500 microns or less.
3. The fastening system of claim 1, wherein the foam layer is an open-cell foam material.
- 15 4. The fastening system of claim 1, wherein at least some of the strands in the nonwoven fabric include an auto-adhesive material.
5. The fastening system of claim 4, wherein the surface modifier is an auto-adhesive material that is similar to the auto-adhesive material in the
20 nonwoven fabric.
6. The fastening system of claim 5, wherein at least some of the plurality of strands that include the auto-adhesive material form auto-adhesive loops that engage the auto-adhesive free-standing struts.
25
7. The fastening system of claim 6, wherein at least some of the auto-adhesive free-standing struts form auto-adhesive hooks such that each auto-adhesive hook is adapted to engage one of the auto-adhesive loops on the web.
- 30 8. The fastening system of claim 6, wherein the extruded strands in the web are formed by meltblowing.

9. The fastening system of claim 1, wherein the surface modifier includes a polyethylene polymer.

10. The fastening system of claim 9, wherein the surface modifier includes
5 a mixture of the polyethylene polymer and a blend of copolymers.

11. The fastening system of claim 1, wherein a strength of a bond
between the nonwoven fabric and a portion of the foam layer including the
surface modifier is greater than 1.5 times a strength of a bond between the
10 nonwoven fabric and a portion of the foam layer not including the surface
modifier.

12. The fastening system of claim 1, wherein the surface modifier is a low-
tack adhesive, a cohesive or a polymer wax.

15

13. The fastening system of claim 1, wherein the foam layer comprises a
foam material selected from the group consisting essentially of: melamines;
polyadehydes; polyurethanes; polyisocyanurites; polyolefins; polyvinylchloride;
epoxy foams; ureaformaldehyde; latex foam; silicone foam; fluoropolymer foams;
20 polystyrene foams; and, mixtures thereof.

14. The fastening system of claim 1, wherein a moist attachment of the
foam layer including the surface modifier and the nonwoven fabric is greater than
60% of a dry attachment of the foam layer including the surface modifier and the
25 nonwoven fabric.

15. An absorbent article including a fastening system for securing the
absorbent article about the waist of a wearer, the fastening system comprising:

a nonwoven fabric that includes a web which is formed of a plurality of
30 extruded strands; and

a foam layer that includes a surface having a plurality of free-standing
struts which are adapted to engage at least a portion of the plurality of strands, at
least some of the free-standing struts including a surface modifier.

16. The absorbent article of claim 15, wherein the absorbent article is an adult incontinent product, a training pant or a diaper.

5 17. The absorbent article of claim 15, wherein the nonwoven fabric bonds to a portion of the foam layer including the surface modifier with a strength that is greater than 1.5 times a strength which is generated when the nonwoven fabric bonds to a portion of the foam layer not including the surface modifier.

10 18. The absorbent article of claim 15, wherein the surface modifier is a low-tack adhesive, a cohesive or a polymer wax.

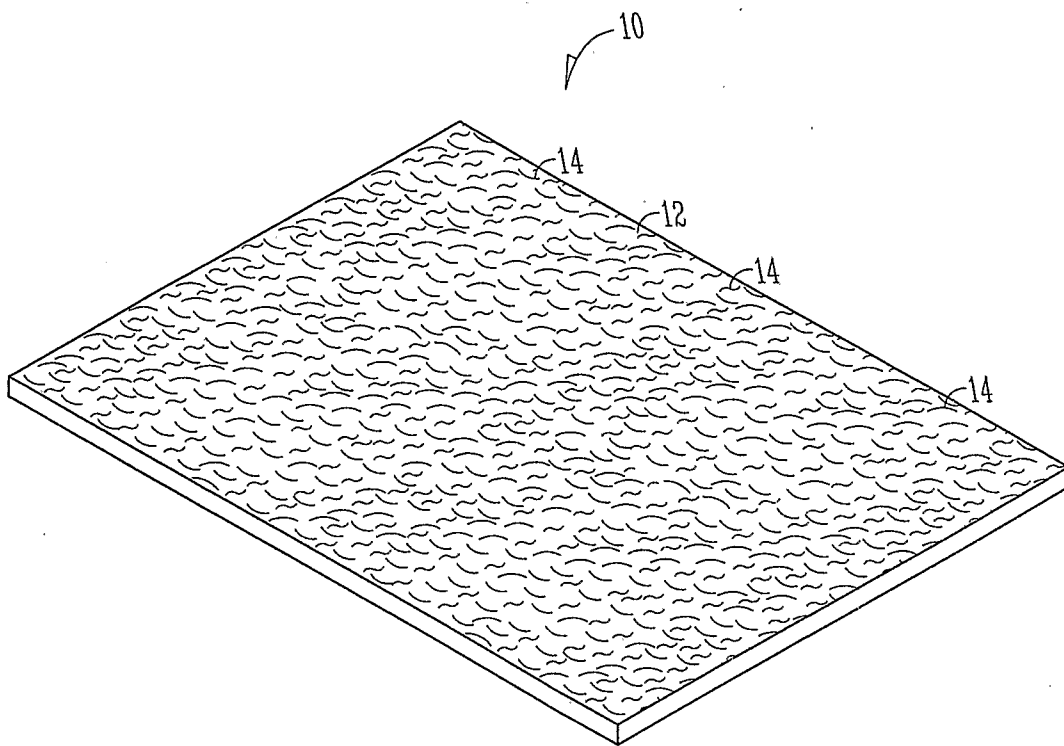
 19. The absorbent article of claim 15, wherein a moist attachment of the foam layer including the surface modifier and the nonwoven fabric is greater than
15 60% of a dry attachment of the foam layer including the surface modifier and the nonwoven fabric.

 20. An absorbent article including a fastening system for securing the absorbent article about the waist of a wearer, the fastening system comprising:

20 a nonwoven fabric that includes a web which is formed of a plurality of extruded strands; and

 a foam layer that includes a surface having a plurality of free-stranding struts which are adapted to engage at least a portion of the plurality of strands, at least some of the free-stranding struts including a surface modifier;

25 wherein the surface modifier is a cohesive or a polymer wax and a strength of a bond between the nonwoven fabric and a portion of the foam layer including the surface modifier is greater than 1.5 times a strength of a bond between the nonwoven fabric and a portion of the foam layer not including the surface modifier.

*FIG. 1*

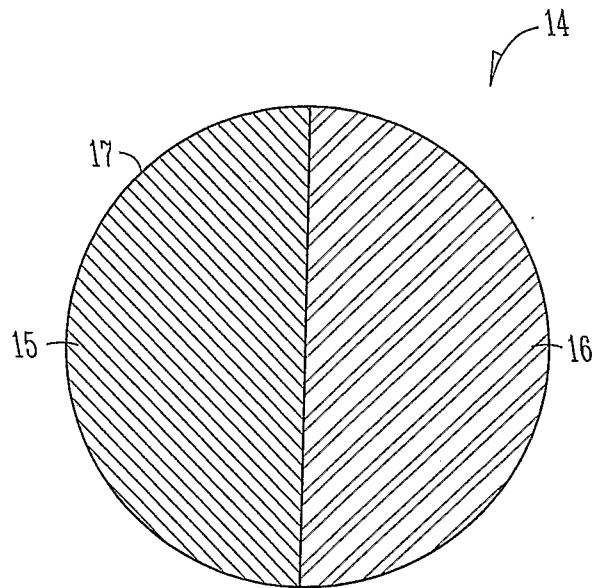


FIG. 2A

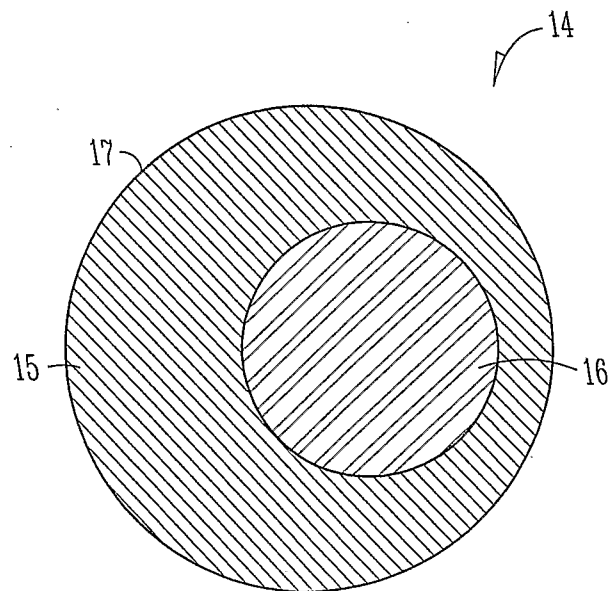


FIG. 2B

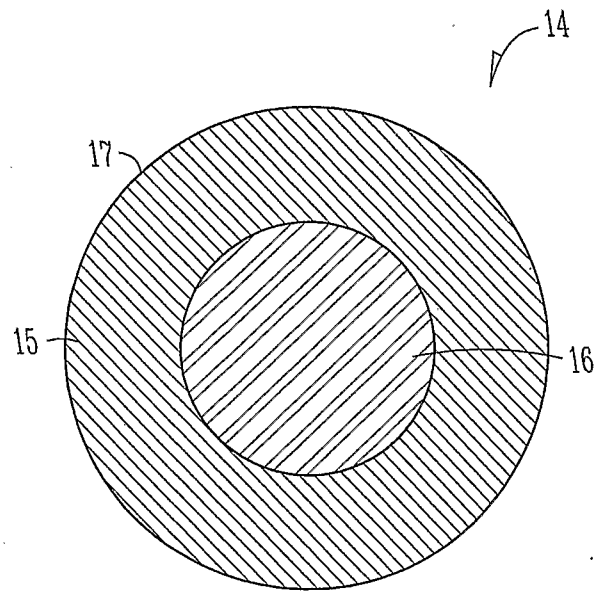


FIG. 2C

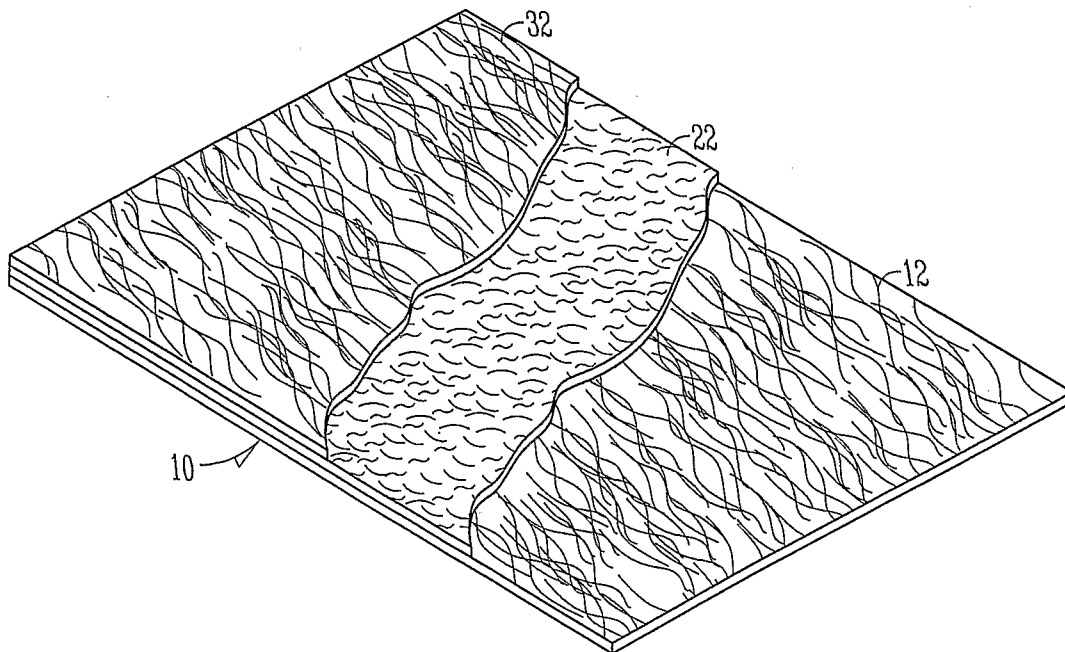


FIG. 3

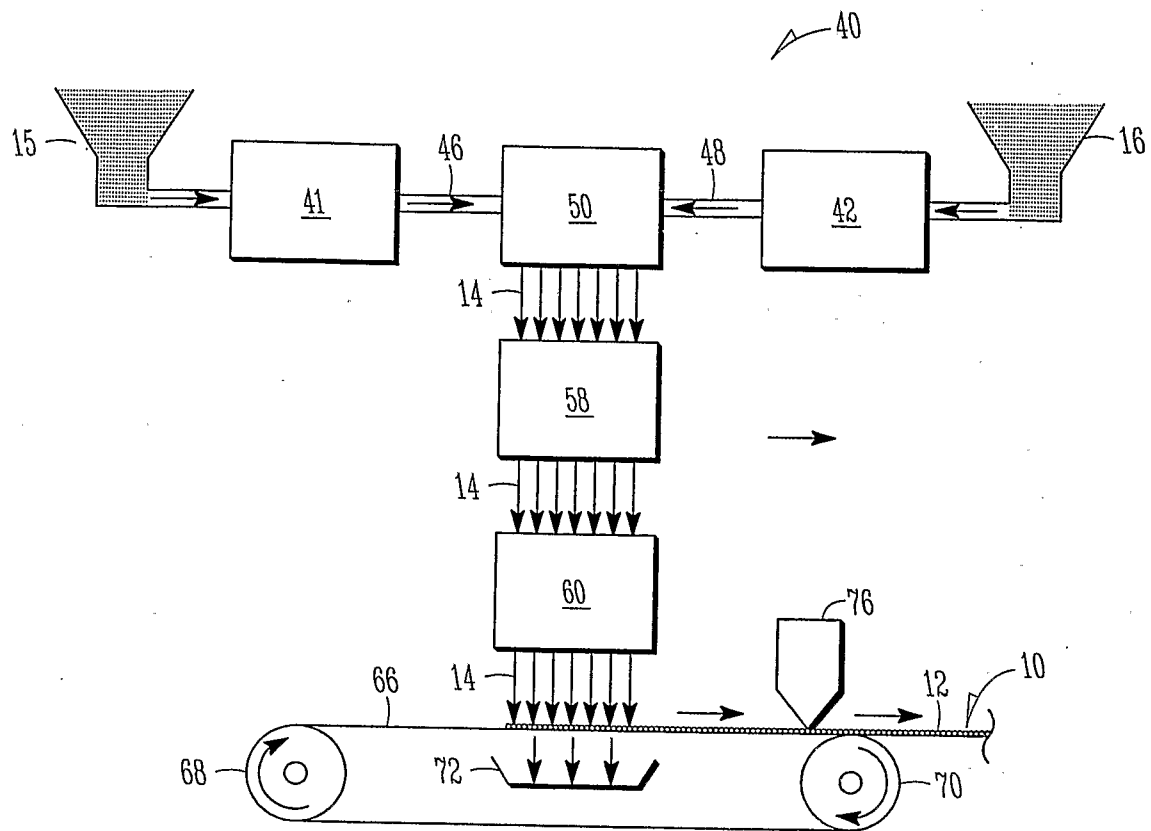


FIG. 4

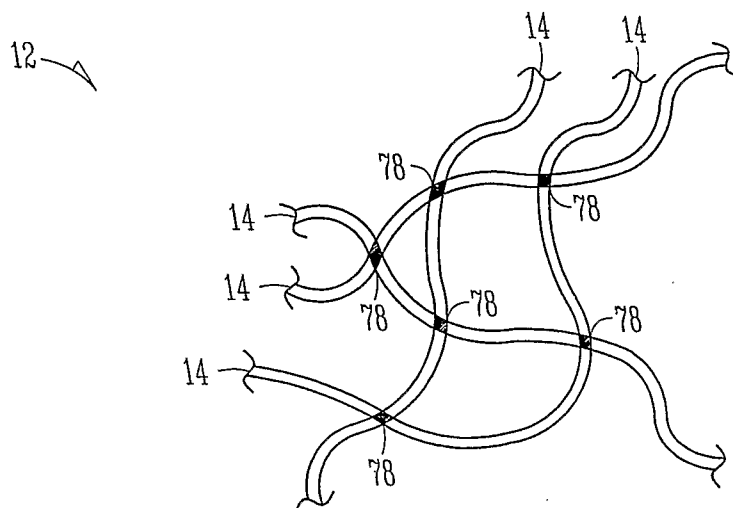
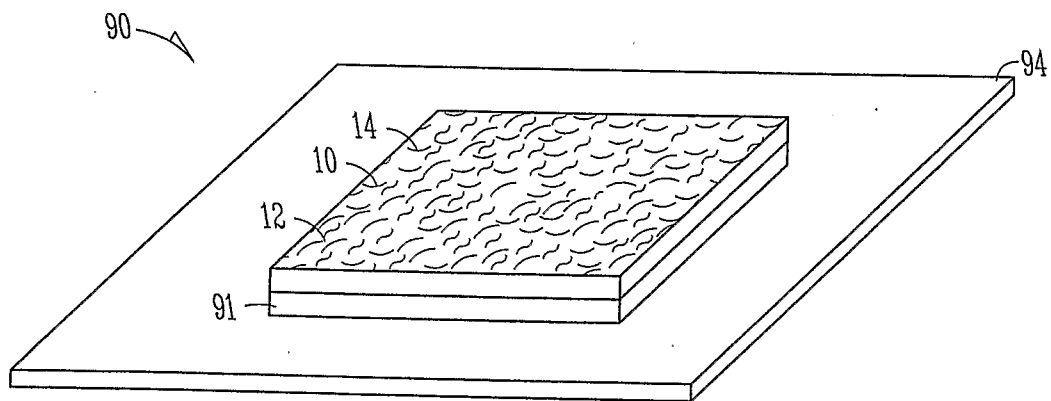


FIG. 5

*FIG. 6*

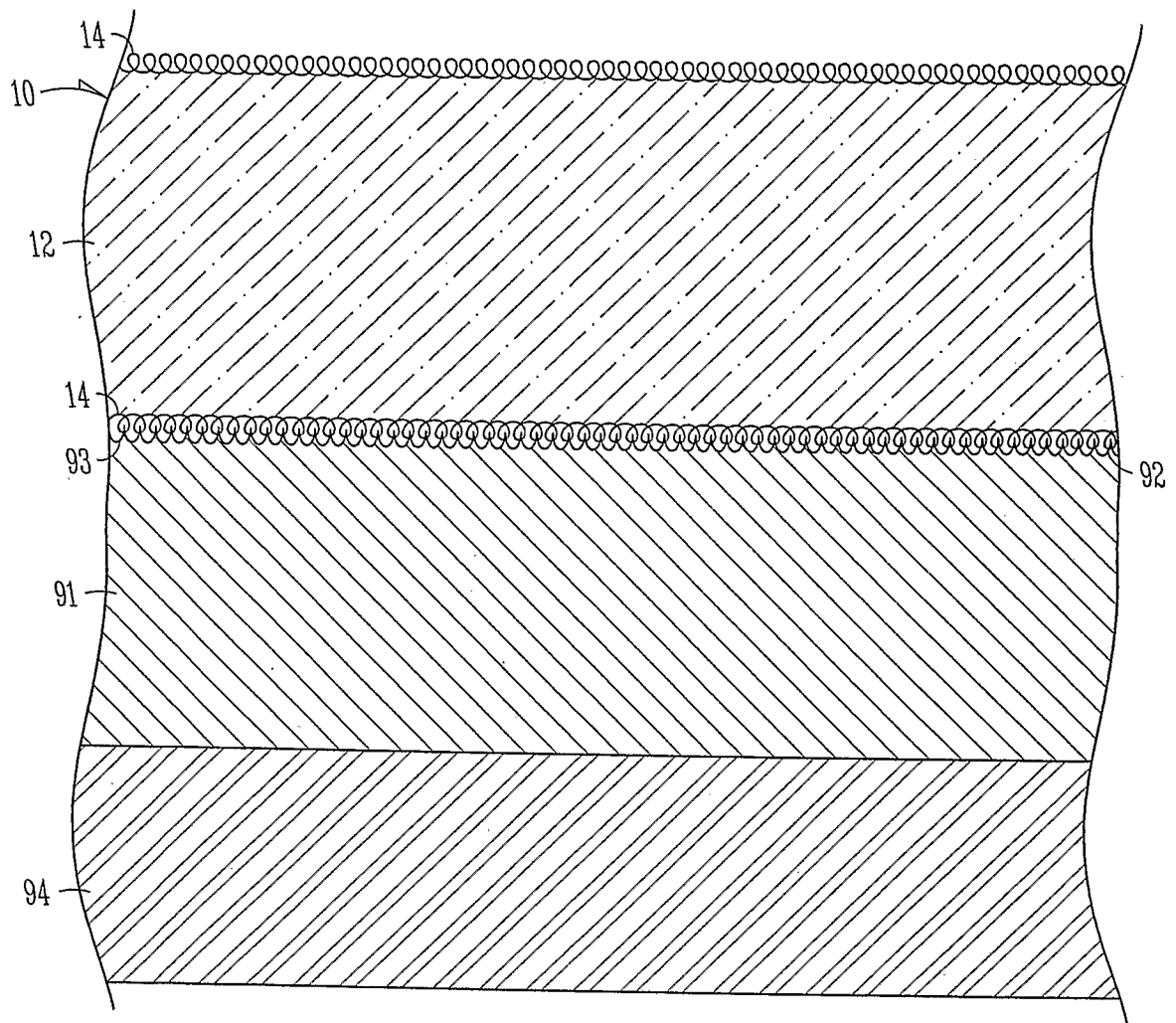


FIG. 7

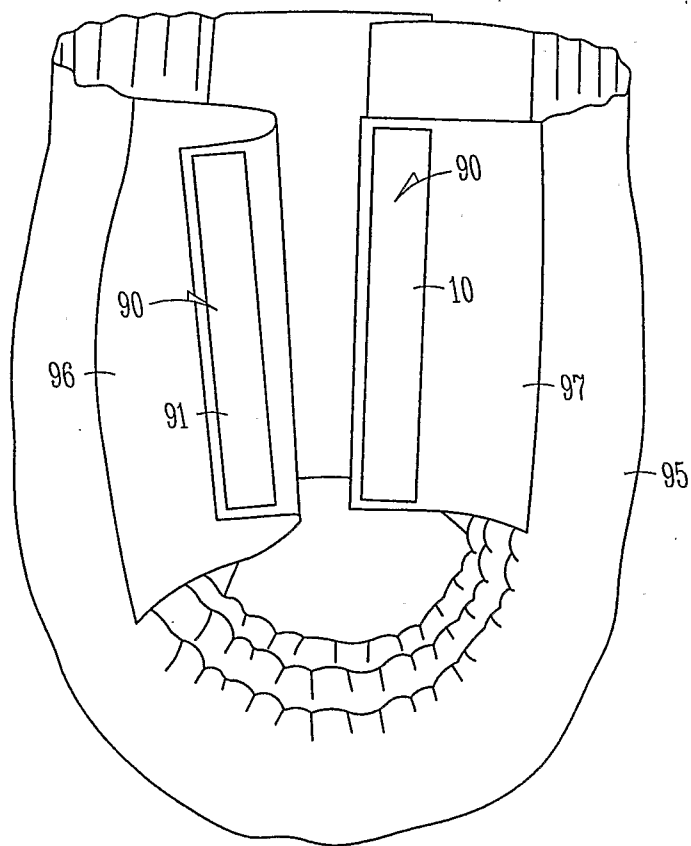


FIG. 8

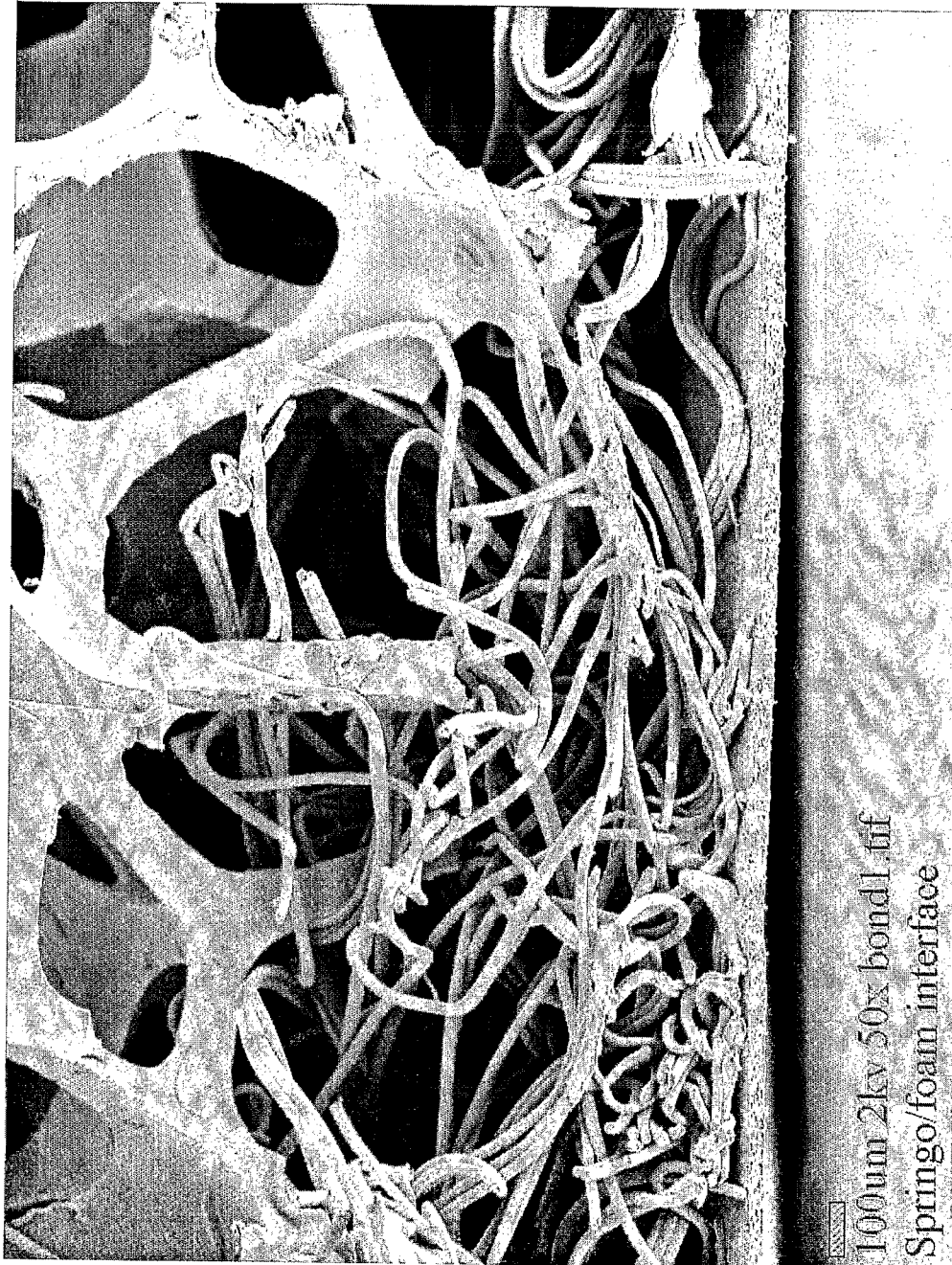


FIG. 9

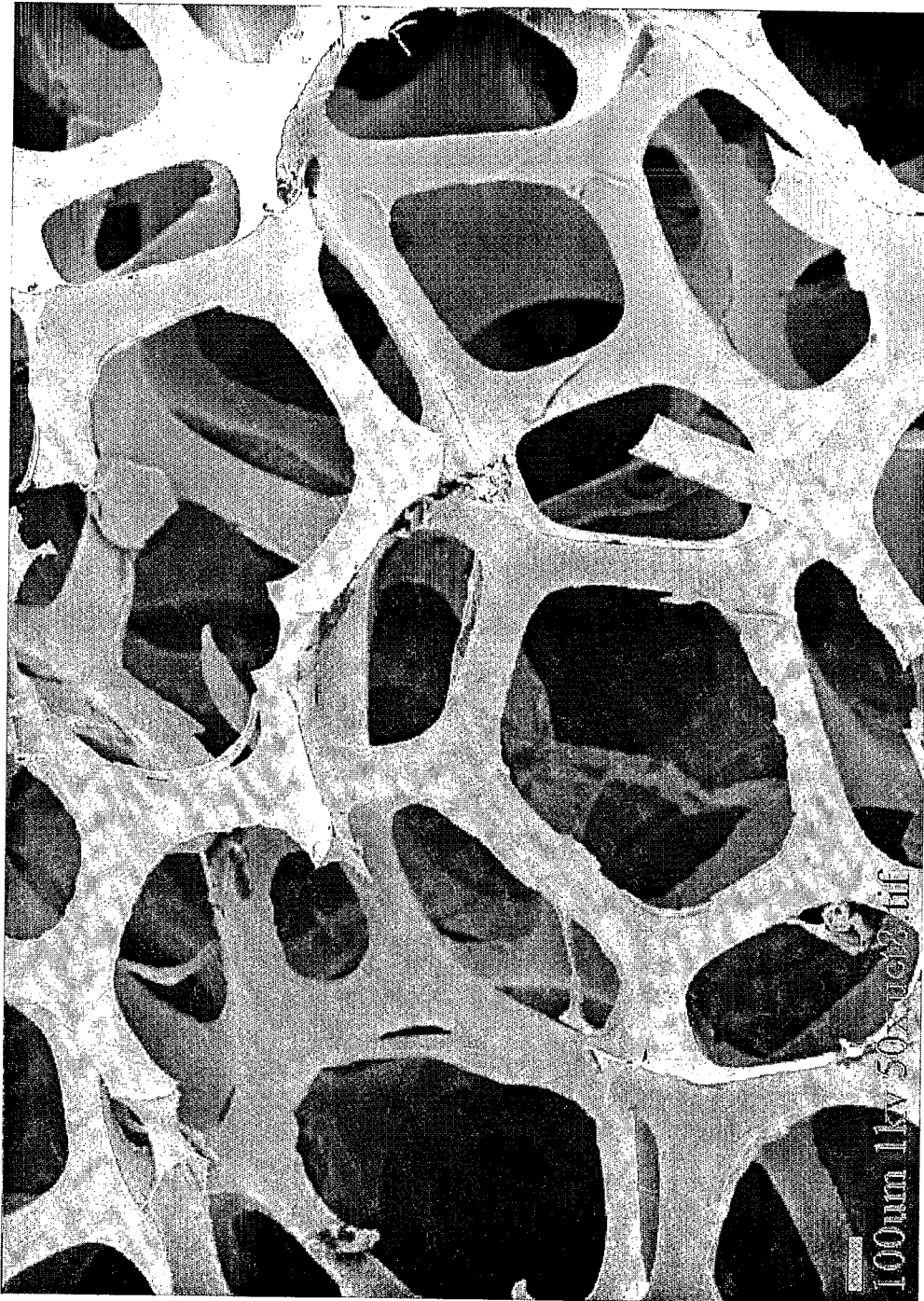


FIG. 10

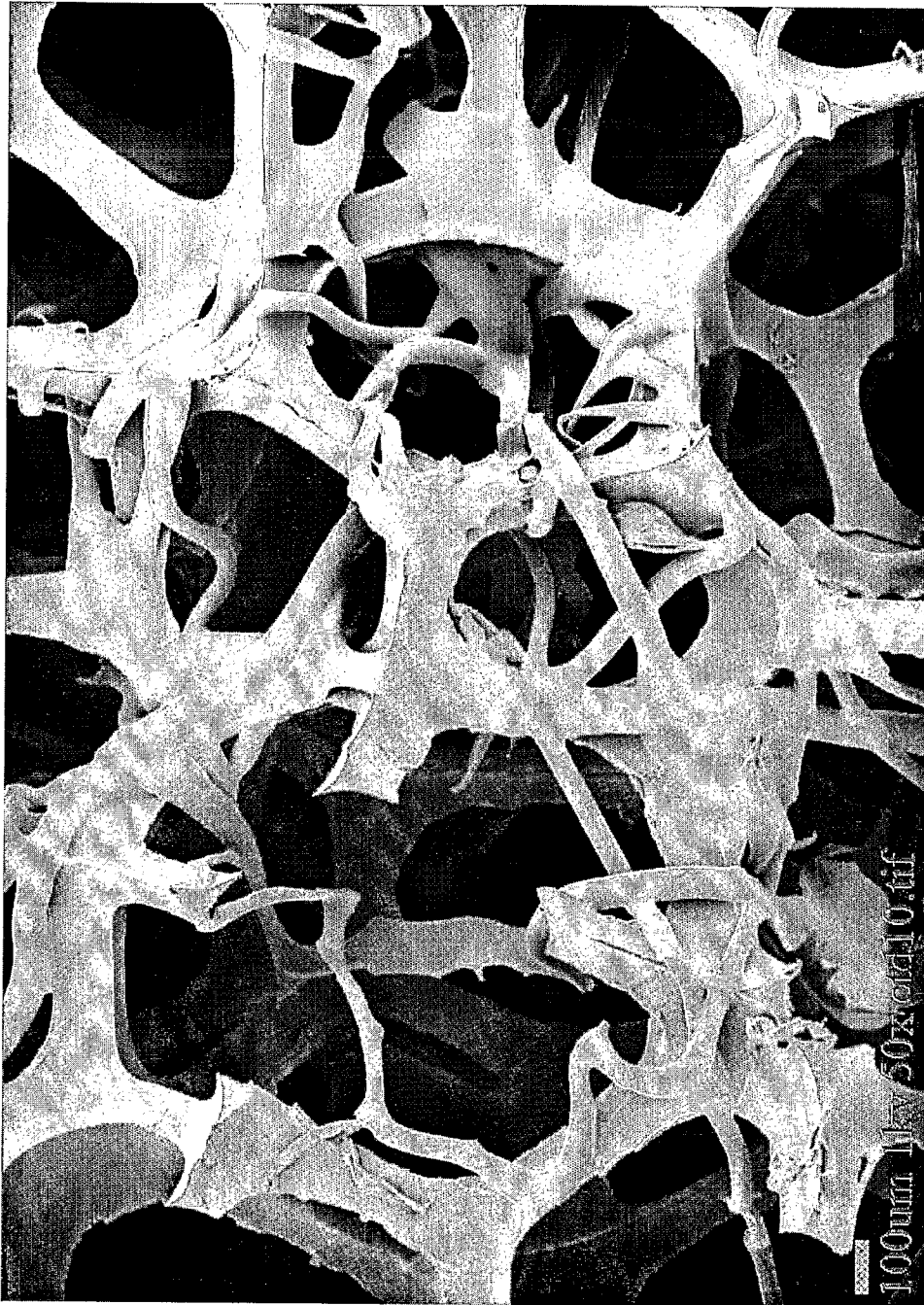


FIG. 11

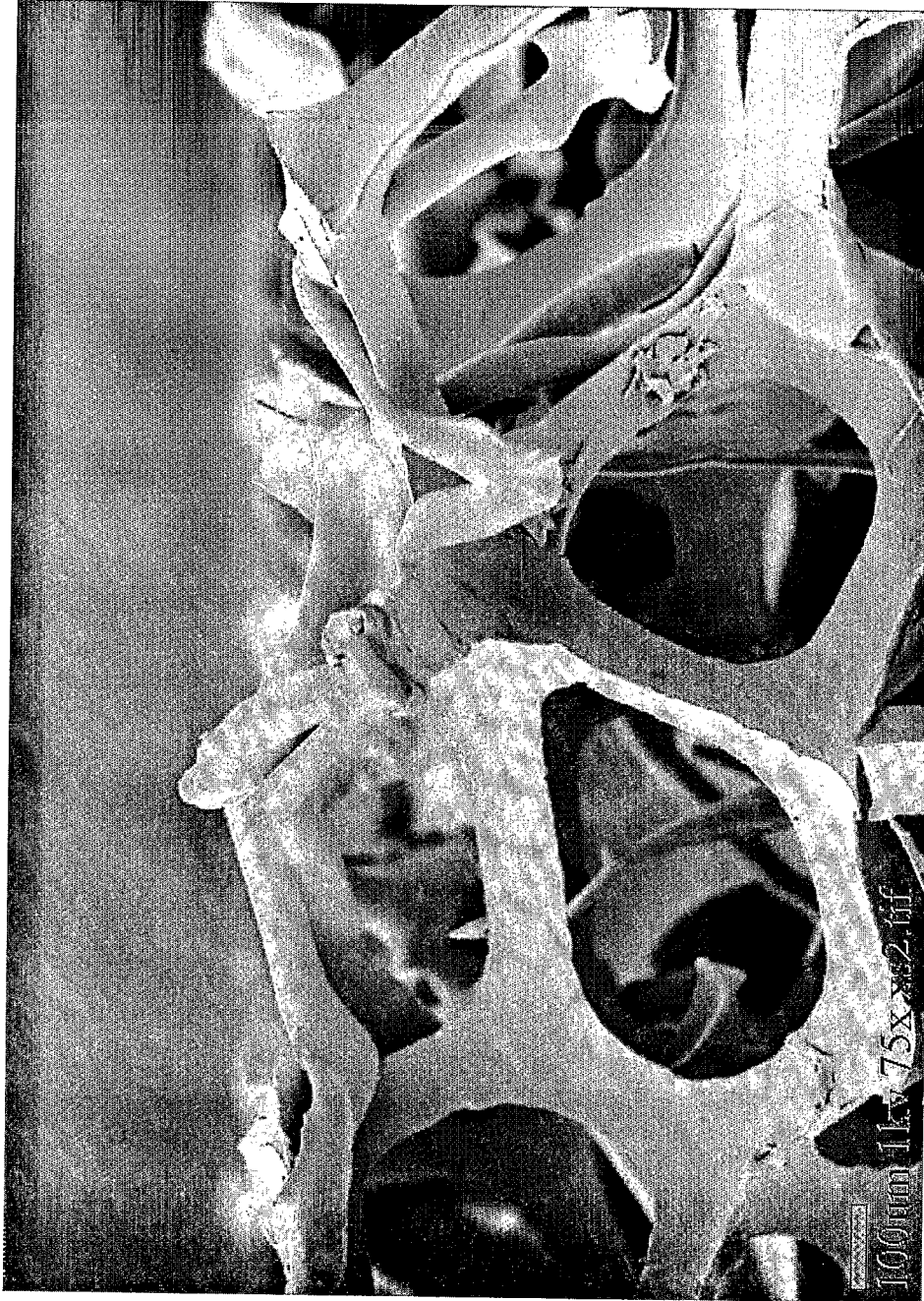


FIG. 12

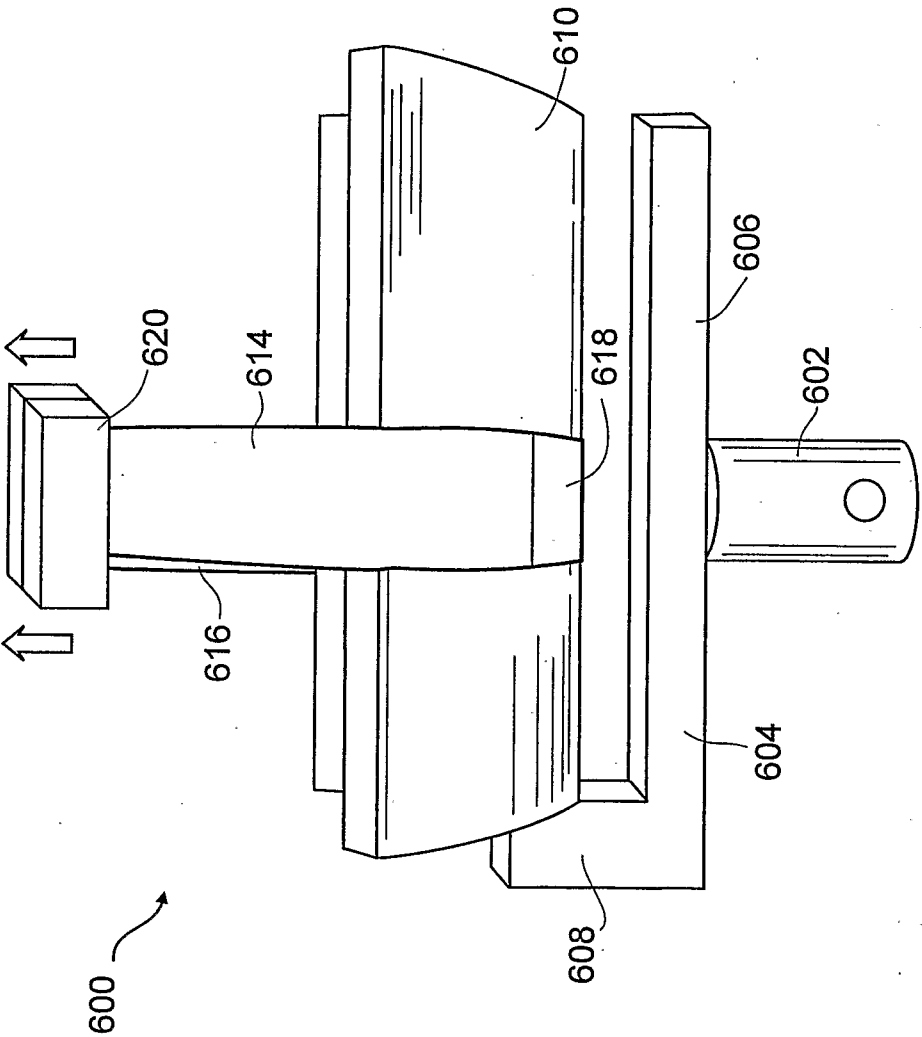


FIG. 13

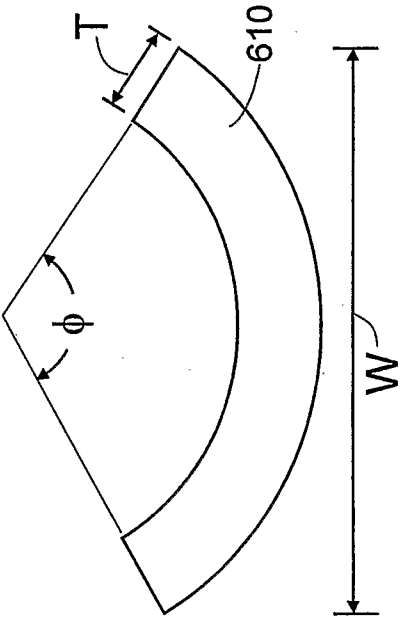


FIG. 14

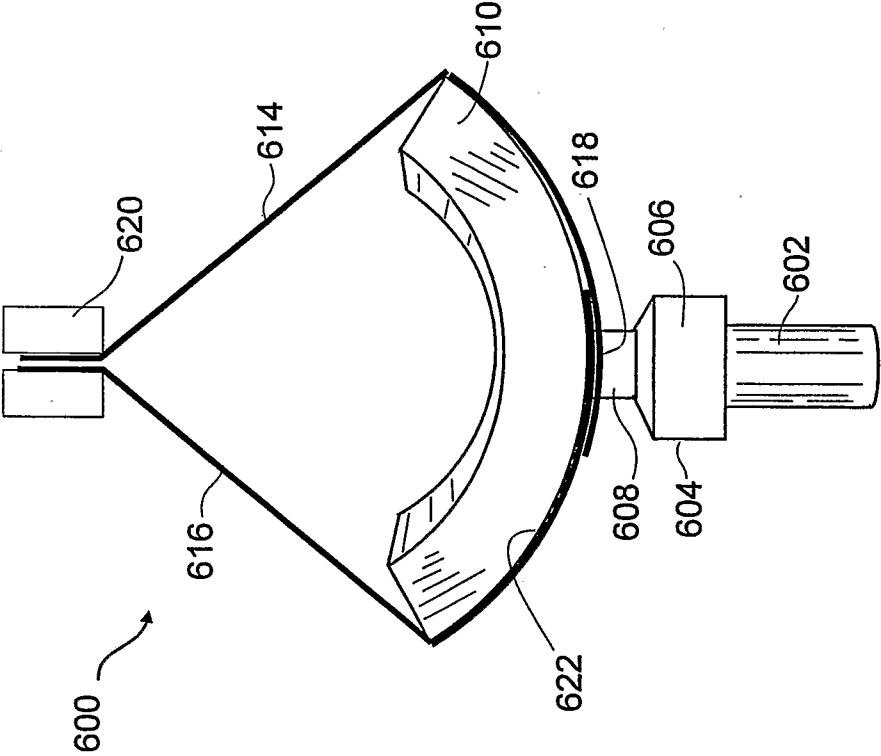


FIG. 15

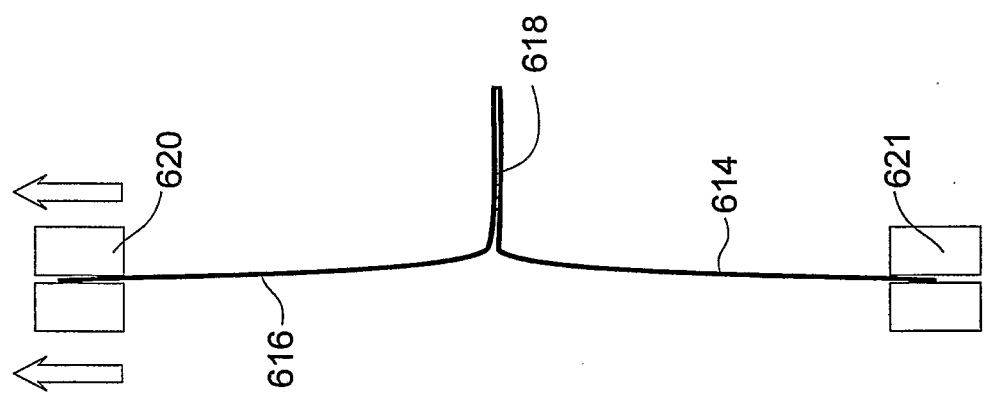


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/038958

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61F13/58 A61F13/56 D04H3/00 D04H1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61F D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/044560 A (BOSTIK, INC; CARPER, JAMES, D; ALPER, MARK, D; SAJOT, NICOLAS, EDGARD) 19 May 2005 (2005-05-19) paragraphs [0018], [0020], [0051], [0055], [0059] -----	1-20
Y	WO 96/25905 A (PROCTER & GAMBLE [US]) 29 August 1996 (1996-08-29) page 5, line 18 - page 7, line 9 -----	1, 15, 20
Y	US 2004/258902 A1 (SETH JAYSHREE [US] ET AL) 23 December 2004 (2004-12-23) paragraphs [0020], [0041], [0049], [0053], [0060] -----	1, 15, 20
A	WO 03/003962 A (KIMBERLY CLARK CO [US]) 16 January 2003 (2003-01-16) page 4, line 19 - page 6, line 20 ----- -/-	1-20

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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O document referring to an oral disclosure, use, exhibition or other means

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X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Z document member of the same patent family

Date of the actual completion of the international search

4 October 2006

Date of mailing of the international search report

22/02/2007

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Authorized officer

Lanniel, Geneviève

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/038958

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 4 216 257 A (BROWN JAMES N [US] ET AL) 5 August 1980 (1980-08-05) column 1, line 53 - column 2, line 33 -----</p>	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2006/038958

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			BR PI0416137 A	02-01-2007
			CA 2544644 A1	19-05-2005
			EP 1682349 A1	26-07-2006
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