ELASTIC SPUNBONDED NONWOVEN AND ELASTIC NONWOVEN FABRIC COMPRISING THE SAME

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ABSTRACT
The elastic spunbonded nonwoven has high elastic recovery properties and includes a plurality of multicomponent filaments. Each multicomponent filament, preferably of the sheath/core type, includes a first polymeric component extending along the length of the filament in at least a first section of the filament, and a second polymeric component extending along the length of the filament in at least a second section of the filament that is distinct from the first section. The first polymeric component comprises an elastic propylene-based olefin copolymer, and the second polymeric component comprises an elastic propylene-based olefin and has a melt flow rate that is higher than the melt flow rate of the first polymeric component. The elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component includes propylene and from 10 to 25 weight % of one or more C2 and/or C4 to C10 alpha-olefin co-monomers.
ELASTIC SPUNBONDED NONWOVEN AND ELASTIC NONWOVEN FABRIC COMPRISING THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to a novel elastic spunbonded nonwoven made from multi-component filaments, and having a remarkable elastic recovery, and to an elastic nonwoven fabric comprising at least two superposed layers, one of which being constituted by the said novel elastic spunbonded nonwoven.

PRIOR ART

[0002] Elastic nonwoven fabrics advantageously offer the ability to conform to irregular shapes, and thus enable to increase fit and to allow more freedom and comfort, for example to body movements, than other textile fabrics with more limited extensibility. Elastic nonwoven fabrics are thus widely used in many industrial applications. Elastic nonwoven fabrics are used in the hygienic and personal care industry for making, for example, disposable diapers, child swim pants, child training pants, adult incontinent garments, sanitary napkins, wipes and other personal care products. Elastic nonwoven fabrics are also used in the manufacture of medical products, such as, for example, gowns, linens, bandages, masks, heads wraps and drapes. Others additional applications of elastic nonwoven fabrics include consumer products, like seat covers and car covers.

[0003] The demand for innovative and low cost elastic nonwoven products has increased in the last years. Several techniques can be used to produce nonwoven fabrics, but recently, due to the increasing of a higher cost efficiency requested by the market, methods based on melt spinning continuous filaments of thermoplastic materials have increased their importance. Such nonwoven fabrics, called “spunbonded” nonwovens can advantageously give the required combinations of physical properties, like softness, strength and durability.

[0004] One solution used in the prior art for making elastic spunbonded nonwoven webs consists in melt spinning filaments made of elastomeric polymer, such as, for example, thermoplastic polyurethane (TPU).

[0005] Significant problems have been however encountered with this solution.

[0006] One of these problems is linked to the “sticky” nature of the elastomeric polymer, typically employed in producing elastic nonwoven materials. In fact during the spinning-bonding process, the large air flow used for drawing the filament can make the filaments stick together and therefore the resulting web uniformity will be negatively affected. Furthermore this bigger filament bundling can give trouble due to the blocking effect when the fabric is wound into rolls.

[0007] Another problem encountered when elastomeric polymers are used for making spunbonded nonwovens is the breakage of the filaments during extrusion and/or drawing for attenuating the filaments. When filaments break they can obstruct the flow of filaments and/or mesh with other filaments, resulting in the formation of a defect in the nonwoven web.

[0008] A further drawback of the use of elastomeric polymers such as TPU for making spunbonded nonwoven is their poor bonding ability, especially thermal-bonding ability, with the most used polyolefin materials.

[0009] In order to overcome these problems, it has been proposed in U.S. Pat. No. 6,225,243 and in PCT application WO 00/08243 to produce spunbonded nonwoven webs made of multi-component filaments including at least two components: a first elastic polymeric component, and a second, extensible polymeric component, the first elastic polymeric component having an elasticity that is greater than the elasticity of the second polymeric component. The first elastic polymeric component preferably comprises at least one elastomer that includes an elastic polypropylene; the second polymeric component preferably comprises at least one polyolefin that is a linear low density polyethylene (LLDPE) having a density greater than 0.90 g/cc.

[0010] This solution disclosed in U.S. Pat. No. 6,225,243 and in PCT application WO 00/08243 is however not satisfying in terms of elastic properties, especially in terms of elastic recovery.

[0011] In PCT application WO2005/090659, elastic nonwovens made of extensible conjugate fiber are disclosed. The extensible conjugate fiber has a total heat of melting of less than 80 Joules per gram, and comprises:

[0012] a. from 0.001% to about 20% by weight of the total fiber of a first component A which comprises at least a portion of the fiber surface, said first component A comprising a polypropylene homopolymer or a polypropylene copolymer,

[0013] b. and a second component B which comprises an elastomeric polypropylene-based olefin polymer.

[0014] Japanese patent application JP 11 323716 discloses an extensible spunbonded nonwoven fabric made of filaments of the eccentric sheath-core type. This spunbonded nonwoven fabric is extensible, but does not exhibit very high elastic properties, in particular high recovery.

OBJECTIVE OF THE INVENTION

[0015] The present invention proposes a novel elastic spunbonded nonwoven that overcomes the aforesaid problems inherent to the use of elastomeric polymers such as TPU, and that enables to achieve very high elastic properties.

SUMMARY OF THE INVENTION

[0016] The above-mentioned objective is achieved by the elastic spunbonded nonwoven of claim 1. This spunbonded nonwoven comprises a plurality of multi-component filaments; each multi-component filament comprises a first polymeric component (P) extending along the length of the filament in at least a first section of the filament, and a second polymeric component (P') extending along the length of the filament in at least a second section of the filament that is distinct from the first section. The said first polymeric component (P) comprises an elastic propylene-based olefin copolymer, and the said second polymeric component (P') comprises an elastic propylene-based olefin and has a melt flow rate MFR2 that is higher than the melt flow rate MFR1 of the first polymeric component. The elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component comprises propylene and from 10 to 25 weight % of one or more C2 and/or C4 to C10 alpha-olefin co-monomers.

[0017] As used therein, the wording “multi-component filament” means a filament that is formed by combining multiple extrudates in the filament resulting in a heterogeneous filament cross section wherein at least two sections are occu-
plied by separate polymeric components along the entire length of the filament. The cross section of the multi-component filament may take different configurations such as side-by-side, sheath-core, eccentric sheath-core, and islands-in-the sea. “Multi-component filaments” are also commonly referred as “conjugate filaments”.

The first polymeric component (P) can advantageously exhibit very high elastic properties, and in particular one can use an elastic polymeric component with a low melt flow rate that would be practically not spinable alone.

For measuring the melt flow rates (MFR1, MFR2) of the first and second polymeric components, standard method ASTM D-1238 can be used.

The wording “elastic propylene-based olefin copolymer”, as used therein, means polypropylene polymers, selected from the group of thermoplastic olefin-based elastomers, that incorporate a low level of co-monomer, such as ethylene or a higher alpha-olefin in the backbone to form an elastomeric copolymer. The term “copolymers” means any polymer comprising two or more monomers, where the monomer present in the polymer is the polymerized form of the monomer. Likewise when catalyst components are described as comprising neutral stable forms of the components, it is well understood that the active form of the component is the form that reacts with the monomers to produce polymers.

As used herein, the term “polypropylene”, “propylene polymer”, or “PP” refers to homopolymers, copolymers, terpolymers, and interpolymers, comprising from 50 to 100 weight % of propylene.

More particularly, “elastic propylene-based olefin copolymer” can be a single semi-amorphous copolymer or a blend of several semi-amorphous polymers, each semi-amorphous polymer comprising propylene from 10 to 25 weight % of one or more C2 and/or C4 to C10 alpha-olefin co-monomers, preferably ethylene, wherein the copolymer comprises isotactically crystallizable alpha-olefin sequences. The term “crystallizable” describes those polymers or sequences which are mainly amorphous in the undeformed state, but upon stretching or annealing, crystallization occurs.

Most preferably, the copolymer is an ethylene propylene copolymer, e.g., ethylene propylene thermoplastic elastomer. The copolymer has a substantially uniform composition distribution preferably as a result of polymerization with a metalloocene catalyst. Composition distribution is a property of copolymers indicating a statistically significant intermolecular or intramolecular difference in the composition of the polymer.

Preferably, each semi-amorphous polymers has: a) heat of fusion of 4 to 70 J/g, as determined by Differential Scanning Calorimetry (DSC); b) a Melt Flow Rate of 0.1 to 2000 g/min, most preferably greater than 2 g/min and less than 100 g/min, as measured by ASTM D-1238 at 230°C C, and 2.16 kg.

A semi-amorphous copolymer may be produced in a continuous solution process using a metalloocene catalyst.

Preferably, copolymers having a narrow molecular weight distribution are used. To produce a copolymer having a narrow molecular weight distribution, a single sited metallocene catalyst is advantageously used, which allows only a single statistical mode of addition of the first and second monomer sequences, and the copolymer is advantageously well-mixed in a continuous flow stirred tank polymerization reactor, which allows only a single polymerization environment for substantially all of the polymer chains of the copolymer.

Preferred semi-amorphous polymers useful in this invention preferably have a molecular weight distribution (Mw/Mn) of less than 5, preferably between 1 and 4.

As used herein, molecular weight (Mn and Mw) and molecular weight distribution (MWD or Mw/Mn) are determined by gel permeation chromatography using polystyrene standards.

As used herein, “metallocene” means one or more compounds represented by the formula CpInRnXq, wherein Cp is a cyclopentadienyl ring which may be substituted, or derivative thereof (such as indene or fluorene) which may be substituted; M is a transition metal, for example titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum and tungsten; R is a substituted or unsubstituted hydrocarbyl group or hydrocarboxy group having from one to 20 carbon atoms; X may be a halide, a hydride, an alkyl group, an alkenyl group or an aryalkyl group; and typically, n=0-3; q=0-3.

A slip agent selected for example from the group consisting of: erucamide, oleylamide, oleamide, and stearamide and used in a concentration from 50 ppm to 10 weight % can be successfully added. During the processing of thermoplastic polymers it is often required to modify the rheology or surface properties of polymers by addition of selected slip agents, in order to reduce the friction and polymer tackiness, and facilitate the whole spinning/drawing process.

Preferred elastic propylene-based olefin copolymers suitable for the invention include thermoplastic elastic propylene-ethylene copolymers formed by using metallocene polymerization catalysis. Such polymers include those commercially available from ExxonMobil Chemical Co., Huston, Tex., under the trademark of VISTAMAXX®, e.g. Vistamaxx 2120 or Vistamaxx 2125 for second polymeric component in the sheath and a blend of Vistamaxx 2125 and Vistamaxx 6100 (or Vistamaxx 6102) for first polymeric component in the core.

Preferably, but not necessarily, each multi-component filament comprises a core and an outer sheath, the core comprises the first polymeric component and the sheath comprises the second polymeric component.

Preferably, but not necessarily, the ratio MFR2/MFR1 between the melt flow rates of the second and first polymeric components is higher than 1.5.

In one variant, the first polymeric component comprises a blend of at least two elastic propylene-based olefin copolymers of different melt flow rate (MFR1a and MFR1b).

Optionally, the elastic spunbonded nonwoven of the invention is further characterized by the following optional features that can be combined or taken alone:

- the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component is an ethylene propylene copolymer;

- the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component has a melt flow rate of 0.1 to 2000 g/10 min, most preferably greater than 2 g/10 min and less than 100 g/10 min, as measured by ASTM D-1238 at 230°C C, and 2.16 kg.

- the elastic propylene-based olefin copolymer for the first polymeric component and for the second poly-
meric component has a molecular weight distribution (Mw/Mn) of less than 5, preferably between 1 and 4;

[0039] the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component comprises at least 80 wt % of propylene units;

[0040] the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component is a metallocene-catalysed polymer;

[0041] the spunbonded nonwoven has a root mean square (RMS) average recovery of at least 85%, said RMS average recovery being calculated from the formula:

\[
RMS_{average} = \sqrt{\frac{1}{2}(R_{MD}^2 + R_{CD}^2)}
\]

[0042] wherein \( R_{MD} \) and \( R_{CD} \) are recovery values (R) measured on a nonwoven specimen respectively in machine direction and cross direction, after 50% elongation and one pull, and calculated from the formula:

\[
R = \frac{L_{S} - L_{P}}{L_{S} - L_{0}}\times 100\%
\]

[0043] wherein \( L_{S} \) represents the stretched length of the specimen, \( L_{P} \) represents the recovered length of the specimen, \( L_{0} \) represents the original length of the specimen;

[0044] the spunbonded nonwoven has a RMS recovery, after two successive 50% pulls, of at least 80%;

[0045] the amount of the first polymeric component is at least 50 wt % of the total weight of the filament, and the amount of the second polymeric component is less than 50 wt % of the total weight of the filament;

[0046] the amount of the second polymeric component is less than 40 wt % of the total weight of the filament, and preferably equal or less than 30 wt % of the total weight of the filament.

[0047] Another object of the invention is to propose an elastic nonwoven fabric comprising at least one elastic spunbonded nonwoven layer as defined above, and at least one additional nonwoven layer.

[0048] More particularly, and optionally, the composite nonwoven is characterized by the following optional features that can be taken alone or combined together:

[0049] the additional nonwoven layer is selected from the group: carded nonwoven; spunbonded nonwoven, meltblown nonwoven;

[0050] the additional nonwoven layer is constituted by a polyelefin-based nonwoven;

[0051] in one variant, the elastic nonwoven fabric comprises at least two additional carded nonwoven layers (C) and an elastic spunbonded nonwoven layer (W) of the invention, and sandwiched between the two carded layers; More particularly, the elastic nonwoven fabric can further comprise an additional meltblown layer (M) interposed between the elastic spunbonded nonwoven layer (W) and one carded nonwoven layer (C).

[0052] the layers can be bonded together by one of the following bonding technologies: thermal bonding, water needling, mechanical needling, ultrasonic bonding, air trough bonding and chemical bonding;

[0053] in one variant, the layers are perforated;

[0054] the elastic nonwoven fabric has a CD permanent set after two cycles at 150% elongation less 50%, and preferably less than 40%.

[0055] the elastic nonwoven fabric has a CD elongation at Peak of at least 150%, and preferably of at least 200%.

[0056] The wording “polyolefin-based nonwoven layer”, as used therein, means any nonwoven layer that is essentially made from a polymer or copolymer that is exclusively or predominantly made up of polyolefin units.

[0057] Preferably, at least one polyolefin-based nonwoven layer is a polypropylene-based nonwoven layer.

[0058] The wording “polypropylene-based nonwoven layer”, as used therein, means any nonwoven layer that is essentially made from a polymer or copolymer that is exclusively or predominantly made up of polypropylene units.

[0059] A further object of the invention is a hydroentangled elastic nonwoven fabric comprising at least one elastic spunbonded nonwoven layer (W) and at least one nonwoven layer, wherein the said elastic spunbonded nonwoven layer (W) comprises a plurality of multi-component filaments, each multi-component filament comprising a first polymeric component (P) and a second polymeric component (P'), and wherein the first polymeric component (P) comprises an elastic polypropylene-based olefin copolymer, and the second polymeric component (P') comprises an elastic polypropylene-based olefin and has a melt flow rate MFR2 that is higher than the melt flow rate MFR1 of the first polymeric component.

[0060] More particularly, in one variant, the layers of the hydroentangled elastic nonwoven fabric are perforated, more especially by means of hydro jets.

BRIEF DESCRIPTION OF DRAWINGS

[0061] Other characteristics and advantages of the invention will appear more clearly on reading the following detailed description which is made by way of non-exhaustive and non-limiting examples, and with reference to the accompanying drawings on which:

[0062] FIGS. 1A to 1F are different examples of spun filaments cross-sections that are suitable for practising the invention,

[0063] FIG. 2 is a schematic drawing of a first example of production line that is used for making a thermo-bonded elastic nonwoven fabric of the invention;

[0064] FIG. 3 is a schematic drawing of a second example of production line that is used for making a hydroentangled elastic nonwoven fabric of the invention,

[0065] FIG. 4 is a schematic drawing of a third example of production line that is used for making a hydroentangled elastic nonwoven fabric of the invention.

[0066] FIG. 5 is a schematic drawing of a fourth example of production line that is used for making a hydroentangled elastic nonwoven fabric of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0067] The elastic nonwoven of the invention is obtained by a spunbonding process and is made of multi-component filaments P comprising at least two different polymeric components P, P' that are specific of the invention. First polymeric component (P) extends along the entire length of each filament in at least a first section of the filament, and a second polymeric component (P') extends along the entire length of each filament in at least a second section of the filament that is distinct from the first section.
According to the invention, both the first (P) and the second (P) polymeric components comprise an elastic propylene-based olefin copolymer, but have two different melt flow rates (MFR1; MFR2), the melt flow rate MFR2 of the second polymeric component being higher than the melt flow rate MFR1 of the first polymeric component.

The elastic propylene-based olefin copolymers that are suitable for the first and second polymeric components are copolymers comprising propylene and from 10 to 25 weight % of one or more C2 and/or C4 to C10 alpha-olefin comonomers, like for example the ones commercially available from ExxonMobil Chemical Co, Huston, Tex. under the trademark of VISTAMAXX®.

More particularly, the elastic propylene-based olefin copolymers that are suitable for the first polymeric components are for example a blend of at least two different propylene-ethylene olefin copolymers commercially available from ExxonMobil Chemical Co, Huston, Tex. under the trademark of VISTAMAXX® and having two different melt flow rate (MFR1a and MFR1b).

The first and second polymeric components can also include other materials, like pigments or colorants, or opacifiers (like TiO2) antioxidants, stabilizers, fillers, surfactants, waxes, flow promoters or special additives to enhance processability of the composition, like for example slip agents. It is particularly recommended to add slip agents in the second polymeric component.

Various shapes in cross section for the filaments F can be envisaged (round shape, oval shape, bilobal shape, trilobal shape, etc . . . ).

Preferably, the multi-component filaments are bi-component filaments. Some non-limiting examples of different cross sections for bicomponent filaments that are suitable for the invention are illustrated on FIGS. 1A, 1B, 1C, 1D, 1E, 1F.

Preferably, as depicted on the particular examples of FIG. 1A to 1F, at least 50% of the whole surface of the filament F is constituted by the second polymeric component P, and even more preferably 100% of the whole surface of the filament F is constituted by the second polymeric component P (FIGS. 1B, 1C, 1D, 1E).

Bicomponent filament of the sheath/core type, like the ones illustrated in FIGS. 1A, 1B, 1C, 1D, wherein the core is made of the first polymeric component P and the sheath is made of the second polymeric component P, are preferably used for a better thermal-bondability of the elastic spunbonded web with other polyolefin layers, as described hereafter. Although the sheath/core configuration is preferred, the invention is however not limited to that particular configuration.

In another variant of the invention, the filaments can however comprise more than two polymeric components.

The method applied to produce the elastic nonwoven web according to the present invention is the spunbonding process. Various types of spunbonding processes are described in U.S. Pat. No. 3,338,992 to Kenney, U.S. Pat. No. 3,692,613 to Dorschner, U.S. Pat. No. 3,802,817 to Matsuaki, U.S. Pat. No. 4,405,297 to Appel, U.S. Pat. No. 4,812,112 to Balk and U.S. Pat. No. 5,665,300 to Brignola et al.

FIG. 2—Thermo-Bonded Elastic Nonwoven Fabric (L1/W/L2)

One example of a suitable process line for producing an elastic nonwoven fabric of the invention is illustrated in FIG. 2. In this example, the process line comprises:

- a spunbonding unit (SU) for producing an elastic spunbonded nonwoven W made of bi-components filaments, preferably of the sheath/core type;
- a first delivering mean L1, in the form of a roll, for delivering a first additional nonwoven layer L1, upstream the area where the spunbonded nonwoven W is being formed;
- a second delivering mean L2, in the form of a roll, for delivering a second additional nonwoven layer L2, downstream the area where the spunbonded nonwoven W is being formed.

Spunbonding Unit (SU)

The spunbonding unit (SU) comprises two hoppers 1 and 2, containing respectively the first polymeric component (P) and the second (P) polymeric components. These two hoppers 1 and 2 feed in parallel two extruders 3 and 4, for separately melting the two polymeric components. The outputs of the two extruders 3 and 4 are connected to two melt polymer pumps 5, 6 respectively. Said pumps 5, 6 feed a dosed amount of polymers to the bi-component spinning pack 7.

The bi-component spinning pack 7 usually contains a certain number of plates stacked one on top of the other to distribute the polymers to the lower plate which is the spinnerets plate, having one or more rows of capillary holes and where the bi-component filaments are extruded. Typical spinnerets die systems well known designed for polypropylene can be used, for example with a die hole density of 2006-6000 holes per meter, and a die capillary hole diameter of 0.3 to 0.8 mm. The barrel temperatures of the two extruders are, for example, ranging from a minimum of 170°C. to a maximum 260°C., depending on screws speed and design.

When the two polymers P, P' are extruded through the spinnerets holes a curtain of filaments P' is formed downward and it encounters the quench air which flow is rectified inside the quench boxes 8, by means of a suitable system, like honeycomb structure, well known to those of ordinary skilled in the art.

During the filaments solidification this system avoids air turbulences which can bring to stick together the filaments in formation. It is recommended to apply the quench air from both sides of the filaments curtain in order to improve the cooling efficiency, as elastic polymers usually show a tendency to stickiness, as well as to keep down the air flow temperature to the minimum reachable. Temperatures below 20°C. are considered suitable for the scope, but lower temperatures, in the range of 10°C. to 15°C., are recommended when more elastic and soft materials are applied in the sheath arrangement. To this purpose two quench boxes 8 are shown in the FIG. 1. Each quench box 8 is connected to a blower which delivers the right low pressure air flow necessary for the filaments cooling.

After having been cooled the filament curtain enters in a draw unit 9, which in the most preferred case is constituted by a slot through which the filaments are drawn by means of air flow entering from the sides of the slot and flowing downward through the passage. The filaments are laid onto a foraminous transport belt (for example wire belt) forming a transport surface T. A vacuum box 12 is positioned below the transport surface T, and delimits a web forming area on the transport surface T.

The spunbonding unit (SU) further comprises a compression roller 10 which stabilizes, by means of a low
compression, the web W just after it is formed and a pair of thermal point calander rolls 13 (one heated engraved roll and one heated smooth roll), that can be used to bond the layers (L1, W and L2) together.

Delivering Means 11, 15

[0088] The first delivering mean 11 is used for laying directly onto the transport surface T, and upstream the web formation area of the spinbonding unit (SU), a bottom pre-consolidated nonwoven layer L1 (for example a spun layer, a meltblown layer or a calender layer). In this configuration, the elastic spinbonded layer W of the invention is formed on top of this bottom layer L1.

[0089] The second delivering mean 15 is used for laying directly onto the spunbonded web W a top pre-consolidated nonwoven layer L2 (for example a spun layer, a meltblown layer or a calender layer). The nonwoven layer W is thus sandwiched between the two outer nonwoven layers L1 and L2.

[0090] In another variant, the elastic spinbonded layer W of the invention can be manufactured off-line and wound up in the form of a roll, and the final elastic nonwoven fabric (L1/W/L2) can be manufactured from a roll of said elastic nonwoven W.

[0091] Referring to FIG. 2, the three layers (L1, W and L2) can be thermo-bonded together by means of calander rolls 13, and the elastic nonwoven fabric (L1/W/L2) is wound up in the form of rolls on a winding machine 14. This winding machine 14 has to be suitable for elastic material, and preferably enables a strict control of tension variations during winding, said tension variations being caused by the elastic properties of the final composite nonwoven.

[0092] The invention is not limited to an elastic composite nonwoven fabric that is consolidated by thermal bonding, but within the scope of the invention the elastic fabric can be consolidated by using any bonding technology known in the field of nonwoven, and including notably: water needling (also called hydroentanglement) by means of hydro jets (on one side or on both sides of the composite nonwoven), mechanical needling, ultrasonic bonding, air trough bonding and chemical bonding.

[0093] The elastic composite nonwoven fabric of the invention can be also perforated by using any perforation technology that is known in the field of nonwoven, including notably mechanical perforation and perforation by means of hydro jets.

![Image](image.png)

FIG. 3—Hydroentangled Elastic Nonwoven Fabric (C/W/S)

[0094] One example of a suitable process line for producing a hydroentangled elastic nonwoven fabric of the invention is illustrated in FIG. 3.

[0095] In this example, the process line comprises a carding unit 18, a first spinbonding unit SU, second spinbonding unit 19, a hydraulic needling unit 20, a dewatering unit 21, a drying unit 22, and a winding unit 23.

[0096] The carding unit 18, which is mounted upstream the spinbonding unit SU, is used for producing in line a bottom carded nonwoven layer C.

[0097] Preferably, between this first carding unit 18 and the spinbonding unit SU, the carded nonwoven layer C is compressed by compaction rolls (not shown on FIG. 3) and/or by means of calander rolls like the calander rolls 13 previously described in reference to FIG. 2. This compression and/or the calandering is performed in order to pre-consolidate the layer C, before the spunbonded layer W is formed. The same considerations apply for the production lines of FIGS. 4 and 5.

[0098] The spinbonding unit SU is similar to the one of FIG. 2 and is used for producing in line the elastic spinbonded nonwoven layer W of the fabric.

[0099] The spinbonding unit 19 is similar to spinbonding unit (SU), but in contrast with spinbonding unit SU, spinbonding unit 19 does not comprise any calender rolls. The spinbonding unit 19 is used for laying a top spinbonded layer S onto the elastic spinbonded layer W.

[0100] The composite nonwoven (C/W/S) is transported, downstream the spinbonding unit 19, by means of a conveyer belt 200 through the hydraulic needling unit 20. This hydraulic needling unit 20 is used for bonding together the layers of the nonwoven composite (C/W/S), by means of high pressure water jets (hydroentanglement process) that are directed at least towards the surface of the top layer S, and that penetrate through the structure of the composite and are partially reflected back to the structure.

[0101] In the particular example of FIG. 3, the water needling process is performed on both sides of the composite nonwoven (C/W/S).

[0102] More particularly, in the example of FIG. 3, the hydraulic needling unit 20 comprises four successive perforated drums. First perforated drum 201 is associated with two successive hydro-jet beams 201a and 201b. Second perforated drum 202 is associated with two successive hydro-jet beams 202a and 202b. Third perforated drum 203 is associated with two successive hydro-jet beams 203a and 203b. Fourth perforated drum 204 is associated with two successive hydro-jet beams 204a and 204b. The water pressure of the upstream hydro-jet beam 201a is lower than the water pressure of all the other downstream hydro-jet beams 201b, 202a, 202b, 203a, 203b, 204a, 204b, in order to obtain a pre-hydroentanglement of the layers.

[0103] At the exit of hydraulic needling unit 20, a hydroentangled elastic composite C/W/S is obtained.

[0104] The fourth drum 204 can be equipped with a perforation screen, in order to create apertures in the multilayer elastic fabric C/W/S. This perforation step can be also performed by replacing the fourth drum 204 by a suitable drum for perforation, having the surface constituted by one net or several nets superposed one on the other.

[0105] The hydroentangled elastic composite C/W/S is transported downstream the hydraulic needling unit 20 by the conveyer belt 210 of a dewatering unit 21, and over a vacuum box 211, that enables to remove by suction from the fabric most of the water that has been absorbed during the water needling process (conventional dewatering process).

[0106] The dewatering unit 20 and the dewatering unit 21 can be integrated in the same industrial equipment.

[0107] The dewatered hydroentangled elastic fabric (C/W/S) issued from the dewatering unit 21 is continuously fed through the oven of the drying unit 22, wherein heat is applied to the fabric (for example by means of hot air), in order to remove the remaining water still contained within the fabric.

[0108] Then the dried fabric (C/W/S) is wound in the form of a roll, by means of the winding unit 23.

FIG. 4—Hydroentangled Elastic Nonwoven Fabric (C/W/C)

[0109] Another example of a suitable process line for producing a hydroentangled elastic nonwoven fabric of the invention is illustrated in FIG. 4.
The process line of FIG. 4 differs from the process line of FIG. 3 by the use of a second carding unit 18' (similar to first carding unit 18), that is substituted to the spunbonding unit 19.

FIG. 5—Hydroentangled Elastic Nonwoven Fabric (C/W/M/C)

Another example of a suitable process line for producing a hydroentangled elastic nonwoven fabric of the invention is illustrated in FIG. 5.

The process line of FIG. 5 differs from the process line of FIG. 4 by the use of an additional meltblown unit 24, that is positioned between the first spunbonding unit SU and the second carding unit 18. This meltblown unit 24 is used for producing a meltblown layer M, sandwiched between the elastic spunbonded layer W issued from the first spunbonding unit SU and the carded layer C issued from the second carding unit 18.

The term “meltblown layer”, as used herein, means any layer essentially made of “meltblown fibers”.

“Meltblown fibers” are well known in the prior art and a meltblown process for making meltblown fibers is disclosed, for example, in U.S. Pat. No. 3,849,241 to Butin. “Meltblown fibers” are generally formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries. The molten threads or filaments issuing from the die capillaries are fed into converging high velocity air streams which attenuate the filaments of molten thermoplastic material and reduce their diameter. Said diameter is generally reduced in order to obtain microfibers. Meltblown fibers are thus microfibers that may be continuous or discontinuous, and are generally smaller than 10 microns in diameter. Thereafter, the meltblown fibers are carried by the high velocity air stream and are deposited onto a collecting surface (i.e. the elastic spunbonded nonwoven of the invention) to form a layer of randomly distributed meltblown fibers.

For example, an additional meltblown layer M is advantageously used when opacity for the elastic nonwoven fabric is required. In particular, in hygienic applications, wherein nonwoven fabrics of higher opacity are required (e.g. for making elastic back eur for diapers or elastic side panel for training pants), a meltblown layer is preferably laid on top of the elastic spunbonded layer W of the invention; for example, the weight of the meltblown layer M is at least 5 gsm, preferably 8 gsm and more preferably 10 gsm. This meltblown layer gives a more uniform white colour to the elastic nonwoven fabric, and thus improves the aesthetic thereof.

EXAMPLES

Elastic Spunbonded Nonwoven (W)

Different samples of fabric (L1/W/L2) have been produced on a pilot plant, like the one of FIG. 2, but without using the calender rolls 13, in order to produce a fabric (L1/W/L2) wherein the layers L1, W and L2 were not thermo-bonded. Then the layers L1 and L2 were removed in order to keep only the elastic spunbonded layer W.

In all samples, the spunbonded nonwoven (W) was made from bi-component filaments having a sheath/core arrangement and having the round cross section of FIG. 1D.

The polymeric materials that have been used for producing these spunbonded nonwovens (W) were the following.

First Polymeric Component (P)

A dry blend of VM2125 (polymer P1) and VM6100 (polymer P2) was used as first polymeric component (P).

VM 2125

VM 2125 is a specially polyethylene elastomer commercially available from ExxonMobil Chemical Co, Huston, Tex. under the trademark of VISTAMAXX®. This specially polyethylene elastomer is a semi-crystalline elastic propylene-based olefin copolymer comprising at least 85 wt % of propylene units and made in the presence of a metallocene catalyst during the polymerization process. This copolymer has a melt flow rate (MFR1a) of 80 g/10 min (measured at 230°C and 2.16 Kg-ASTM D-1238), a broad melting temperature range and a highest melting peak of 160°C. This copolymer has a slower crystallization rate than polypropylene homopolymers.

VM6100 (VMX6102)

VM 6100 is a specially polyethylene elastomer commercially available from ExxonMobil Chemical Co, Huston, Tex. under the trademark of VISTAMAXX®. This specially polyethylene elastomer is a semi-crystalline elastic propylene-based olefin copolymer comprising at least 80 wt % of propylene units and made in the presence of a metallocene catalyst during the polymerization process. This copolymer has a melt flow rate (MFR1b) of 3 g/10 min (measured at 230°C and 2.16 Kg-ASTM D-1238), a broad melting temperature range and a highest melting peak of 160°C. This copolymer has a slower crystallization rate than polypropylene homopolymers. VMX 6100 can be replaced by the equivalent grade VM 6102, having same chemical properties as VM 6100 and giving the same elastic properties to the nonwovens produced.

The melt low rate (MFR1) of the first polymeric component (P) was calculated by means of the following equation:

\[ \ln(MFR1) = W_a \ln(MFR1_a) + W_b \ln(MFR1_b) \]  

Wherein:

- MFR1a is the melt flow rate of polymer P₁ (MFR1a = 80 g/10 min for VM2125)
- MFR1b is the melt flow rate of polymer P₂ (MFR1b = 3 g/10 min for VM6100 or VM6102)
- W_a and W_b are the weight ratios of polymers P₁ and P₂ in the blend (W_a + W_b = 1).

In the following examples, the weight ratio (W_a) of VM2125 was 0.8 and the weight ratio (W_b) of VM6100 (or VM6102) was 0.2. The melt flow rate MFR1 of the blend (first polymeric component P) calculated by means of above formula (1) was thus around 41 g/10 min.

Second Polymeric Component (P)

The second polymeric component was made of aforesaid elastic propylene-based olefin copolymer VM2115

Other technical characteristics of materials VM6100 (VMX6102) and VM 2125 are given in table 1.
The percent recovery can then be measured. At the end the recovery (R) was measured in both CD and MD directions, according to the formula: 

\[ R = \frac{(L_S - L_r)}{(L_S - L_o)} \times 100\% \] 

wherein the percent recovery can then be measured. At the end the recovery (R) was measured in both CD and MD directions, according to the formula: 

\[ R = \frac{(L_S - L_r)}{(L_S - L_o)} \times 100\% \] 

The main spunbonding process parameters are summarized in the following table 3 for each sample of spunbonded nonwoven W.

### TABLE 3

<table>
<thead>
<tr>
<th>Sample</th>
<th>(I) Basic weight of W (g)</th>
<th>(II) Filament count (dpf)</th>
<th>(III) T° of extruder (° C.)</th>
<th>(IV) T° of extruder (° C.)</th>
<th>(V) T° of Spinning Beam (° C.)</th>
<th>(VI) Throughput (kg/hr/m)</th>
<th>(VII) Throughput (g/hr)</th>
<th>(VIII) Line speed (m/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-7-6</td>
<td>60</td>
<td>4.6</td>
<td>270</td>
<td>265</td>
<td>240</td>
<td>150</td>
<td>0.50</td>
<td>54</td>
</tr>
<tr>
<td>E-7-8</td>
<td>30</td>
<td>4.6</td>
<td>270</td>
<td>265</td>
<td>240</td>
<td>150</td>
<td>0.50</td>
<td>113</td>
</tr>
<tr>
<td>E-7-10</td>
<td>60</td>
<td>4.6</td>
<td>270</td>
<td>265</td>
<td>240</td>
<td>150</td>
<td>0.50</td>
<td>40.5</td>
</tr>
</tbody>
</table>

The elastic properties of the resulting spunbonded nonwoven W of the invention were measured at 23° C. ±2, using an Instron Testing apparatus set at 5 inch gauge length and a stretching rate of 5 inches per minute. At the designated 50% elongation value, the sample is held in the stretched state for 30 seconds and then allowed to fully relax at zero force. Recovery 1st Pull—50%:

### TABLE 1

<table>
<thead>
<tr>
<th>VM 6100-VM 6102-VM 2125-VM 2320 MAIN CHARACTERISTICS</th>
<th>VM 6100 POLYOLEFIN</th>
<th>VM 6102 POLYOLEFIN</th>
<th>VM 2125 POLYOLEFIN</th>
<th>VM 2120 POLYOLEFIN</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFR_ g/10 min (1)</td>
<td>3</td>
<td>3</td>
<td>80</td>
<td>200</td>
<td>ASTM D-1238</td>
</tr>
<tr>
<td>DENSITY_ g/cm³</td>
<td>0.855</td>
<td>0.863</td>
<td>0.865</td>
<td>0.866</td>
<td>ASTM D-3900</td>
</tr>
<tr>
<td>Ethylene Content (wt %)</td>
<td>/</td>
<td>16</td>
<td>13</td>
<td>14</td>
<td>ASTM D-2240</td>
</tr>
<tr>
<td>HARDNESS (SHORE A)</td>
<td>55</td>
<td>59</td>
<td>63</td>
<td>62</td>
<td>ASTM D-900</td>
</tr>
<tr>
<td>FLEXURAL</td>
<td>/</td>
<td>8.5</td>
<td>29.8</td>
<td>18.6</td>
<td>ASTM D-412</td>
</tr>
<tr>
<td>MODULUS_ Mpa</td>
<td>/</td>
<td>&gt;8.3</td>
<td>8.1</td>
<td>6.7</td>
<td>ASTM D-412</td>
</tr>
<tr>
<td>TENSILE @ BREAK_ Mpa</td>
<td>/</td>
<td>&gt;2000</td>
<td>860</td>
<td>853</td>
<td>ASTM D-412</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>/</td>
<td>1.6</td>
<td>3.5</td>
<td>2.8</td>
<td>ASTM D-412</td>
</tr>
<tr>
<td>ASTM 300% ELONG. Mpa</td>
<td>/</td>
<td>2.0</td>
<td>4.6</td>
<td>3.6</td>
<td>ASTM D-412</td>
</tr>
</tbody>
</table>

The compositions of the filaments of the different samples of spunbonded nonwoven W are summarized in table 2.

### TABLE 2

<table>
<thead>
<tr>
<th>Filaments composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>E-7-6</td>
</tr>
<tr>
<td>E-7-8</td>
</tr>
<tr>
<td>E-7-10</td>
</tr>
</tbody>
</table>

(a) the additive in the sheath is a slip agent masterbatch containing lubricant and used for facilitating spinning.

The main spunbonding process parameters are summarized in the following table 3 for each sample of spunbonded nonwoven W.
Recovery 2nd Pull—50%:

[0133] The web samples were elongated a second time at 50% elongation, held in the stretched state for 30 seconds and then relaxed to zero tensile force. At the end the recovery (R) was measured.

[0134] The resulting nonwoven of the invention has a root mean square (RMS) average recovery of at least 85%, said RMS average recovery being based on machine direction (R_M) and cross direction (R_C) recovery values after 50% elongation and one pull. RMS average recovery are calculated from the formula:

\[ \text{RMS} = \left( \frac{1}{2}R_M^2 + R_C^2 \right)^{1/2} \]

wherein R_M is the recovery measured in the cross direction and R_C is the recovery measured in the machine direction. Preferably, the fabrics have at least about a RMS recovery of 80% after two successive 50% pulls.

[0135] The recovery results issued from these experiments are summarized in Table 4 (elastic spunbonded nonwoven W of the invention).

[0136] Table 5 relates to recovery results obtained with comparative spunbonded webs W not covered by the invention. The main characteristics of the TPU materials used in the comparative examples of Table 5 are also summarized in Table 6.

**TABLE 4**

<table>
<thead>
<tr>
<th>Example No.</th>
<th>Arrangement</th>
<th>Filament bi-component</th>
<th>Spunbonded filament composition</th>
<th>Spunbonded Web</th>
<th>(W) - weight gain</th>
<th>Recovery 1st pull 50%</th>
<th>Recovery 2nd pull 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-7-6</td>
<td>core</td>
<td>85 wt %</td>
<td>VM2125 (80 wt %) + VM6100 (20 wt %)</td>
<td>60</td>
<td>92.3</td>
<td>90.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>15 wt %</td>
<td>VM 2125 (97 wt %) + slip agent (3 wt %)</td>
<td>30</td>
<td>89.5</td>
<td>87.3</td>
<td></td>
</tr>
<tr>
<td>E-7-8</td>
<td>core</td>
<td>85 wt %</td>
<td>VM2125 (80 wt %) + VM6100 (20 wt %)</td>
<td>30</td>
<td>89.5</td>
<td>87.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>15 wt %</td>
<td>VM 2125 (97 wt %) + slip agent (3 wt %)</td>
<td>30</td>
<td>89.5</td>
<td>87.3</td>
<td></td>
</tr>
<tr>
<td>E-7-10</td>
<td>core</td>
<td>85 wt %</td>
<td>VM2125 (80 wt %) + VM6100 (20 wt %)</td>
<td>80</td>
<td>94.1</td>
<td>92.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>15 wt %</td>
<td>VM 2125 (97 wt %) + slip agent (3 wt %)</td>
<td>30</td>
<td>89.5</td>
<td>87.3</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 5**

<table>
<thead>
<tr>
<th>Example No.</th>
<th>Filament bi-component</th>
<th>Filament composition</th>
<th>Web (W) - weight gain</th>
<th>Recovery 1st pull 50%</th>
<th>Recovery 2nd pull 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>core</td>
<td>70 wt %</td>
<td>TPU 1185 AM</td>
<td>49</td>
<td>97.1</td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>30 wt %</td>
<td>TPU 1185 AM</td>
<td>45</td>
<td>96.1</td>
</tr>
<tr>
<td>20</td>
<td>core</td>
<td>70 wt %</td>
<td>TPU 1180 A</td>
<td>50</td>
<td>97.3</td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>30 wt %</td>
<td>TPU 1180 A</td>
<td>49</td>
<td>96.0</td>
</tr>
<tr>
<td>21</td>
<td>core</td>
<td>70 wt %</td>
<td>TPU 2180 A</td>
<td>49</td>
<td>96.0</td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>30 wt %</td>
<td>TPU 2180 A</td>
<td>49</td>
<td>96.0</td>
</tr>
<tr>
<td>22</td>
<td>core</td>
<td>70 wt %</td>
<td>VM 2125</td>
<td>50</td>
<td>88.1</td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>30 wt %</td>
<td>VM 2125</td>
<td>45</td>
<td>86.3</td>
</tr>
<tr>
<td>23</td>
<td>core</td>
<td>70 wt %</td>
<td>VM 2120</td>
<td>50</td>
<td>88.1</td>
</tr>
<tr>
<td></td>
<td>sheath</td>
<td>30 wt %</td>
<td>VM 2120</td>
<td>49</td>
<td>86.3</td>
</tr>
</tbody>
</table>
TABLE 6

<table>
<thead>
<tr>
<th>Elastollan grades</th>
<th>Grade 2180 A</th>
<th>Grade 1180 A</th>
<th>MAIN CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENSITY, g/cm³</td>
<td>1.14</td>
<td>1.11</td>
<td>Polyether</td>
</tr>
<tr>
<td>HARDNESS (SHORE A)</td>
<td>80</td>
<td>88</td>
<td>Polyether</td>
</tr>
<tr>
<td>TENSILE STRENGTH, Mpa</td>
<td>45</td>
<td>45</td>
<td>Polyether-ether</td>
</tr>
<tr>
<td>ELONGATION @ BREAK, %</td>
<td>650</td>
<td>600</td>
<td>Polyether-ether</td>
</tr>
<tr>
<td>TENSILE STRESS @ 100%</td>
<td>4.5</td>
<td>7</td>
<td>Polyether-ether</td>
</tr>
<tr>
<td>ELONG, Mpa</td>
<td>8</td>
<td>12</td>
<td>Polyether-ether</td>
</tr>
</tbody>
</table>

(1) Measurements were performed on compression molded specimens.

The spunbonded layer (W) of the invention (samples E-7-6; E-7-8; E-7-10) exhibits very high recovery values. These recovery values are higher than recovery values that are obtained for example with spunbonded web made of Sheath/Core bi-component filaments (LLDPE/TPU) as the ones described in examples No 10 of U.S. Pat. No. 6,225,243.

The comparative examples No 19, 20 and 21 were based on pure TPU, same in core and in sheath arrangement. Even though elasticity was good, the elastic TPU layer exhibits a high stickiness. Furthermore, the elastic TPU layer was not thermo-bondable to other polyolefin-based layers. In addition, because of the degradation of the TPU during melting, TPU materials can not be processed in standard polypropylene extruders.

Compared to examples 19 to 21 (TPU/TPU), the elastic spunbonded layer of the invention (samples E-7-6; E-7-8; E-7-10) is advantageously less sticky, and thus easier to wound and unwound. Furthermore, the chemical composition of the sheath is similar to polyolefin materials that are mostly used in the field of nonwoven. The polymeric materials used for practicing the invention can thus be advantageously processed in standard polypropylene extruders. Furthermore, thermal bondability of the spunbonded layers (W) of the invention with other polyolefin-based nonwoven layers (L1, L2) is improved.

The comparative examples No 22 and No 23 were based on pure VM2125 or VM 2120. Compared to examples No 22 and No 23 (VM/VM), the spunbonded layers (W) of the invention (E-7-6; E-7-8; E-7-10) have advantageously a higher elasticity and elastic recovery.

Additionally, it has to be outlined that advantageously, and in contrast with other solutions of the prior art as the ones described, for example, in US patent application No 2005/0215964, the spunbonded nonwoven layer W of the invention does not necessarily require any activation step for obtaining its elastic properties.

EXAMPLES

Perforated Hydroentangled Elastic Nonwoven Fabrics

Different perforated composite nonwoven fabric (C/W, C/W/S and C/W/C) have been produced according to the manufacturing processes of FIGS. 3 and 4 (examples E-150-FP, E-151-FP, E-152-FP, E-153-FP, E-155-FP). The compositions of these composite nonwoven fabrics are summarized in Table 7.

TABLE 7

<table>
<thead>
<tr>
<th>Examples structure</th>
<th>total B.W. (gsm)</th>
<th>Bottom Layer, type</th>
<th>Elastic spunbonded Layer W (gsm)</th>
<th>Top Layer, type</th>
<th>Top gsm</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-150-FP</td>
<td>60</td>
<td>on line carded PP</td>
<td>30 E-7-8</td>
<td>NONE</td>
<td>0</td>
</tr>
<tr>
<td>E-151-FP</td>
<td>58</td>
<td>on line carded PP</td>
<td>20 E-7-8</td>
<td>Spunbonded PP</td>
<td>8</td>
</tr>
<tr>
<td>E-152-FP</td>
<td>110</td>
<td>on line carded PP</td>
<td>20 E-7-10</td>
<td>Spunbonded PP</td>
<td>10</td>
</tr>
<tr>
<td>E-153-FP</td>
<td>90</td>
<td>on line carded PP</td>
<td>20 E-7-6</td>
<td>Spunbonded PP</td>
<td>10</td>
</tr>
</tbody>
</table>
TABLE 7-continued

Perforated hydroentangled elastic nonwoven of the invention

<table>
<thead>
<tr>
<th>Examples</th>
<th>structure</th>
<th>Elastic total B.W. (gsm)</th>
<th>Bottom spunbonded Layer, type</th>
<th>Elastic spunbonded Layer W (see table 4)</th>
<th>Top Layer, type</th>
<th>gsm</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-155-FP</td>
<td>C/W/C</td>
<td>94 on line carded PP</td>
<td>20 E-7-6 Carded PP</td>
<td>60</td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

C: carded layer  
W: Elastic spunbonded layer of the invention  
M/C: Spunbonded layer  
PP: Polypropylene

[0143] The outer carded layers (C) with low basis weight give textile appearance and soft touch to the final nonwoven fabric. This property is particularly useful in all applications wherein the composite nonwoven has to come into contact with the skin, for example in diapers, feminine/adult care or the like. The outer polypropylene carded layers (C) also give advantageously a dimensional stabilization to the nonwoven fabric in the machine direction.

The main process parameters for the final hydroentanglement and perforation steps by means of hydro-jets are summarized in the following table 8.

TABLE 8

Production data - Hydroentanglement and perforation

<table>
<thead>
<tr>
<th>Examples</th>
<th>Pattern</th>
<th>beam 201a</th>
<th>beam 201b</th>
<th>beam 202a</th>
<th>beam 202b</th>
<th>beam 203a</th>
<th>beam 203b</th>
<th>beam 204a</th>
<th>beam 204b</th>
<th>speed, m/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-150-FP</td>
<td>perfo, screen, 4th drum (i)</td>
<td>50</td>
<td>60</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>150</td>
<td>150</td>
<td>16</td>
</tr>
<tr>
<td>E-151-FP</td>
<td>perfo, screen, 4th drum (i)</td>
<td>50</td>
<td>70</td>
<td>NA</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
<td>180</td>
<td>180</td>
<td>16</td>
</tr>
<tr>
<td>E-152-FP</td>
<td>perfo, screen, 4th drum (i)</td>
<td>50</td>
<td>70</td>
<td>NA</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
<td>200</td>
<td>200</td>
<td>16</td>
</tr>
<tr>
<td>E-153-FP</td>
<td>perfo, screen, 4th drum (i)</td>
<td>50</td>
<td>70</td>
<td>NA</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
<td>200</td>
<td>200</td>
<td>16</td>
</tr>
<tr>
<td>E-155-FP</td>
<td>perfo, screen, 4th drum (i)</td>
<td>30</td>
<td>40</td>
<td>NA</td>
<td>70</td>
<td>NA</td>
<td>NA</td>
<td>180</td>
<td>180</td>
<td>16</td>
</tr>
</tbody>
</table>

NA: Not active jet beam  
(i): In all these examples, the screen used for performing the perforation on the fourth drum 204 was the same, namely a screen manufactured by ALBANY under reference BZ FW 9.5. 
The specifications of this screen provided by the manufacturer were the following:
Metal count: 9.5 x 8.5/1cm  
Warp diameter: 0.63 x 0.33 mm BZ  
Shade diameter: 0.51 mm BZ  
Caliper: 0.93 mm  
Nominal air permeability: 3.77 m3/s-850 CFM.

EXAMPLE

Non-Perforated Hydroentangled Elastic Nonwoven Fabrics

[0145] A non perforated composite nonwoven fabric (C/W/M/C) of basis weight 92 gsm has been also produced in a pilot plant according to the manufacturing process of FIG. 5 (example referred “E-105/HET”).

[0146] In this example the two external layers were carded layers (C) made of PP (polypropylene fibers). The basis weight of each carded layer (at the output of the carded unit) was 14 gsm.

[0147] The elastic spunbonded layer W was made of bicomponent sheath/core filaments having the round cross-section of FIG. 1D. The core of the filaments was made (first polymeric component P) of a blend VM2125 (70 wt %) and VM6100 (30 wt %). The melt flow rate MFR1 of this blend (first polymeric component P) calculated by means of formula (1) was thus around 29.87 g/10 min. 

[0148] The outer sheath of the filaments was made of VM 2125 (second polymeric component P). The weight of the core was 90% of the total basis weight, and the weight of the sheath was 10% of the total basis weight. The basis weight of the elastic spunbonded layer (W) was 54 gsm.
In this example the material used for the elastic meltblown layer (M) was VM 2320. The basis weight of the meltblown layer (M) was 10 gsm.

VM 2320

VM 2320 is a specialty polyolefin elastomer suitable for melt blown process commercially available from ExxonMobil Chemical Co, Huston, Tex, under the trademark of VISTAMAXX®. This specialty polyolefin elastomer is a semi-crystalline elastic polypropylene-based olefin copolymer comprising at least 80 wt% of propylene units and made in the presence of a metallocene catalyst during the polymerization process. This copolymer has a MFR (Melt Flow Rate) of 200 (measured at 230°C and 2.16 Kg, ASTM D-1238), a broad melting temperature range and a highest melting peak of 160°C. This copolymer has a slower crystallization rate than polypropylene homopolymers.

Other technical characteristics of materials VM 2320 are given in Table 1.

More generally, the thermoplastic materials used for making the meltblown fibers will be knowingly selected by one skilled in the art, in respect of the properties required for the elastic nonwoven fabric. Specialty elastomeric polyolefin VM2320 is given only by way of example. This specialty elastomeric polyolefin can be replaced by any other known thermoplastic material, in particular by any thermoplastic material that are used in the field of hygienic product (diapers, training pants, . . . ) for making meltblown layers.

Elastic properties of these elastic nonwoven fabrics of the invention were measured at 23°C ±2, using an Instron Testing apparatus equipped with Grips type line contact or similar. The grip defines the gauge for the specimen, therefore those skilled in the art know that the grip must hold the specimen to avoid slipping or damage. The above mentioned apparatus has to be set at 1 inch gauge length and a stretching rate of 10 inches per minute. The specimens will have the following dimensions: width 1 inch and length 3 inches. The forces were measured in Newton/inch. Tensile tests, load at peak and elongation at peak and hysteresis cycles have been performed on the above mentioned specimens specifically in cross direction (CD). The Instron Testing apparatus is equipped with a software which plots the load-elongation curve and the data are stored in the buffer memory.

CD Load@peak:
The specimen has been pulled at a stretching rate of 10 inches per minute until the maximum load has been reached. The corresponding value of the CD Load@peak expressed in N/inch is reported in Table 9.

The data in the last column of Table 9 ("ELASTIC layer %) represent the weight percentage of the elastic material [i.e. elastic spunbonded layer (W) and elastic meltblown layer for example E-105/HET and elastic spunbonded layer (W) for examples E-150-FP, E-151-FP, E-152-FP, E-153-FP, E-155-FP, E-105-FP] on the total weight of the elastic nonwoven fabric.

### EXAMPLE

**Elastic Spunbonded Nonwoven (W/M)**

Samples of multilayer nonwoven (C/W/M/C) have been produced on a pilot plant, without bonding the layers together. Then the two outer carded layers were removed in order to keep only the elastic spunbonded (W) and meltblown (M) layers.

The elastic spunbonded layer W was made of bicomponent sheath/core filaments having the round cross-section of FIG. 1D. The core of the filaments was made (first polymeric component P) of a blend VM2125 (70 wt%) and
VM6100 (30 wt %). The outer sheath of the filaments was made of VM 2125 (second polymeric component P'). The weight of the core was 90% of the total basis weight, and the weight of the sheath was 10% of the total basis weight. The basis weight of the elastic spunbonded layer (W) was 54 gsm.

In this example the material used for the elastic meltblown layer (M) was VM 2520. The basis weight of the meltblown layer (M) was 10 gsm. The elastic properties of the elastic spunbonded nonwoven (W/M) were measured and are given in Table 10.

<table>
<thead>
<tr>
<th></th>
<th>CD PERMANENT SET AFTER 2 CYCLES</th>
<th>CD ELONGATION (%)</th>
<th>CD LOAD (%)</th>
<th>CD PEAK (%)</th>
<th>CD LOAD (%)</th>
<th>CD PEAK (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-105</td>
<td>21</td>
<td>398</td>
<td>1.4</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The elastic nonwoven fabric of the invention is not limited to the particular multilayered structures of the examples previously described. The invention actually encompasses any elastic nonwoven fabric wherein at least one of the layers is an elastic spunbonded nonwoven W as the one defined in the claims.

1. An elastic spunbonded nonwoven comprising a plurality of multi-component filaments, wherein each multi-component filament comprises a first polymeric component extending along the length of the filament in at least a first section of the filament, and a second polymeric component extending along the length of the filament in at least a second section of the filament that is distinct from the first section, wherein the first polymeric component comprises an elastomeric olefin-based olefin polymer, and the second polymeric component comprises an elastomeric olefin-based olefin and has a melt flow rate MFR2 that is higher than the melt flow rate MFR1 of the first polymeric component, and wherein the elastomeric olefin-based olefin copolymer for the first polymeric component and for the second polymeric component comprises propylene and from 10 to 25 weight % of one or more C2 and/or C4 to C10 alpha-olefin co-monomers.

2. An elastic spunbonded nonwoven according to claim 1, wherein each multi-component filament comprises a core and an outer sheath, and wherein the core comprises the first polymeric component, and the sheath comprises the second polymeric component.

3. An elastic spunbonded nonwoven according to claim 1, wherein the ratio MFR2/MFR1 is higher than 1.5.

4. An elastic spunbonded nonwoven according to claim 1, wherein the first polymeric component comprises a blend of at least two elastic propylene-based olefin copolymers of different melt flow rate.

5. An elastic spunbonded nonwoven according to claim 1, wherein the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component is an ethylene propylene copolymer.

6. An elastic spunbonded nonwoven according to claim 1, wherein the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component has a melt flow rate of 0.1 to 2000 g/10 min, most preferably greater than 2 g/10 min and less than 100 g/10 min, as measured by ASTM D-1238 at 230° C. and 2.16 kg.

7. An elastic spunbonded nonwoven according to claim 1, wherein the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component has a molecular weight distribution of less than 5, preferably between 1 and 4.

8. An elastic spunbonded nonwoven according to claim 1, wherein the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component comprises at least 80 wt % of propylene units.

9. An elastic spunbonded nonwoven according to claim 1, wherein the elastic propylene-based olefin copolymer for the first polymeric component and for the second polymeric component is a metallocene-catalysed polymer.

10. An elastic spunbonded nonwoven according to claim 1, wherein at least 50% of the whole surface of each filament is constituted by the second polymeric component.

11. An elastic spunbonded nonwoven according to claim 10, wherein 100% of the whole surface of each filament is constituted by the second polymeric component.

12. An elastic spunbonded nonwoven according to claim 1, having a root mean square (RMS) average recovery of at least 85%, said RMS average recovery being calculated from the formula:

$$R = \frac{L_r}{L_s}$$

wherein $L_s$ represents the stretched length of the specimen; $L_r$ represents the recovered length of the specimen, $L_o$ represents the original length of the specimen.

13. An elastic spunbonded nonwoven according to claim 12, and having a RMS recovery, after two successive 50% pulls, of at least 80%.

14. An elastic spunbonded nonwoven according to claim 1, wherein the amount of the first polymeric component is at least 50 wt % of the total weight of the filament, and the amount of the second polymeric component is less than 50 wt % of the total weight of the filament.

15. A spunbonded nonwoven according to claim 14, wherein the amount of the second polymeric component is less than 40 wt % of the total weight of the filament, and preferably equal or less than 30 wt % of the total weight of the filament.

16. An elastic nonwoven fabric comprising at least one first elastic spunbonded nonwoven layer according to claim 1 and at least one additional nonwoven layer.

17. An elastic nonwoven fabric according to claim 16, wherein the said at least one additional nonwoven layer is selected from the group:

- a carded nonwoven layer, a meltblown layer, a spunbonded layer, a polyolefin-based nonwoven layer, a polypropylene-based nonwoven layer.

18. An elastic nonwoven fabric according to claim 16, comprising at least two additional carded nonwoven layers and wherein the elastic spunbonded nonwoven layer is sandwiched between the two carded layers.
19. An elastic nonwoven fabric according to claim 18, and comprising an additional meltblown layer interposed between the elastic spunbonded nonwoven layer and one carded nonwoven layer.

20. An elastic nonwoven fabric according to claim 16, wherein the layers are bonded together by one of the following bonding technologies: thermal bonding, water needling, mechanical needling, ultrasonic bonding, air trough bonding and chemical bonding.

21. An elastic nonwoven fabric according to claim 16, wherein the layers are perforated.

22. An elastic nonwoven fabric according to claim 16, and having a CD permanent set after two cycles at 150% elongation less than 50%, and preferably less than 40%.

23. An elastic nonwoven fabric according to claim 16, and having a CD elongation/Peak of at least 150%, and preferably of at least 200%.

24. An elastic nonwoven fabric according to claim 16 wherein the layers have been hydroentangled.

25. A hydroentangled elastic nonwoven fabric according to claim 24, wherein the layers are perforated, notably by means of hydro jets.

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