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Carter et al.(10) **Pub. No.: US 2006/0191115 A1**(43) **Pub. Date: Aug. 31, 2006**(54) **METHOD OF MAKING A FILAMENTARY LAMINATE AND THE PRODUCTS THEREOF****Related U.S. Application Data**

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(75) Inventors: **Nick M. Carter**, Hutchinson, KS (US);
Sergio Diaz deLeon, Huntersville, NC (US); **Ralph A. Moody III**,
 Mooresville, NC (US)**Publication Classification**(51) **Int. Cl.****D04H 5/02** (2006.01)**D04H 1/46** (2006.01)(52) **U.S. Cl.** **28/104**; 442/408; 28/103

Correspondence Address:

WOOD, PHILLIPS, KATZ, CLARK & MORTIMER
500 W. MADISON STREET
SUITE 3800
CHICAGO, IL 60661 (US)(57) **ABSTRACT**

The present invention is directed to a nonwoven composite fabric comprising one or more layers of discontinuous filaments or nano-fiber filaments positioned between at least one continuous filament web and one cellulosic fiber web that are subsequently hydroentangled, wherein the discontinuous filaments or nano-fiber filaments provide a barrier to prevent the loss of the cellulosic fibrous material through the highly porous continuous filament web.

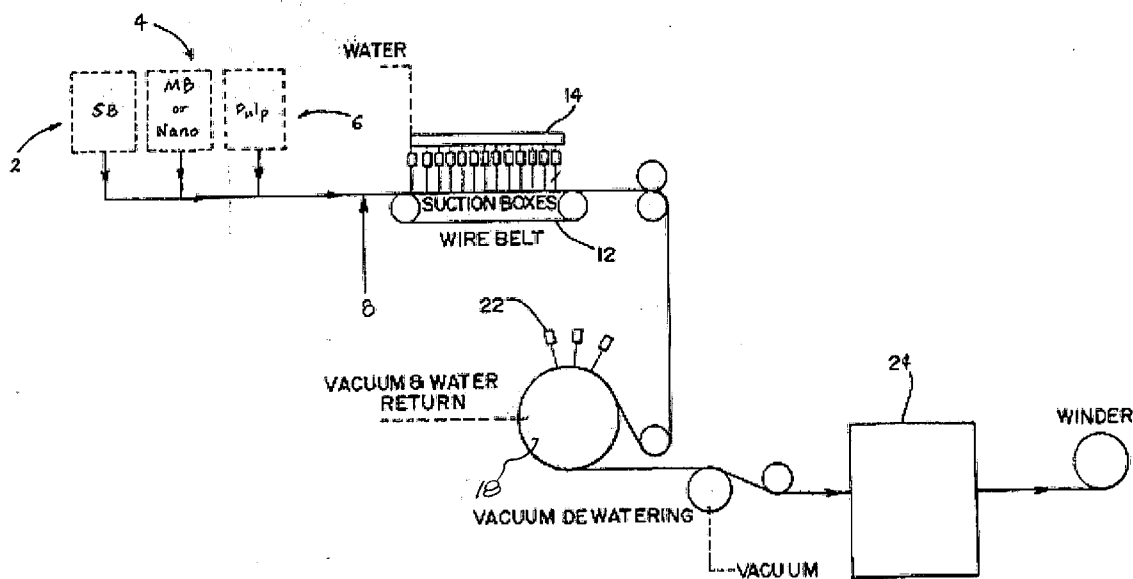
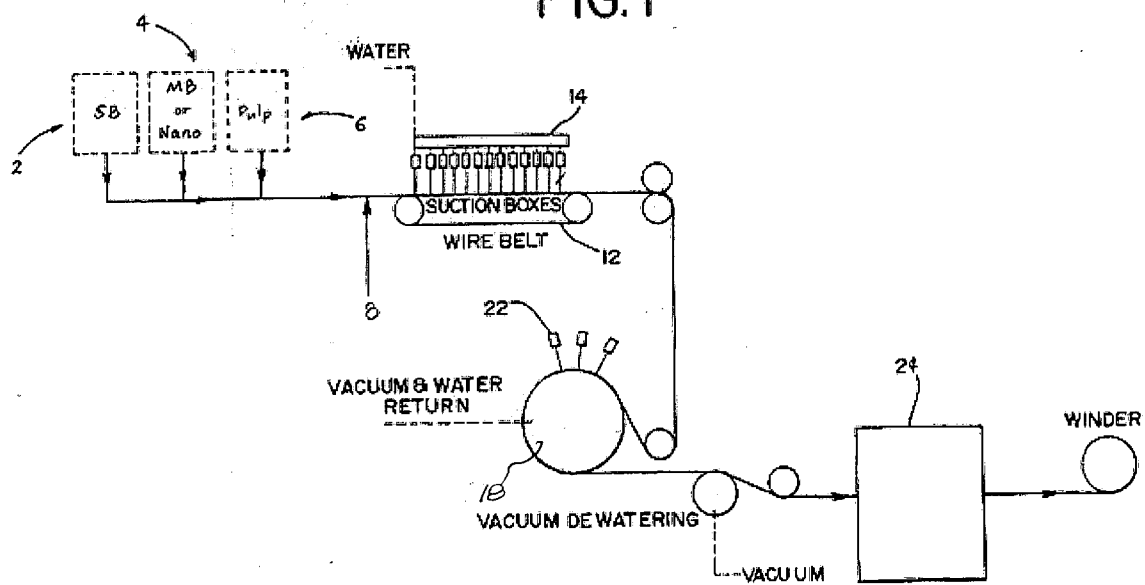
(73) Assignee: **PGI Polymer, Inc.**(21) Appl. No.: **11/291,132**(22) Filed: **Nov. 30, 2005**

FIG. 1



METHOD OF MAKING A FILAMENTARY LAMINATE AND THE PRODUCTS THEREOF

TECHNICAL FIELD

[0001] The present invention relates generally to hydroentangled (spunlaced) nonwoven fabrics, and more particularly to hydroentangled laminate nonwoven laminate comprising one or more continuous filament webs, fine denier filament webs, and a cellulosic fiber web, which are integrated so that the cellulosic fibers become integrated with the filamentary structure. Nonwoven fabrics embodying the present invention exhibit unique performance attributes, such as improved barrier characteristics, excellent strength and absorbency, and is particularly suited for use in hygiene, medical, and industrial applications

BACKGROUND OF THE INVENTION

[0002] Nonwoven fabrics are used in a wide variety of applications where the engineered qualities of the fabrics can be advantageously employed. The use of selected thermoplastic polymers in the construction of the fibrous fabric component, selected treatment of the fibrous component (either while in fibrous form or while in an integrated structure), and selected use of various mechanisms by which the fibrous component is integrated into a useful fabric, are typical variables by which to adjust and alter the performance of the resultant nonwoven fabric.

[0003] Formation of nonwoven fabrics by hydroentanglement (spunlacing) is particularly advantageous in that the fibers or filaments from which the fabric is formed can be efficiently integrated and oriented as may be desired for a specific application. Blends of different types of fibers can be readily combined by hydroentanglement so that resultant fabrics exhibiting selected physical properties can be fabricated.

[0004] Continuous filament fabrics are relatively known for being highly porous, and ordinarily require an additional component in order to impart a barrier performance. Typically, barrier performance has been enhanced by the use of a barrier "melt-blown" layer of very fine filaments, which are drawn and fragmented by a high velocity air stream, and deposited into a self-annealing mass. Typically, such a melt-blown layer exhibits very low porosity, enhancing the barrier properties of laminate fabrics formed with spunbond and melt-blown layers.

[0005] Heretofore, nonwoven fabrics formed from blends of continuous filaments and cellulosic fibers have been known, with such fabrics desirably exhibiting physical properties which are characteristic of the constituent synthetic and cellulosic fibers. Typically, synthetic fibers can be formed into a fabric so that the characteristics such as good abrasion resistance and tensile strength can be provided in the resultant fabric. The use of cellulosic fibers provides such fabrics with desired absorbency and softness.

[0006] U.S. Pat. No. 5,459,912, to Oathout, hereby incorporated by reference, discloses patterned, spunlaced fabrics formed from synthetic fibers and wood pulp which are stated as exhibiting good absorbency, and low particle counts. The fabrics are thus suited for use where these characteristics are desirable, such as for use as wipes in clean rooms, wipes for food service, and like applications. However, this patent

contemplates integration of wood pulp fibers and synthetic fibers in a dry state, with subsequent hydroentanglement by treatment on one side only (prior to aperturing). It is believed that this results in significant loss of the wood pulp fibrous material through the loosely bonded synthetic fibers, thus detracting from the efficiency of the manufacturing process.

[0007] Additionally, the juxtaposition of continuous filament webs and pulp fibers, with subsequent hydroentanglement has shown significant loss of the wood pulp fibrous material through the filaments due to high level of porosity within the continuous filament web. Because laminate nonwoven fabric materials formed from continuous filament and cellulosic fibers can provide a combination of desirable physical properties, the present invention is directed to a method of making such a laminate nonwoven fabric which facilitates efficient fabric formation by abating loss of cellulosic fibers to the filtrate water during integration by hydroentanglement.

SUMMARY OF THE INVENTION

[0008] The present invention is directed to a nonwoven composite fabric comprising one or more layers of discontinuous filaments or nano-fiber filaments positioned between at least one continuous filament web and one cellulosic fiber web that are subsequently hydroentangled, wherein the discontinuous filaments or nano-fiber filaments provide a barrier to prevent the loss of the cellulosic fibrous material through the highly porous continuous filament web.

[0009] In accordance with the present invention, the discontinuous filament or nano-fiber layer is lightweight, less than 2 grams per square meter. The discontinuous filaments or nano-fiber filaments may be directly extruded onto the continuous filament web or alternately, unwound and positioned atop the continuous filament web.

[0010] The thermoplastic polymers of the continuous filament and discontinuous filament layer or layers are chosen from the group consisting of polyolefins, polyamides, and polyesters, wherein the polyolefins are chosen from the group consisting of polypropylene, polyethylene, and combinations thereof. It is within the purview of the present invention that the continuous filament spunbond layer or layers may comprise either the same or different thermoplastic polymers. Further, the continuous filaments of the spunbond layer or layers may comprise homogeneous, bi-component, and/or multi-component profiles and the blends thereof.

[0011] Once the discontinuous filament or nano-fiber layer is positioned atop the continuous filament web, the cellulosic fibrous material of the present fabric is introduced by juxtaposing the cellulosic fibrous web atop the discontinuous filament layer or nano-fiber layer. The layered webs are then hydroentangled, and subsequently dried to form the present composite nonwoven fabric. Notably, the incorporation of a discontinuous filament or nano-fiber layer has been found to desirably minimize loss of the cellulosic material as the various layers are integrated by hydroentanglement.

[0012] Other features and advantages of the present invention will become readily apparent from the following detailed description, the accompanying drawing, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1** is a diagrammatic illustration of a process embodying the principles of the present invention.

DETAILED DESCRIPTION

[0014] While the present invention is susceptible of embodiment in various forms, there will hereinafter be described, presently preferred embodiments, with the understanding that the present disclosure is to be considered as an exemplification of the invention, and is not intended to limit the invention to the specific embodiments disclosed herein.

[0015] The present invention is directed to a nonwoven composite fabric comprising a combination of desirable physical properties. The hydroentangled continuous filament layer, discontinuous filament or nano-fiber layer, and cellulosic layer provide a soft and absorbent fabric suitable for various hygiene, medical, and industrial end-use applications, such as wipes and protective cover materials. It has been contemplated that the addition of a discontinuous filament or nano-fiber layer positioned between a continuous filament layer, or spunbond layer, and pulp layer, optimizes the measure of cellulosic fiber within the product due to the inability of the fiber to be washed away in the hydroentanglement process.

[0016] A process for the formation of spunbond involves supplying a molten polymer, which is then extruded under pressure through a large number of orifices in a plate known as a spinneret or die. The resulting continuous filaments are quenched and drawn by any of a number of methods, such as slot draw systems, attenuator guns, or Godet rolls. The continuous filaments are collected as a loose web upon a moving foraminous surface, such as a wire mesh conveyor belt. When more than one spinneret is used in line for the purpose of forming a multi-layered fabric, the subsequent webs are collected upon the uppermost surface of the previously formed web. The web is then at least temporarily consolidated, usually by means involving heat and pressure, such as by thermal point bonding. Using this bonding means, the web or layers of webs are passed between two hot metal rolls, one of which has an embossed pattern to impart and achieve the desired degree of point bonding, usually on the order of 10 to 40 percent of the overall surface area being so bonded.

[0017] A process related to the formation of spunbond is the meltblown process, which involves the formation of discontinuous filaments. Again, a molten polymer is extruded under pressure through orifices in a spinneret or die. High velocity air impinges upon and entrains the filaments as they exit the die. The energy of this step is such that the formed filaments are greatly reduced in diameter and are fractured so that microfibers of finite length are produced. This differs from the spunbond process whereby the continuity of the filaments is preserved. The process to form either a single layer or a multiple-layer fabric is continuous, that is, the process steps are uninterrupted from extrusion of the filaments to form the first layer until the bonded web is wound into a roll. Methods for producing these types of fabrics are described in U.S. Pat. No. 4,041,203. The meltblown process, as well as the cross-sectional profile of the spunbond filament or meltblown microfiber, is not a critical limitation to the practice of the present invention.

[0018] A nano-fiber of finite or infinite length may also be utilized in the present invention, wherein the average fiber diameter of the nano-fiber is in the range of less than or equal to 1000 nanometers, and preferably less than or equal to 500 nanometers. Formation of fabrics from nano-fibers, particularly when a light basis weight nano-fiber barrier layer is preferred, is either coated or "dusted" onto a substrate layer. The present invention may utilize a nano-fiber layer of less than about 2 grams per square meter.

[0019] In accordance with the present invention and as noted in **FIG. 1**, a meltblown layer or nano-fiber layer **4** is directly extruded onto, or unwound and positioned adjacent a spunbond layer **2**. Subsequently, a cellulosic fiber web **6** is juxtaposed with the meltblown layer or nano-fiber layer **4** for formation of the present composite nonwoven fabric. The cellulosic fibers are provided in the form of wood pulp fibers introduced in the form of a wetlaid web, commonly referred to as "tissue".

[0020] At this stage in the process, the juxtaposed layers are subjected to hydroentanglement under the influence of high pressure liquid streams generated by suitable manifolds **14** positioned above an entangling belt **12**. As illustrated in **FIG. 1**, the high pressure liquid streams from the manifolds **14** are directed against a first expansive surface of the juxtaposed webs. Thereafter, the layers are directed about another entangling device, such as drum **18**, with high pressure liquid streams from manifolds **22** directed against the opposite expansive surface of the webs. The now integrated webs can be transferred over a dewatering slot, then dried at **24** and wound for storage and shipment.

[0021] Optionally, the entangled nonwoven composite may include additional fabric layers, as well as film layers. Such film layers may include one or more breathable, apertured, imaged films. Further, the composite fabric may be imparted with a three-dimensional image. The entangling apparatus may further include an imaging foraminous surface, such as a three-dimensional imaging drum comprising a three-dimensional image transfer device for effecting imaging of the now-entangled laminate. Such three-dimensional image transfer devices are disclosed in U.S. Pat. No. 5,098,764, which is hereby incorporated by reference. The image transfer device includes a moveable imaging surface which moves relative to a plurality of entangling manifolds which act in cooperation with three-dimensional elements defined by the imaging surface of the image transfer device to affect additional imaging and patterning of the fabric being formed.

[0022] As will be appreciated, a fabric formed in accordance with the present invention need not be subjected to hydroentanglement treatment by direction of hydraulic water jets against both expansive surfaces of the fabric as it is formed. Additionally, it will be recognized that the illustrated nip rolls can be utilized to improve fabric density, and reduce the moisture content of the web prior to drying.

[0023] The composite nonwoven fabric of the present invention may be treated with one or more mechanical or chemical post treatments. For instance, the resultant fabric may be mechanically compacted and/or additives imparted to achieve a specific performance within the fabric. Such additives may include pigments, thermochromics, fragrances, emollients, natural herbs and botanicals, UV chemistries, antimicrobials, and the combinations thereof, as well

as various other performance or aesthetically modifying additives. The composite of the present invention is suitable for various hygiene, medical, and industrial end-uses, whereby the composite is especially suitable for wipes. Incorporation of a discontinuous filament or nano-fiber layer positioned between a continuous filament layer, or spunbond layer, and pulp layer, optimizes the measure of cellulosic fiber within the product due to the inability of the cellulosic fiber to be washed away in the hydroentanglement process. As a result, the wipe product exhibits improved absorbency when utilized in a dry state and retains aqueous additives better when utilized in a wet state.

[0024] From the foregoing, numerous modifications and variations can be effected without departing from the true spirit and scope of the novel concept of the present invention. It is to be understood that no limitation with respect to the specific embodiment disclosed herein is intended or should be inferred. The disclosure is intended to cover, by the appended claims, all such modifications as fall within the scope of the claims.

What is claimed is:

1. A method of making a composite nonwoven fabric, comprising the steps of:

- providing a continuous filament web;
- providing a discontinuous filament web, wherein said web has a basis weight less than about 2 grams per square meter;
- providing a cellulosic fiber web;
- hydroentangling said webs to form a partially entangled web;
- hydroentangling said juxtaposed partially entangled web and cellulosic fiber web; and
- drying said hydroentangled webs to form said nonwoven fabric.

2. A method of making a laminate nonwoven fabric in accordance with claim 1, wherein said continuous filament web may be selected from the group consisting of polyolefins, polyamides, polyesters, and the blends thereof.

3. A method of making a laminate nonwoven fabric in accordance with claim 2, wherein said polyolefins may be selected from the group consisting of polypropylene, polyethylene, and combinations thereof.

4. A method of making a laminate nonwoven fabric in accordance with claim 1, wherein said step of hydroentangling said juxtaposed webs comprises first directing high-pressure liquid streams against a first expansive surface of said juxtaposed webs, and thereafter directing high-pressure liquid streams against an opposite expansive surface of said juxtaposed web.

5. A method of making a laminate nonwoven fabric in accordance with claim 1, wherein said laminate comprises additional wood pulp layers, continuous or discontinuous filaments layers, film layers, or a combination thereof.

6. A method of making a laminate nonwoven fabric, comprising the steps of:

- providing a continuous filament web;
- providing a foraminous surface;
- hydroentangling said continuous filament web to form a partially entangled web;
- juxtaposing a cellulosic fiber web with said partially entangled web;
- advancing said juxtaposed partially entangled web and cellulosic fiber web onto said foraminous surface and hydroentangling said webs on said surface so as to impart at least one three-dimensional image into said laminate; and

drying said hydroentangled webs to form said nonwoven fabric.

6. A method of making a laminate nonwoven fabric in accordance with claim 6, wherein said foraminous surface is a three-dimensional image transfer device.

7. A method of making a laminate nonwoven fabric in accordance with claim 6, wherein:

said step of hydroentangling said juxtaposed partially entangled web and paper web comprises first directing high-pressure liquid streams against a first expansive surface of the juxtaposed webs, and thereafter directing high-pressure liquid streams against an opposite expansive surface of said juxtaposed web.

8. A method of making a laminate nonwoven fabric as in claim 1, wherein said laminate is a wipe.

9. A method of making a laminate nonwoven fabric as in claim 6, wherein said laminate is a wipe.

10. A method of making a composite nonwoven fabric, comprising the steps of:

- providing a continuous filament web;
- providing a discontinuous filament web, wherein said web has a basis weight less than about 2 grams per square meter;
- providing a cellulosic fiber web;
- juxtaposing said webs;
- hydroentangling said webs; and
- drying said hydroentangled webs to form said nonwoven fabric.

11. A method of making a laminate nonwoven fabric in accordance with claim 10, wherein said step of hydroentangling said juxtaposed webs comprises first directing high-pressure liquid streams against a first expansive surface of said juxtaposed webs, and thereafter directing high-pressure liquid streams against an opposite expansive surface of said juxtaposed web.

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