PROCESS TO PRODUCE NONWOVEN FABRICS WITH TOTALLY OR PARTIALLY HYDROPHILIC AREAS AND HYDROPHOBIC AREAS

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ABSTRACT

A nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas which have a certain geometry and, optionally, a hydrophilic gradient is provided. The process to manufacture the fabric includes a treatment stage thereof with a plasma, whether in a vacuum or at atmospheric pressure. By controlling the plasma generation and application parameters, the particular area and the quantity of hydrophilic groups incorporated in the fabric surface is controlled. The fabric can be used in applications of the hygiene and sanitary sector to manufacture nappies, incontinence products and feminine hygiene products, for example.
FIG. 1

FIG. 2

FIG. 3
PROCESS TO PRODUCE NONWOVEN FABRICS WITH TOTALLY OR PARTIALLY HYDROPHILIC AREAS AND HYDROPHOBIC AREAS

RELATED APPLICATIONS

[0001] This application claims priority to Spanish Application No. 200502891, filed Nov. 23, 2005, which is incorporated herein by reference.

DESCRIPTION

[0002] 1. Field of the Invention

[0003] The present invention belongs to the field of nonwoven fabrics manufactured with polyolefins which, by their very nature, are hydrophobic, i.e. they have a degree of water repellency. More specifically, it relates to a process to produce nonwoven fabrics which have totally or partially hydrophilic areas and hydrophobic areas with a certain geometry and, optionally, with a hydrophilic gradient. Said fabrics can be used as the top sheet in different hygiene products as they have advantages with respect to a feeling of dryness and comfort.

[0004] 2. Background of the Invention

[0005] Many applications from the hygiene sector need a hydrophilic fabric. Thus, in most nappies, incontinence products and feminine hygiene products currently manufactured, the part called top sheet, which comes into contact with urine and other secretions is hydrophilic.

[0006] Currently, the treatment performed to convert a hydrophobic nonwoven fabric into a hydrophilic nonwoven fabric uses superficial treatments with hydrophilic agents or wetting solutions sometimes called surfactants.

[0007] Surfactants are substances which are defined from a physicochemical point of view as a polar-nonpolar duality. The polar part has affinity for polar solvents, in particular for water and is called hydrophilic. By contrast, the nonpolar group is called the hydrophobic or lipophilic part.

[0008] When the nonwoven fabric undergoes treatment with surfactant solutions, the fabric only contains the active part of the solution once it has dried, i.e. the surfactant. In the case of a nonwoven fabric manufactured with polypropylene, the hydrophobic part of the surfactant is oriented towards the polypropylene chains (100% nonpolar) and the hydrophilic part towards the exterior of the polypropylene chains increasing the critical surface tension of the polypropylene, giving the nonwoven fabric hydrophilic characteristics.

[0009] When a drop of liquid comes into contact with a solid, different forces act on it: the surface tension of the liquid, the critical surface tension of the solid and the interfacial tension between both compounds. The ratio between these forces will depend on the greater or lesser resistance of the fabric to the passage of water or another liquid.

[0010] Therefore, from these three parameters, two of them (critical surface tension of the solid and interfacial tension between fabric and liquid) directly depend on the raw material.

[0011] The critical surface tension of polypropylene is approximately 29 mN/m, whilst that of pure water is 72 mN/m. The smaller the difference (increasing the value of the critical surface tension of polypropylene), the greater the absorbency produced.

[0012] Nevertheless, the use of solutions with liquid hydrophilic agents has some drawbacks:

[0013] 1. Important generation of wastes that must be treated. This represents high handling and treatment costs.

[0014] 2. As the nonwoven fabric is treated with a solution, this involves the subsequent drying of the water and, therefore, energy consumption.

[0015] 3. The solutions cannot be stored and reused due to the risk of bacteriological contamination and the solution should be exhaustively cleaned from the system when changing from one agent to another. This all represents an added cost and a risk from possible bacteriological contamination.

[0016] An alternative technology to achieve fabrics with hydrophilic characteristics is plasma technology. The application of plasma technology to textiles commenced in Russia in the 1960s, taking center stage in the United States and Europe from the 1980s. Several studies have been published since then with the results of experiments in vacuum reactors basically designed for the treatment of inorganic materials.

[0017] The advantages of these new plasma technologies compared with the humid method are evident:


[0019] 2. Reduction or elimination of wastes generated by the use of liquid hydrophilic agents.


[0021] Nevertheless, the hydrophilic coatings produced are uniform.

[0022] Nonwoven fabrics have been disclosed in the state of the art with specific hydrophilic areas, based on a series of openings made on the surface therein (U.S. Pat. No. 6,911,573).

OBJECT OF THE INVENTION

[0023] The present invention, therefore, has the object of providing a nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas with a defined geometry of the hydrophilic areas on its surface.

[0024] Another object of the invention is to provide a process to produce said nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas.

[0025] Finally, another object of the invention is to provide the use of said nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas in applications of the hygiene or sanitary sector.

DESCRIPTION OF THE INVENTION

[0026] In an aspect of the invention, a nonwoven fabric is provided with totally or partially hydrophilic areas and hydrophobic areas which have a defined geometry of the hydrophilic areas on its surface.
In a particular embodiment, the hydrophilic areas have a hydrophilic gradient.

Thus, in the nonwoven fabric, the aim is to generate hydrophilic areas of different or equal degree, i.e., that more liquid passes through on one edge of the area than on the other. The areas that are or are not absorbent, as well as the gradient areas, are not random.

There can be any geometry in accordance with the use that is going to be made of said nonwoven fabric. Thus, hydrophilic areas can be produced in the top sheet of a nappy where one wants liquid to pass through, i.e., hydrophilic, and other predetermined untreated areas so that said areas are hydrophobic.

In a particular embodiment, said nonwoven fabric is manufactured with a polyolefin. In a preferred embodiment, said nonwoven fabric is manufactured with polypropylene. As has been mentioned, polypropylene is, among many others, a hydrophobic polymer used to manufacture hydrophobic nonwoven fabrics, i.e., with a certain degree of water repellency.

In another particular embodiment, said nonwoven fabric is a spunbond fabric. In another particular embodiment, said nonwoven fabric is a meltblown fabric.

Spunbond fabric is formed from continuous fibers, which are more or less smooth, with a diameter in the order of 17-20 microns which cohere to one another by calendaring. Thus, generating close soldering points joined by portions of straight, and comparatively very hard, fibers, gives a certain rigidity to the fabric.

Meltblown fabric is formed from continuous fibers with very fine diameters in the order of 4 to 7 microns which cohere to one another without the need for a final cohesion process (a calender or a hydrogland, for example).

In another aspect of the invention, a process is provided to produce a nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas as previously described, which comprises a stage of treating the fabric with gaseous plasma.

In the context of the invention, the term “plasma” relates to a partially ionized gas formed from ions, electrons and neutral species, capable of modifying the substrate surface without modifying the substrate’s intrinsic properties.

The plasma is generated by applying a large quantity of energy to a volume of gas, the following parameters defining the final characteristics of the surface to treat:

Gas composition

Plasma generation and application properties: pressure, power, frequency, application time and application distance.

Substrate properties.

The final characteristics of the surface to treat that can be produced in accordance with the three previous points are varied: hydrophilic, hydrophobic, printing and sterilization, among others. The objective of this invention is to produce hydrophilic properties to a greater or lesser extent in certain fabric areas.

The substrate, as has already been mentioned, is a nonwoven fabric, of spunbond or meltblown type, or the combination of both, manufactured with polyolefins, in general and polypropylene, in particular. In a particular embodiment, said fabric is manufactured with polypropylene.

When the polypropylene is bombarded with plasma, a series of chemical and/or physical reactions occur which modify the hydrophobic nature of the polypropylene.

In accordance with the gas used, the reactive species, as well as the ions will be different and, therefore, the action on the polypropylene will give it different final characteristics. The gas used may be of a different nature, e.g., organic, inorganic or a liquid precursor. The modification of the substrate by plasma treatment is superficial and the intrinsic characteristics of the polypropylene are not modified, i.e., the mechanical properties, e.g., traction and elongations.

There are different forms of inducing the ionization of gases in accordance with the technology applied:

Glow discharge (at low pressures, vacuum plasma).

Corona discharge (at atmospheric pressure or slightly higher).

Dielectric barrier discharge (at atmospheric pressure).

The source of gas ionization may be, for example, a two-electrode system whereby the electric energy of a radiofrequency generator is applied.

The objective of this invention is to produce hydrophilic characteristics using plasma technology in a vacuum or at atmospheric pressure. In the case of vacuum-plasma, greater uniformity and flexibility is attained than with any other plasma treatment.

The plasma is applied according to a variable geometry by controlling certain plasma generation and application parameters. In this way, the area and quantity of hydrophilic groups which are incorporated in the nonwoven fabric’s surface is controlled.

The plasma generation and application parameters that are controlled are the following:

the power or voltage of the gas ionization source to generate the plasma;

the frequency of the gas ionization to generate the gaseous plasma;

the plasma application distance, and

the plasma application time.

Depending on the degree and dimension of the hydrophilic areas one wants to produce, it will act on either one or another concept or several thereof.

 Said parameters can be controlled, for example, by computer with the aid of suitable software.

Furthermore, via a plasma gradient on a spunbond or meltblown nonwoven fabric, for example, we can produce a greater or lesser deposition of hydrophilic groups.
will depend on the quantity thereof that the nonwoven fabric is more or less hydrophilic in certain areas in accordance with the gradient used.

[0059] The application of plasma by areas is provided to control the area and quantity of hydrophilic groups that are incorporated on the surface of the nonwoven fabric. There are different possibilities for the application of plasma by areas.

[0060] In a first embodiment, the plasma is projected from several individual heads, each one of which projects in a certain area, defining a certain geometry on the nonwoven fabric. These heads have an on/off-type frequency controller and enable partially hydrophilic areas to be produced.

[0061] In a second embodiment the plasma is projected from a single head positioned across the nonwoven fabric and, between said head and the substrate to treat, there is a sheet of stainless steel, aluminum or another material provided with holes. Said holes can have varied geometries and can be distributed on the surface of the sheet in very different ways, so that the nonwoven fabric produced will have hydrophilic areas with a geometry defined by the projection of plasma through the holes in the sheet.

[0062] A third embodiment comprises a single head positioned throughout the fabric and incorporates software that permits defining the number of plasma pulsations per time unit. This permits the intermittent application of plasma on the nonwoven fabric which will be displaced under the head producing previously defined hydrophilic and hydrophobic areas in the end product.

[0063] Another group of solutions will focus on the treatment subsequent to the plasma treatment. This treatment consists of a deposition of a vaporized monomer together with hydrophilic groups. This gives properties that last with time, as the anchoring of the functional groups is much stronger.

[0064] The use of plasma as pre-treatment means the activation of the nonwoven fabric's fibers for subsequent coating treatment by deposition of a vaporized monomer with phlic functional groups. Said deposition is performed in the areas of the nonwoven fabric previously treated with plasma. It is necessary to provide the system with a vacuum box under the nonwoven fabric to direct and collect the vapor generator. After vaporization, it is necessary to cure the monomer to produce homogeneous treatment in the areas treated.

[0065] The deposition treatment can be performed using a monomer evaporator and a plate with holes positioned across the nonwoven fabric. Said holes can have varied geometries and can be distributed on the surface of the plate in very different manners.

[0066] In another possible embodiment, the deposition treatment is performed by several evaporators using corresponding rotating cylindrical plates, which are individual, perforated and oriented towards the nonwoven fabric. Said holes can have varied geometries and may be distributed on the surface of the plate in very different forms.

[0067] In either of the two cases, the nonwoven fabric that will be produced has coated hydrophilic and hydrophobic areas in previously defined areas distributed with a defined geometry.

[0068] Another aspect of the invention provides the use of said nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas in applications of the hygiene or sanitary sector. In a preferred embodiment, said fabric is used to manufacture a hygiene or sanitary product, such as a nappy, an incontinence product or a feminine hygiene product. Said product is much more comfortable since the process of the invention permits a top sheet design which keeps the skin in contact with said top sheet dryer and more hygienic. Indeed, the hydrophilic areas of the hygiene product’s top sheet, transport body fluids to the absorbent core, achieving a feeling of dryness and comfort, and it avoids the skin being humid for too long, thus preventing problems due to excess hydration of the skin or due to contact thereof with the biological or chemical materials in the fluids.

BRIEF DESCRIPTION OF THE FIGURES

[0069] To complement the description being made and with the object of aiding towards a better understanding of the characteristics of the invention, in accordance with a preferred example of embodiment thereof, a set of drawings is attached as an integral part of said description, wherein the following has been represented, with an illustrative, non-limiting character:

[0070] FIG. 1 shows a schematic representation of a plasma projection system using individual heads applied on a nonwoven fabric.

[0071] FIG. 2 shows a schematic representation of a plasma projection system using a single head applied across the fabric with the intermediation of a sheet provided with holes.

[0072] FIG. 3 shows a schematic representation of a plasma projection system using a single head across the fabric, provided with software to define the number of pulsations that is translated in plasma projections per time unit.

[0073] FIG. 4 shows a schematic representation of a coating system by deposition of a monomer using a plate, as well as showing a detailed view of the unequal structure produced in the nonwoven fabric.

[0074] FIG. 5 shows a possible monomer deposition coating system using monomer evaporators with perforated plates oriented towards the nonwoven fabric, as well as showing a detailed view of the unequal structure produced in the nonwoven fabric.

[0075] FIG. 6 shows another detailed view of the unequal structure of the fabric produced by the process of projection by areas.

[0076] FIG. 7 shows another detailed view of the unequal structure of the fabric produced by the process of projection by areas.

PREFERRED EMBODIMENT OF THE INVENTION

[0077] Below, a preferred embodiment of the invention will be described with reference to the figures.

[0078] As is observed in FIGS. 1 to 3, the process to produce nonwoven fabrics with totally or partially hydrophilic areas and hydrophobic areas that comprises the object
of this invention basically consists of the partial projection of plasma on certain sectors of the surface of a nonwoven fabric (2) manufactured with a hydrophobic material, preferably polyolefin, to produce in those sectors a geometry of hydrophilic areas (5) and/or partially hydrophilic areas (7) between hydrophobic areas (6).

[0079] FIGS. 1 to 3 show different possibilities with regard to the means used for plasma application.

[0080] These FIG. 1 shows several heads (1) that project plasma on a nonwoven fabric (2) in different sectors, whilst this continually moves.

[0081] FIG. 2 shows that the head (1) projects plasma throughout the width of the nonwoven fabric (2) using a sheet (3), provided with holes (4) to, in this way, define the hydrophilic areas (5) in the nonwoven fabric in correspondence with said holes (4).

[0082] In FIG. 3, the nonwoven fabric (2) is displaced under a head (1) which projects plasma at different instants controlled by software.

[0083] The heads (1) can also be displaceable to define different geometries of hydrophilic areas (5) or partially hydrophilic areas (7) on the nonwoven fabric (2).

[0084] The result of the unequal application of the plasma projection on the nonwoven fabric (2) causes a specific geometry, as is reflected in FIG. 6, or as in the case of FIG. 7 which shows a nappy with hydrophilic areas (5), hydrophobic areas (6) or partially hydrophilic areas (7).

[0085] The heads (1) incorporate frequency controllers, not represented, which enable the plasma projection frequency to be modified to produce the partially hydrophilic areas (7) on the nonwoven fabric (2).

[0086] FIG. 4 represents a monomer evaporator (8) which is applied complementarily to the plasma projection on the hydrophilic areas (5) of the nonwoven fabric (2) giving rise to coated hydrophilic areas (13). Said FIG. 4 represents a plate (9) provided with openings (10) whereby the monomer passes to coat the hydrophilic areas (5).

[0087] Likewise, FIG. 5 has represented several monomer evaporators (8) in correspondence with which are positioned rotating plates (11) provided with openings (12) whereby the monomer is projected for its deposition on the hydrophilic areas (5) of the nonwoven fabric (2) giving rise to coated hydrophilic areas (13).

What is claimed is:

1. A method of producing a nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas, which comprises projecting plasma on determined sectors of the surface of a nonwoven fabric manufactured with a hydrophobic material, to produce, in those sectors, a geometry of hydrophilic areas and/or partially hydrophilic areas between hydrophobic areas.

2. The method of claim 1, wherein the hydrophobic material is polyolefin.

3. The method according to claim 1, wherein the plasma projection is performed in a vacuum.

4. The method according to claim 1, wherein the plasma projection is performed at atmospheric pressure.

5. The method according to claim 1, further comprising applying a coating to the hydrophilic area or partially hydrophilic area by deposition of a vaporized monomer with functional philic groups after applying the plasma.

6. The method according to claim 5, further comprising performing a curing phase after coating.

7. The method according to claim 1, wherein the nonwoven fabric is polypropylene.

8. The method according to claim 1, wherein the nonwoven fabric is a meltblown fabric.

9. The method according to claim 1, wherein the nonwoven fabric is a spunbond fabric.

10. The method according to claim 1, wherein the nonwoven fabric is a combined spunbond and meltblown fabric.

11. A nonwoven fabric produced with totally or partially hydrophilic areas and hydrophobic areas in accordance with the process described in claim 1.

12. A hygiene or sanitary product comprising a nonwoven fabric with totally or partially hydrophilic areas and hydrophobic areas according to claim 11.

13. The hygiene or sanitary product according to claim 12 which is selected from the group consisting of nappies, incontinence products and feminine hygiene products.

14. The hygiene or sanitary product according to claim 12 which is an absorbent product used in operating theatres.

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